Programming in Visual Basic 2008

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PROGRAMMING IN VISUAL BASIC 2008

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Preface

Visual Basic (VB) has become such a popular programming language for several reasons. VB is easy to learn, which makes it an excellent tool for understanding elementary programming concepts. In addition, it has evolved into such a powerful and popular product that skilled Visual Basic programmers are in demand in the job market.

Visual Basic is fully object-oriented and compatible with many other languages using the .NET Framework. This book incorporates the object-oriented concepts throughout, as well as the syntax and terminology of the language.

Visual Basic is designed to allow the programmer to develop applications that run under Windows and/or in a Web browser without the complexity generally associated with programming. With very little effort, the programmer can design a screen that holds standard elements such as buttons, check boxes, radio buttons, text boxes, and list boxes. Each of these objects operates as expected, producing a "standard" Windows or Web user interface.

About This Text

This textbook is intended for use in an introductory programming course, which assumes no prior knowledge of computer programming. The later chapters are also appropriate for professional programmers who are learning a new language to upgrade their skills.

This text assumes that the student is familiar with the Windows operating environment and can use an Internet browser application.

Approach

This text incorporates the basic concepts of programming, problem solving, programming logic, as well as the design techniques of an object-oriented, event-driven language. VB is a fully object-oriented language, which includes inheritance and polymorphism. Object-oriented programming (OOP) is introduced in Chapter 1, and its features appear in every chapter of the book.

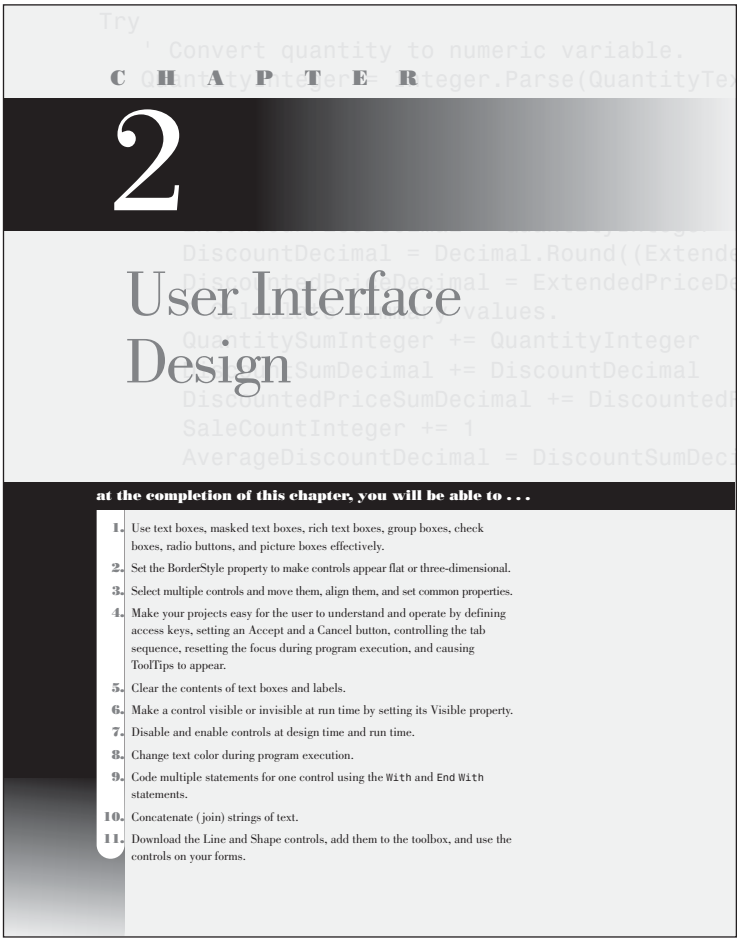
Chapter topics are presented in a sequence that allows the programmer to learn how to deal with a visual interface while acquiring important programming skills such as creating projects with objects, decisions, loops, and data management.

A high priority is given to writing applications that are easy for the user to understand and to use. Students are presented with interface design guidelines throughout the text.

Text Features

Object-Oriented Concepts

are presented throughout the text to offer students an introduction to object-oriented design before learning to create their own classes.



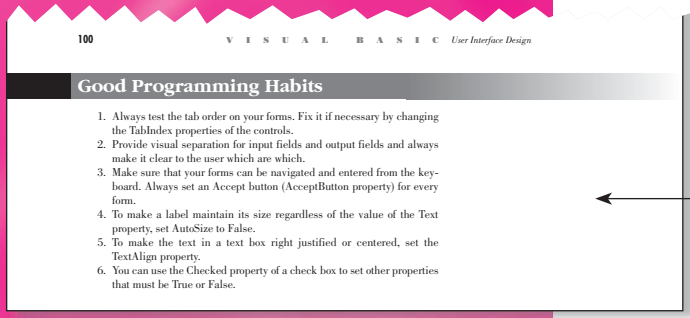
CHAPTER

2

User Interface Design

at the completion of this chapter, you will be able to . . .

1. Use text boxes, masked text boxes, rich text boxes, group boxes, check boxes, radio buttons, and picture boxes effectively.
2. Set the BorderStyle property to make controls appear flat or three-dimensional.
3. Select multiple controls and move them, align them, and set common properties.
4. Make your projects easy for the user to understand and operate by defining access keys, setting an Accept and a Cancel button, controlling the tab sequence, resetting the focus during program execution, and causing ToolTips to appear.
5. Clear the contents of text boxes and labels.
6. Make a control visible or invisible at run time by setting its Visible property.
7. Disable and enable controls at design time and run time.
8. Change text color during program execution.
9. Code multiple statements for one control using the `With` and `End With` statements.
10. Concatenate (join) strings of text.
11. Download the Line and Shape controls, add them to the toolbox, and use the controls on your forms.



100 VISUAL BASIC *User Interface Design*

Good Programming Habits

1. Always test the tab order on your forms. Fix it if necessary by changing the TabIndex properties of the controls.
2. Provide visual separation for input fields and output fields and always make it clear to the user which are which.
3. Make sure that your forms can be navigated and entered from the keyboard. Always set an Accept button (AcceptButton property) for every form.
4. To make a label maintain its size regardless of the value of the Text property, set AutoSize to False.
5. To make the text in a text box right justified or centered, set the TextAlign property.
6. You can use the Checked property of a check box to set other properties that must be True or False.

Interface Guidelines

are presented to offer students a better understanding of meeting user needs and employing industry standards.

Feedback 7.3

1. Identify the statements that are correctly formed and those that have errors. For those with errors, state what is wrong and how to correct it.
   (a)
```
For IndexDecimal = 3.5D To 6.0D, Step 0.5D
    Next IndexDecimal
```
   (b)
```
For IndexInteger = BeginInteger To EndInteger Step IncrementInteger
    Next EndInteger
```
   (c)
```
For 4 = 1 To 10 Step 2
    Next For
```
   (d)
```
For IndexInteger = 100 To 0 Step –25
    Next IndexInteger
```
   (e)
```
For IndexInteger = 0 To –10 Step –1
    Next IndexInteger
```
   (f)
```
For IndexInteger = 10 To 1
    Next IndexInteger
```
2. How many times will the body of the loop be executed for each of these examples? What will be the value of the loop index after normal completion of the loop?
   (a)
```
For CountInteger = 1 To 3
```
   (b)
```
For CountInteger = 2 To 11 Step 3
```
   (c)
```
For CountInteger = 10 To 1 Step –1
```
   (d)
```
For CounterDecimal = 3.0D To 6.0D Step 0.5D
```
   (e)
```
For CountInteger = 5 To 1
```

Making Entries Appear Selected

You can use several techniques to make the text in a text box or list appear selected.

Feedback Questions

give students time to reflect on the current topic and to evaluate their understanding of details.

Tips

in the margins help students avoid potential trouble spots in their programs and encourage them to develop good programming habits.

Fortunately, the Visual Studio smart editor helps you enter the arguments; you don't have to memorize or look up the argument lists. Type "MessageBox.Show(" and IntelliSense pops up with the first of the signatures for the Show method (Figure 3.8). Notice in the figure that there are 21 possible forms of the argument list, or 21 signatures for the Show method. (We only showed 4 of the 21 signatures in the previous example, to simplify the concept.)

To select the signature that you want to use, use the up or down arrows at the left end of the IntelliSense popup. For example, to select the signature that needs only the text of the message and the title bar caption, select the 14th format (Figure 3.9). The argument that you are expected to enter is shown in bold, and a description of that argument appears in the last line of the popup. After you type the text of the message and a comma, the second argument appears in bold and the description changes to tell you about that argument (Figure 3.10).

TIP

You can use the keyboard up and down arrow keys rather than the mouse to view and select the signature. ■

Figure 3.8

IntelliSense pops up the first of 21 signatures for the Show *method. Use the up and down arrows to see the other possible argument lists.*

```
MessageBox.Show(
```

1 of 21 ▾ Show (**text As String**, caption As String, buttons As System.Windows.Forms.MessageBoxButtons,

Feedback 4.2

Assume that FrogsInteger = 10, ToadsInteger = 5, and PolliwogsInteger = 6. What will be displayed for each of the following statements?

1.
```
If FrogsInteger > PolliwogsInteger Then
    FrogsRadioButton.Checked = True
Else
    FrogsRadioButton.Checked = False
End If
```
2.
```
If FrogsInteger > ToadsInteger + PolliwogsInteger Then
    ResultTextBox.Text = "It's the frogs."
Else
    ResultTextBox.Text = "It's the toads and the polliwogs."
End If
```
3.
```
If PolliwogsInteger > ToadsInteger And FrogsInteger <> 0 _
  Or ToadsInteger = 0 Then
    ResultTextBox.Text = "It's true."
Else
    ResultTextBox.Text = "It's false."
End If
```
4. Write the statements necessary to compare the numeric values stored in ApplesTextBox.Text and OrangesTextBox.Text. Display in MostTextBox.Text which has more, the apples or the oranges.
5. Write the Basic statements that will test the current value of BalanceDecimal. When BalanceDecimal is greater than zero, the check box for Funds Available, called FundsCheckBox, should be selected, the BalanceDecimal set back to zero, and CountInteger incremented by one. When BalanceDecimal is zero or less, FundsCheckBox should not be selected (do not change the value of BalanceDecimal or increment the counter).

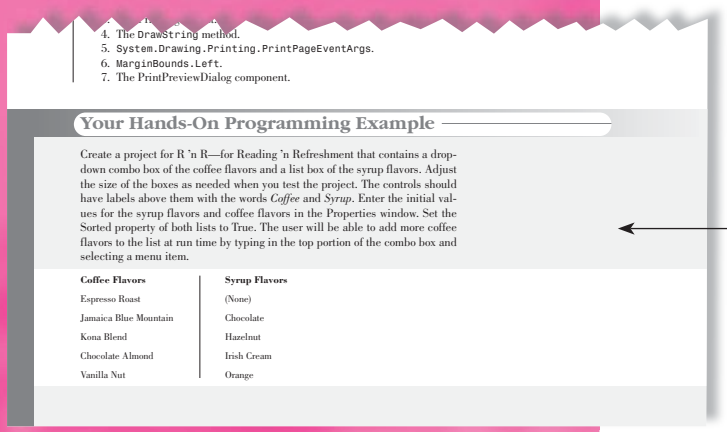
TIP

Indentation can help you catch errors. Visual Basic always matches an `Else` with the last unmatched `If` regardless of the indentation. ■

Using If Statements with Radio Buttons and Check Boxes

In Chapter 2 you used the CheckedChanged event for radio buttons and check boxes to carry out the desired action. Now that you can use If statements, you

Text Features



4. The DrawString method.
5. System.Drawing.Printing.PrintPageEventArgs.
6. MarginBounds.Left.
7. The PrintPreviewDialog component.

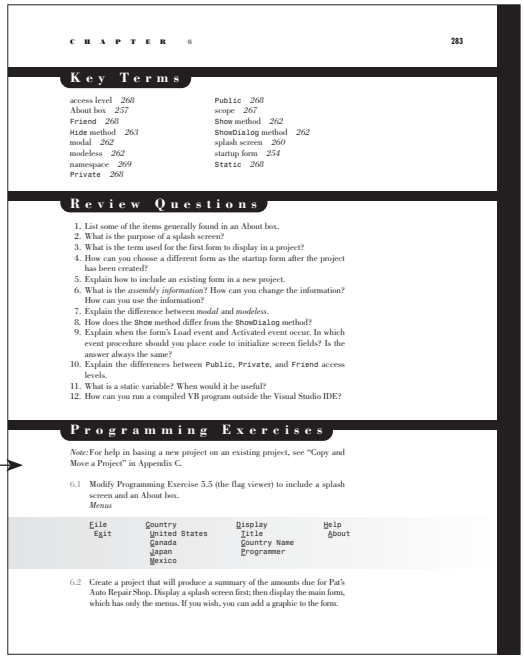
Your Hands-On Programming Example

Create a project for R 'n R—for Reading 'n Refreshment that contains a drop-down combo box of the coffee flavors and a list box of the syrup flavors. Adjust the size of the boxes as needed when you test the project. The controls should have labels above them with the words *Coffee* and *Syrup*. Enter the initial values for the syrup flavors and coffee flavors in the Properties window. Set the Sorted property of both lists to True. The user will be able to add more coffee flavors to the list at run time by typing in the top portion of the combo box and selecting a menu item.

Coffee Flavors	Syrup Flavors
Espresso Roast	(None)
Jamaica Blue Mountain	Chocolate
Kona Blend	Hazelnut
Chocolate Almond	Irish Cream
Vanilla Nut	Orange

Your Hands-On Programming Examples

guide students through the process of planning, writing, and executing Visual Basic programs.



CHAPTER 6 283

Key Terms

access level 268
About box 257
Friend 268
Hide method 263
modal 262
modeless 262
namespace 269
Private 268
Public 268
scope 267
Show method 262
ShowDialog method 262
splash screen 260
startup form 254
Static 268

Review Questions

1. List some of the items generally found in an About box.
2. What is the purpose of a splash screen?
3. What is the term used for the first form to display in a project?
4. How can you choose a different form as the startup form after the project has been created?
5. Explain how to include an existing form in a new project.
6. What is the *assembly information*? How can you change the information? How can you use the information?
7. Explain the difference between *modal* and *modeless*.
8. How does the Show method differ from the ShowDialog method?
9. Explain when the form's Load event and Activated event occur. In which event procedure should you place code to initialize screen fields? Is the answer always the same?
10. Explain the differences between Public, Private, and Friend access levels.
11. What is a static variable? When would it be useful?
12. How can you run a compiled VB program outside the Visual Studio IDE?

Programming Exercises

Note: For help in basing a new project on an existing project, see "Copy and Move a Project" in Appendix C.

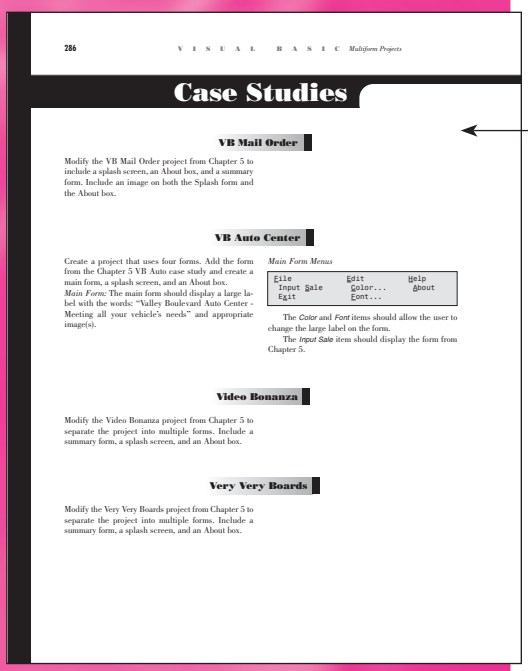
6.1 Modify Programming Exercise 5.5 (the flag viewer) to include a splash screen and an About box.
Menus

File	Country	Display	Help
Exit	United States	Title	About
	Canada	Country Name	
	Japan	Programmer	
	Mexico		

6.2 Create a project that will produce a summary of the amounts due for Pat's Auto Repair Shop. Display a splash screen first; then display the main form, which has only the menus. If you wish, you can add a graphic to the form.

Programming Exercises

test students' understanding of the specific programming skills covered in that chapter.



286 VISUAL BASIC *Multiform Projects*

Case Studies

VB Mail Order

Modify the VB Mail Order project from Chapter 5 to include a splash screen, an About box, and a summary form. Include an image on both the Splash form and the About box.

VB Auto Center

Create a project that uses four forms. Add the form from the Chapter 5 VB Auto case study and create a main form, a splash screen, and an About box.
Main Form: The main form should display a large label with the words: "Valley Boulevard Auto Center - Meeting all your vehicle's needs" and appropriate image(s).

Main Form Menus

File	Edit	Help
Input Sale	Color...	About
Exit	Font...	

The *Color* and *Font* items should allow the user to change the large label on the form.
The *Input Sale* item should display the form from Chapter 5.

Video Bonanza

Modify the Video Bonanza project from Chapter 5 to separate the project into multiple forms. Include a summary form, a splash screen, and an About box.

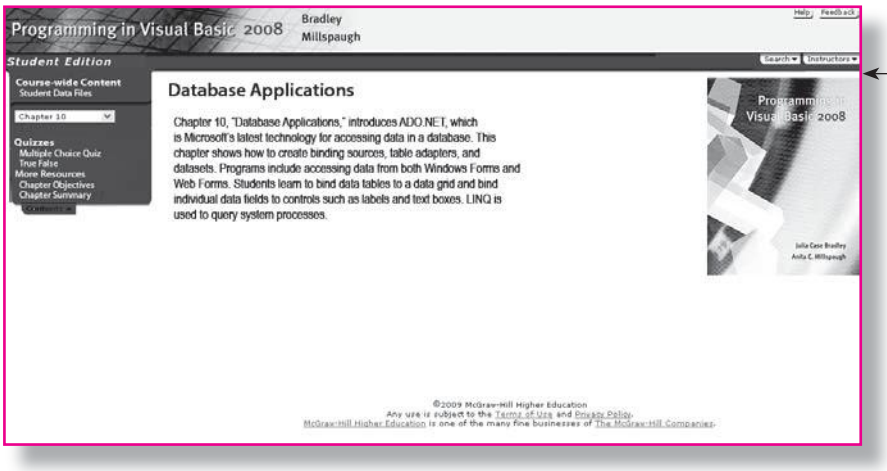
Very Very Boards

Modify the Very Very Boards project from Chapter 5 to separate the project into multiple forms. Include a summary form, a splash screen, and an About box.

Case Studies

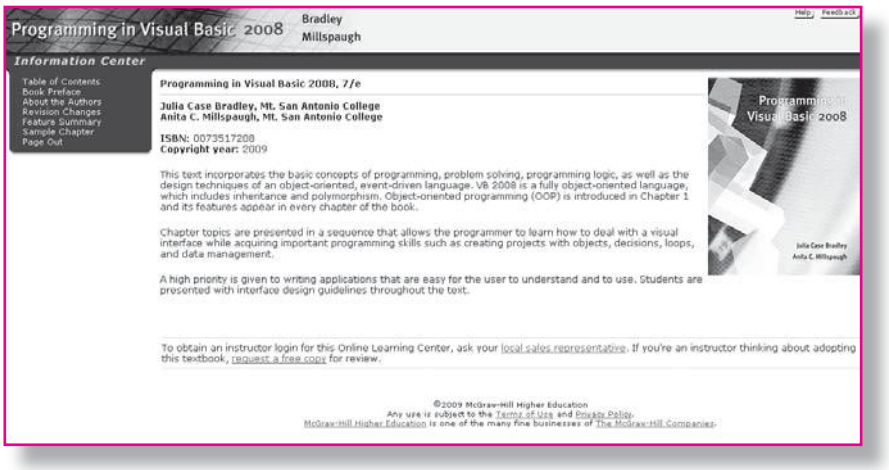
provide continuing-theme exercises that may be used throughout the course, providing many opportunities to expand on previous projects.

For the Student



Student Data

available on the text's Web site offers a debugging project, database files for the programming exercises and case studies, graphics, and sound files.

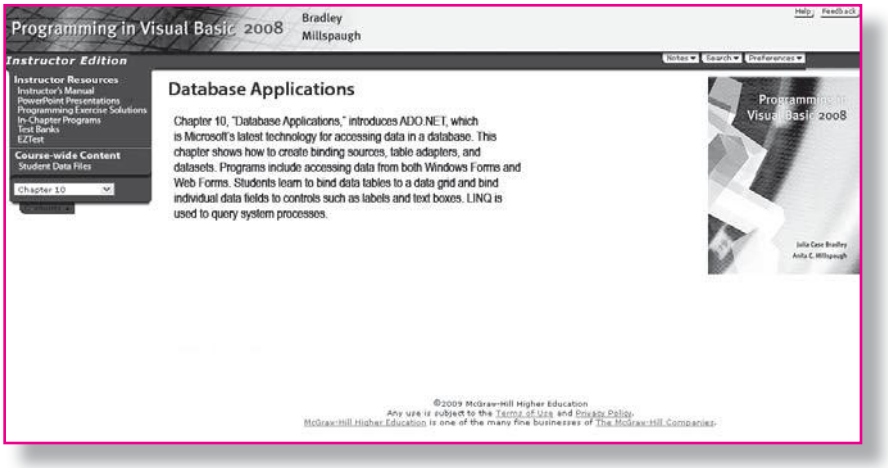


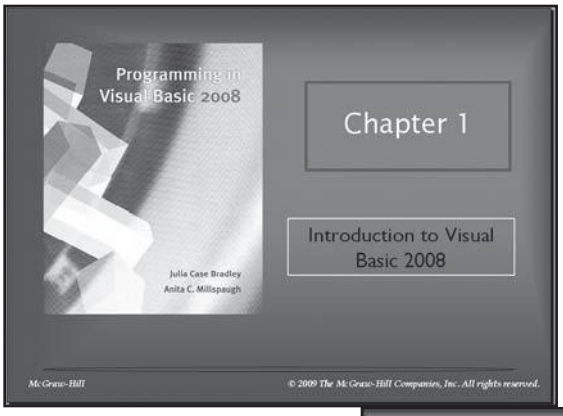
Visit the **VISUAL BASIC 2008** Web site at:
http://www.mhhe.com/VB2008/ for
instructor and student resources.

For the Instructor

Instructor Web Site

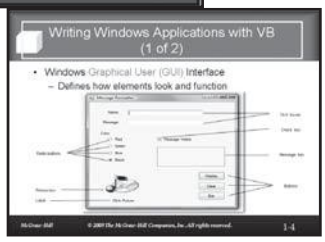
includes: Instructor Manual with teaching hints, outlines, and a matrix of the chapter features required for each programming exercise; PowerPoint Slides; Testing Files (using EZ Test and in Word files); as well as Solutions to End-of-Chapter Exercises.

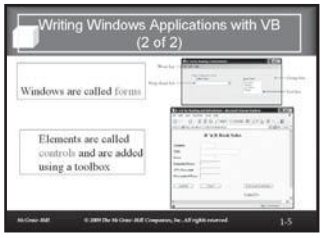




PowerPoint Presentations

provide instructors with complete, detailed presentations that walk students through the important concepts covered in each chapter.





Visit the **VISUAL BASIC 2008** Web site at:
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instructor and student resources.

Changes in This Edition

This revision of the text is based on the Professional Edition of Visual Basic 2008. The 2008 version of VB includes Language Integrated Queries (LINQ) for a more consistent means of querying a variety of data sources. XML literals make it easier to read and write XML files. The Windows Presentation Foundation (WPF) brings new dimensions to interface design.

The Editor now has a much richer IntelliSense that makes it unnecessary to use the `Me` keyword in most instances.

This version now contains a PrintForm control that is very convenient for the classroom environment. The PrintForm is covered in Chapter 1 for output to either the printer or a Print Preview. Standard printing is still covered in Chapter 7.

LINQ is covered in Chapter 10 ("Database Applications") and again in the XML section of Chapter 14.

Chapter 11 ("Data Files") includes a method for writing small amounts of data using the My object.

Drag-and-drop for images is now covered in the graphics chapter (Chapter 13). Students learn the development techniques for this familiar operation.

Chapter 14 includes XML data files and an introduction to programming with WPF.

The narrative, step-by-step exercises, screen captures, and appendices have all been updated to VB 2008. The screen captures are all based on Windows Vista.

Changes to coding conventions include the use of Pascal casing for variable identifiers.

Features of This Text

Each chapter begins with identifiable objectives and a brief overview. Numerous coding examples as well as hands-on projects with guidance for the planning and coding appear throughout. Thought-provoking feedback questions give students time to reflect on the current topic and to evaluate their understanding of the details. The end-of-chapter items include a chapter review, questions, programming exercises, and four case studies.

Chapter 1, "Introduction to Visual Basic 2008," introduces Microsoft's Visual Studio integrated development environment (IDE). The single environment is used for multiple programming languages. A step-by-step program gets students into programming very quickly (quicker than most books). The PrintForm control is included to allow students to easily submit screen captures of the form at run time. The chapter introduces the OOP concepts of objects, properties, methods, and events. The elements of debugging and using the Help system are also introduced.

Chapter 2, "User Interface Design," demonstrates techniques for good program design, including making the interface easy for users as well as guidelines for designing maintainable programs. Several controls are introduced, including text boxes, rich text boxes, masked text boxes, group boxes, check boxes, radio buttons, picture boxes, and the new Shape and Line controls.

***Chapter 3*, "*Variables, Constants, and Calculations*,"** presents the concepts of using data and declaring the data type. Students learn to follow standards to indicate the data type and scope of variables and constants and always to use Option Strict, which forces adherence to strong data typing.

Error handling is accomplished using structured exception handling. The `Try/Catch/Finally` structure is introduced in this chapter along with calculations. The student learns to display error messages using the MessageBox class and also learns about the OOP concept of overloaded constructors.

***Chapter 4*, "*Decisions and Conditions*,"** introduces taking alternate actions based on expressions formed with the relational and logical operators. This chapter uses the `If` statement to validate input data. Multiple decisions are handled with both nested `If` statements and the `Select Case` structure.

The debugging features of the IDE are covered, including a step-by-step exercise that covers stepping through program statements and checking intermediate values during execution.

***Chapter 5*, "*Menus, Common Dialog Boxes, Sub Procedures, and Function Procedures*,"** covers the concepts of writing and calling general sub procedures and function procedures. Students learn to include both menus and context menus in projects, display the Windows common dialog boxes, and use the input provided by the user.

***Chapter 6*, "*Multiform Projects*,"** adds splash forms and About forms to a project. Summary data are presented on a separate form. The `Friend` keyword is introduced.

***Chapter 7*, "*Lists, Loops, and Printing*,"** incorporates list boxes and combo boxes into projects, providing the opportunity to discuss looping procedures and printing lists of information. Printing is accomplished in .NET using a graphics object and a callback event. The printing controls also include a Print Preview, which allows students and instructors to view output without actually printing it.

***Chapter 8*, "*Arrays*,"** introduces arrays, which follow logically from the lists covered in Chapter 7. Students learn to use single- and multidimension arrays, table lookups, and arrays of structures.

***Chapter 9*, "*Web Applications*,"** introduces Web applications using Web Forms. Students learn to design and develop simple Web applications that consist of Web pages that execute in a browser application. Multiple-page Web sites are covered along with validator controls and an introduction to state management.

***Chapter 10*, "*Database Applications*,"** introduces ADO.NET, which is Microsoft's latest technology for accessing data in a database. This chapter shows how to create binding sources, table adapters, and datasets. Programs include accessing data from both Windows Forms and Web Forms. Students learn to bind data tables to a data grid and bind individual data fields to controls such as labels and text boxes. LINQ is used to query system processes.

***Chapter 11*, "*Data Files*,"** presents the VB object-oriented techniques for data file handling. Students learn to save and read small amounts of data using the My object and using streams. The StreamWriter and StreamReader objects are used to store and reload the contents of a combo box.

***Chapter 12*, "*OOP: Creating Object-Oriented Programs*,"** explains more of the theory of object-oriented programming. Although we have been using OOP concepts since Chapter 1, in this chapter students learn the terminology and application of OOP. Inheritance is covered for visual objects (forms) and for extending existing classes. The samples are kept simple enough for an introductory class.

***Chapter 13*, "*Graphics*, *Animation*, *Sound*, *and Drag-and-Drop*,"** covers the classes and methods of GDI+. The chapter covers graphics objects, pens, and brushes for drawing shapes and lines. Animation is accomplished using the Timer control and the `SetBounds` method for moving controls. My.Computer.Audio.Play is used to provide sound, and drag-and-drop events are used to transfer the contents of a text box to a list box and to move images.

***Chapter 14*, "*Additional Topics in Visual Basic*,"** introduces some advanced VB topics. This final chapter covers validating user input using Error Providers and the Validating event of controls. Students learn to create applications using multiple document interfaces (MDI), create toolbars and status bars using ToolStrip and StatusStrip controls, and add Web content to a Windows Form using the WebBrowser control. The code snippet feature is introduced. Reading and writing XML text files is covered using the new XML literals and using LINQ.

An introduction to Windows Presentation Foundation (WPF) includes using WPF interoperability with a standard Windows Form and creating a WPF Form project.

The appendices offer important additional material. Appendix A holds the answers to all Feedback questions. Appendix B covers methods and functions for math, string handling, and date manipulation. In OOP style, most actions that were formerly done with functions are now accomplished with methods of the Math class and String class.

Appendix C, on mastering the Visual Studio environment, is based on the .NET IDE and includes instructions for using snap lines for form design. Appendix D discusses security issues for both Windows and Web programming.

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Many people have worked very hard to design and produce this text. We would like to thank our editors, Scott Davidson and Alaina Grayson. Our thanks also to the many people who produced this text, including Marlena Pechan, Becky Komro, and Betsy Blumenthal.

We greatly appreciate Theresa Berry of Mt. San Antonio College and Peter van der Goes of Rose State College for their thorough technical reviews, constructive criticism, and many valuable suggestions. We would like to thank Brenda Nielsen of Mesa Community College for her work in creating the PowerPoint Presentations that accompany this text and to Theresa Berry for the Instructor's Manual and Test Bank. And most importantly, we are grateful to Dennis and Richard for their support and understanding through the long days and busy phone lines.

The Authors

We have had fun teaching and writing about Visual Basic. We hope that this feeling is evident as you read this book and that you will enjoy learning or teaching this outstanding programming language.

Julia Case Bradley
Anita C. Millspaugh

To the Student

The best way to learn to program in Visual Basic is to do it. If you enter and run the sample projects, you will be on your way to writing applications. Reading the examples without trying to run them is like trying to learn a foreign language or mathematics by just reading about it. Enter the projects, look up your questions in the extensive MSDN Help files, and make those projects *run*.

Installing Visual Basic

For the programs in this text, you need to install the .NET Framework, Visual Basic, and the MSDN (Microsoft Developers Network) library, which contains all of Help and many instructive articles. You do not need to install C++ or C#.

You can download the Express Edition of Visual Basic and Visual Web Developer from msdn.microsoft.com/express. Using these two products, you can complete most of the exercises in this text.

Format Used for Visual Basic Statements

Visual Basic statements, methods, and functions are shown in `this font`. Any values that you must supply are in *`italics`*. Optional items are in [square brackets]. Braces and a vertical bar indicate that you must choose one or the other value `{one | other}`.

Examples

```
Const Identifier [As Datatype] = Value
Do {While | Until} Condition
```

As you work your way through this textbook, note that you may see a subset of the available options for a Visual Basic statement or method. Generally, the options that are included reflect those covered in the chapter. If you want to see the complete format for any statement or all versions of a method, refer to Help.

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A.C.M.

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Brief Contents

Chapter 1
Introduction to Visual Basic 2008 1

Chapter 2
User Interface Design 67

Chapter 3
Variables, Constants, and Calculations 109

Chapter 4
Decisions and Conditions 159

Chapter 5
Menus, Common Dialog Boxes, Sub Procedures, and Function Procedures 213

Chapter 6
Multiform Projects 253

Chapter 7
Lists, Loops, and Printing 287

Chapter 8
Arrays 329

Chapter 9
Web Applications 361

Chapter 10
Database Applications 401

Chapter 11
Data Files 439

Chapter 12
OOP: Creating Object-Oriented Programs 469

Chapter 13
Graphics, Animation, Sound, and Drag-and-Drop 525

Chapter 14
Additional Topics in Visual Basic 561

Appendix A
Answers to Feedback Questions 607

Appendix B
Methods and Functions for Working with Dates, Financial Calculations, Mathematics, and String Operations 621

Appendix C
Tips and Shortcuts for Mastering the Environment 635

Appendix D
Security 647

Glossary 651

Index 662

Contents

1 Introduction to Visual Basic 2008 1

Writing Windows Applications with Visual Basic 2
The Windows Graphical User Interface 3

Programming Languages—Procedural, Event Driven, and Object Oriented 3
The Object Model 4
Microsoft's Visual Studio 5

Writing Visual Basic Projects 6
The Three-Step Process 6
Visual Basic Application Files 7

The Visual Studio Environment 8
Default Environment Settings 8
The IDE Initial Screen 9
The New Project Dialog 9
The IDE Main Window 11
The Toolbars 12
The Document Window 12
The Form Designer 13
The Solution Explorer Window 13
The Properties Window 13
The Toolbox 13
Help 13
Design Time, Run Time, and Debug Time 14

Writing Your First Visual Basic Project 14
Set Up Your Workspace 14
Plan the Project 18
Define the User Interface 19
Set Properties 23
Write Code 29
Visual Basic Code Statements 30
Code the Event Procedures for Hello World 32
Run the Project 35
Save Your Work 36
Open the Project 37
Modify the Project 38
Print the Code 45

A Sample Printout 45

Finding and Fixing Errors 46
Syntax Errors 46
Run-Time Errors 49
Logic Errors 49
Project Debugging 50
Naming Rules and Conventions for Objects 50

Visual Studio Help 51
Installing and Running MSDN 52
Viewing Help Topics 52
Context-Sensitive Help 55
Managing Windows 55

Your Hands-On Programming Example 56

2 User Interface Design 67

Introducing More Controls 68
Text Boxes 69
Masked Text Boxes 70
Rich Text Boxes 71
Displaying Text on Multiple Lines 71
Group Boxes 72
Check Boxes 73
Radio Buttons 73
Picture Boxes 73
Using Smart Tags 76
Using Images for Forms and Controls 77
Setting a Border and Style 77
Drawing a Line 77

Working with Multiple Controls 78
Selecting Multiple Controls 78
Deselecting a Group of Controls 79
Moving Controls as a Group 79
Setting Properties for Multiple Controls 79
Aligning Controls 80

Designing Your Applications for User Convenience 80
Designing the User Interface 80
Defining Keyboard Access Keys 81
Setting the Accept and Cancel Buttons 82
Setting the Tab Order for Controls 82
Setting the Form's Location on the Screen 84
Creating ToolTips 85

Coding for the Controls 87
Clearing Text Boxes and Labels 87
Resetting the Focus 87
Setting the Checked Property of Radio Buttons and Check Boxes 88
Setting Visibility at Run Time 88
Disabling Controls 89
Setting Properties Based on User Actions 89
Changing the Color of Text 90
Using Radio Buttons for Selecting Colors 90
Changing Multiple Properties of a Control 92
Concatenating Text 93
Continuing Long Program Lines 93
Downloading and Using the Line and Shape Controls 93

Your Hands-On Programming Example 95

Good Programming Habits 100

3 Variables, Constants, and Calculations 109

Data—Variables and Constants 110
Data Types 111
Naming Rules 112
Naming Conventions 112
Constants: Named and Intrinsic 113
Declaring Variables 115
Scope and Lifetime of Variables 117

Calculations 120
Converting Strings to a Numeric Data Type 120
Arithmetic Operations 122
Order of Operations 123
Using Calculations in Code 124
Option Explicit and Option Strict 125
Converting between Numeric Data Types 127
Performing Calculations with Unlike Data Types 128
Rounding Numbers 129

Formatting Data for Display 130
Using Format Specifier Codes 130
Choosing the Controls for Program Output 132

A Calculation Programming Example 133
Planning the Project 133
The Project Coding Solution 136

Handling Exceptions 137
Try/Catch Blocks 138

Displaying Messages in Message Boxes 140
The TextMessage String 141
The Titlebar Text 141
MessageBoxButtons 141
MessageBoxIcon 141
Using Overloaded Methods 141
Testing Multiple Fields 143

Counting and Accumulating Sums 144
Summing Numbers 145
Counting 145
Calculating an Average 145

Your Hands-On Programming Example 145

4 Decisions and Conditions 159

If Statements 160
Charting If Statements 162
The Helpful Editor 162

Boolean Expressions 163
Comparing Numeric Variables and Constants 163
Comparing Strings 164
Testing for True or False 166
Comparing Uppercase and Lowercase Characters 166
Compound Boolean Expression 167
Short-Circuit Operations 169

Nested If Statements 169

Using If Statements with Radio Buttons and Check Boxes 172
A "Simple Sample" 174
Checking the State of a Radio Button Group 174
Checking the State of Multiple Check Boxes 175

Enhancing Message Boxes 175
Displaying the Message String 175
Displaying Multiple Buttons 177

Input Validation 179
Checking for a Range of Values 179
Checking for a Required Field 179
Performing Multiple Validations 180

The Case Structure 181

Sharing an Event Procedure 183

Calling Event Procedures 185

Your Hands-On Programming Example 187

Debugging Visual Basic Projects 193
Writing Debug Output 194
Pausing Execution with the Break All Button 195
Forcing a Break 195
Checking the Current Values of Expressions 196
Stepping through Code 196
The Locals Window 198
The Autos Window 198

Debugging Step-by-Step Tutorial 199

5 Menus, Common Dialog Boxes, Sub Procedures, and Function Procedures 213

Menus 214
Defining Menus 214
Creating a Menu—Step-by-Step 219
Coding for Menu Items 220
Standards for Windows Menus 222

Common Dialog Boxes 223
Displaying a Windows Common Dialog Box 223
Using the Information from the Dialog Box 224
Setting Initial Values 226

Creating Context Menus 226
Creating a Context Menu—Step-by-Step 227
Sharing Procedures 228

Writing General Procedures 229
Creating a New Sub Procedure 229
Passing Arguments to Procedures 230
Writing Function Procedures 231
Functions with Multiple Parameters 234
Breaking Calculations into Smaller Units 235

Basing a New Project on an Existing Project 237

Your Hands-On Programming Example 238

6 Multiform Projects 253

Using Multiple Forms 254
Creating New Forms 254
Adding and Removing Forms 256

An About Box 257
Using the About Box Template 257
Setting Assembly Information 257

A Splash Screen 260
Using the Splash Screen Template 260
Making the Splash Form Display First 261
Other Template Forms 262

Using the Methods and Events of Forms 262
Showing a Form 262
Hiding or Closing a Form 263
Responding to Form Events 264
The Sequence of Form Events 264
Writing Event Procedures for Selected Events 264
Holding the Splash Screen Display 267

Variables and Constants in Multiform Projects 267
Scope 267
Access Level 268
Lifetime 268
Namespaces 269
Declaration Summary for Variables and Constants 270
Guidelines for Declaring Variables and Constants 270

Running Your Program Outside the IDE 271

Your Hands-On Programming Example 272

5 Lists, Loops, and Printing 287

List Boxes and Combo Boxes 288
The Items Collection 289
Filling a List 289
The SelectedIndex Property 292
The Items.Count Property 292
Referencing the Items Collection 292
Removing an Item from a List 293
Clearing a List 294
List Box and Combo Box Events 295

Do/Loops 296
The Boolean Data Type Revisited 298
Using a Do/Loop with a List Box 298

For/Next Loops 299
Negative Increment or Counting Backward 301
Conditions Satisfied before Entry 301
Altering the Values of the Loop Control Variables 301
Endless Loops 302
Exiting Loops 302
Skipping to the Next Iteration of a Loop 303

Making Entries Appear Selected 304
Selecting the Entry in a Text Box 304
Selecting an Entry in a List Box 305

Sending Information to the Printer 305
The PrintDocument Component 306
Getting Started with Printing—Step-by-Step 308
Printing Summary 310
Printing the Contents of a List Box 310
Printing the Selected Item from a List 310
Aligning Decimal Columns 310
Displaying a Print Preview 311
Adding a PrintPreview Dialog to the Print Project—Step-by-Step 312
The Using Block 313
Printing Multiple Pages 313

Your Hands-On Programming Example 314

8 Arrays 329

Single-Dimension Arrays 330
Subscripts 330
Valid Subscripts 331

For Each/Next Statements 332

Structures 333
Declaring Variables Based on a Structure 334
Accessing the Elements in a Structure Variable 334
Including an Array in a Structure 334

Using Array Elements for Accumulators 335
Adding to the Correct Total 335
Debugging Array Programs 337

Table Lookup 337
Coding a Table Lookup 338

Using List Boxes with Arrays 340

Multidimensional Arrays 341
Initializing Two-Dimensional Arrays 343
Printing a Two-Dimensional Table 343
Summing a Two-Dimensional Table 344
Lookup Operation for Two-Dimensional Tables 345

Your Hands-On Programming Example 347

9 Web Applications 361

Visual Basic and Web Programming 362
Client/Server Web Applications 362

Types of Web Sites 364
File System Web Sites 364
IIS Web Sites 364
Remote Sites and FTP Sites 365

Creating a Web Site 365
Web Page Files 365
Web Forms in the Visual Studio IDE 366
Creating Your First Web Form—Step-by-Step 367
Viewing the HTML Code 369
Controls 369
Event Handling 370
Files 371
Debugging 371
Testing in Other Browsers 372

Laying Out Web Forms 373
Using Tables for Layout 373
Absolute Positioning 375
Including Images on Web Pages 376
Cascading Style Sheets 378

Navigating Web Pages 383
Using Hyperlinks 383
Adding a Second Web Page 383

Using the Validator Controls 385

Maintaining State 386
Retaining the Contents of Controls 386
Retaining the Values of Variables 387

AJAX 388

Managing Web Projects 389
Using the Copy Web Site Tool 390

Some Web Acronyms 390

Your Hands-On Programming Example 390

10 Database Applications 401

Databases 402
Visual Basic and Databases 402
Database Terminology 402
XML Data 403

Using ADO.NET and Visual Basic 404
Data Access in Visual Studio 405
Binding Sources 406
Table Adapters 406
Datasets 406

Creating a Database Application 407
A Windows Database Application—Step-by-Step 407
The Smart Tag 412
The Database Schema File 412

Binding Individual Data Fields 413
The Data Sources Window 413
Database Details Program—Step-by-Step 415

Selecting Records from a List 417
Converting to Combo Box Selection—Step-by-Step 417
Selecting Fields from the Table 420
Sorting the List Data 421
Choosing the Control Type for Fields 421

Selecting Records Using Web Forms 423
Security in Web Database Applications 424
Creating the Web Selection Application—Step-by-Step 424

LINQ 431
Querying Operating System Data 431
Creating a LINQ Project—Step-by-Step 431
A FileSystem LINQ Example 432

Your Hands-On Programming Example 434

11 Data Files 439

Data Files 440

Simple VB File I/O 440
Writing and Reading Text Files 441

Writing and Reading Delimited Files 441

.NET File Handling 447
File Handling Using Streams 447
Writing Data in a File Using a StreamWriter 447
Reading Data from a File Using a StreamReader 449

Using the File Common Dialog Box 452
OpenFileDialog Component Properties 452
Displaying the Open File Dialog Box 453
The Open and Write File Program 455

Saving the Contents of a List Box 456
Loading the List Box 457
Checking for Existence of the File 457
Saving the File 458
Querying the User to Save 459
The FormClosing Event Procedure 459

XML Files 460

Your Hands-On Programming Example 460

12 OOP: Creating Object-Oriented Programs 469

Object-Oriented Programming 470
Objects 470
Object-Oriented Terminology 471
Reusable Classes 473
Multitier Applications 473

Classes 474
Designing Your Own Class 474
Creating Properties in a Class 475
Class Methods 476
Constructors and Destructors 477
Creating a New Class—Step-by-Step 478
Property Procedures with Mixed Access Levels 483

Creating a New Object Using a Class 484
Defining and Using a New Object—Step-by-Step 485
Instance Variables versus Shared Variables 487
Adding Shared Properties to the Step-by-Step Exercise 489
Destructors 490
Garbage Collection 491

Inheritance 491
Inheriting Properties and Methods 491
Constructors in Inheritance 491
Overriding Methods 492
Accessing Properties 493
Creating a Derived Class Based on BookSale 493
Adding Inheritance to the Step-by-Step Exercise 494
Creating a Base Class Strictly for Inheritance 497
Inheriting Form Classes 497

Passing Properties between Forms 501
Passing Values to a Summary Form 501
Passing Objects as Properties 503

Managing Multiclass Projects 504
Adding an Existing Class File to a Project 504

Using the Object Browser 504
Examining VB Classes 506
Examining Your Own Classes 507

Your Hands-On Programming Example 507

13 Graphics, Animation, Sound, and Drag-and-Drop 525

Graphics in Windows and the Web 526

The Graphics Environment 526
Steps for Drawing Graphics 526
The Paint Event Procedure 527
Pen and Brush Objects 527
The Coordinate System 529
Graphics Methods 530

Random Numbers 532

Simple Animation 534
Displaying an Animated Graphic 534
Controlling Pictures at Run Time 534
Moving a Picture 537

The Timer Component 537

The Scroll Bar Controls 539
Scroll Bar Properties 539
Scroll Bar Events 541
A Programming Example 541

Playing Sounds 543
Adding Sound Files to the Resources for a Project 543
A Sound-Playing Program 543

Playing Videos 545
Using the Windows Media Player Control 545

Drag-and-Drop Programming 547
The Source Object 547
The Target Object 548
The Drag-and-Drop Program 549
Dragging and Dropping an Image 550

Your Hands-On Programming Example 552

11 Additional Topics in Visual Basic 561

Advanced Validation Techniques 562
The ErrorProvider Component 562
The MaxLength and CharacterCasing Properties 565
Field-Level Validation 566
Capturing Keystrokes from the User 569
Using the Masked Text Box for Validation 570

Code Snippets and Samples 570
Code Snippets 570
Sample Projects 571

Multiple Document Interface 571
Creating an MDI Project 572
Adding a Window Menu 573

Toolbars and Status Bars 575
Toolbars 575
Status Bars 577

Some Helpful Date Controls 578
The Calendar Controls 578

Displaying Web Pages on a Windows Form 581
The WebBrowser Control 581
A WebBrowser Program 582
Checking for the Enter Key 583

XML Data Files 584
Nodes, Elements, and Attributes 584
VB Tools for Reading XML Files 585
Writing and Reading an XML File 591

Windows Presentation Foundation (WPF) 593
WPF Interoperability 593
Adding a WPF Control to a Windows Form—Step-by-Step 597
Writing a WPF Application 597
Creating a WPF Hello World Application—Step-by-Step 599
The Role of Expression Blend 601

A Answers to Feedback Questions 607

B Methods and Functions for Working with Dates, Financial Calculations, Mathematics, and String Operations 621

Working with Dates 622
The DateTime Structure 622
Retrieving the System Date and Time 623
Date Variables 624
Converting Values to a Date Format 625
Finding the Difference between Dates 625
Checking for the Day of the Week 625

Financial Functions 626
The Pmt Function 626
The Rate Function 627
Functions to Calculate Depreciation 628

Mathematical Functions 628

Working with Strings 630

Methods for Conversion between Data Types 632

Functions for Checking Validity 633

Functions for Formatting Output 634

C Tips and Shortcuts for Mastering the Environment 635

Set Up the Screen for Your Convenience 636

Close or Hide Extra Windows 636
Use the Full Screen 638
Modify the Screen Layout 639
Split the Screen Vertically 640
Reset the IDE Layout 640
Set Options for Your Work 640

Use Shortcuts in the Form Designer 641

Use the Layout Toolbar 641
Nudge Controls into Place 641
Use Snap Lines to Help Align Controls 641

Use Shortcuts in the Editor 642

Use the Text Editor Toolbar 643
Use Keyboard Shortcuts When Editing Code 643
Split the Editor Window 644
Use Drag-and-Drop Editing 645
Drag Commonly Used Code to the Toolbox 645
Rename Variables and Objects 645

Use Context-Sensitive Help 645

Copy and Move Projects 646

Copy and Move a Project 646

Deploy Applications 646

D Security 647

Authentication and Authorization 648

Authorization and Impersonation 648

Writing Secure Code 649

SQL Injection 649
Error Messages 649

Code Access Security 649

Glossary 651

Index 662

CHAPTER

1

Introduction to Visual Basic 2008

at the completion of this chapter, you will be able to . . .

1. Describe the process of visual program design and development.
2. Explain the term *object-oriented programming*.
3. Explain the concepts of classes, objects, properties, methods, and events.
4. List and describe the three steps for writing a Visual Basic project.
5. Describe the various files that make up a Visual Basic project.
6. Identify the elements in the Visual Studio environment.
7. Define design time, run time, and debug time.
8. Write, run, save, print, and modify your first Visual Basic project.
9. Identify syntax errors, run-time errors, and logic errors.
10. Use AutoCorrect to correct syntax errors.
11. Look up Visual Basic topics in Help.

Writing Windows Applications with Visual Basic

Using this text, you will learn to write computer programs that run in the Microsoft Windows environment. Your projects will look and act like standard Windows programs. You will use the tools in Visual Basic (VB) and Windows Forms to create windows with familiar elements such as labels, text boxes, buttons, radio buttons, check boxes, list boxes, menus, and scroll bars. Figure 1.1 shows some sample Windows user interfaces.

Beginning in Chapter 9, you will create programs using Web Forms and Visual Web Developer. You can run Web applications in a browser such as

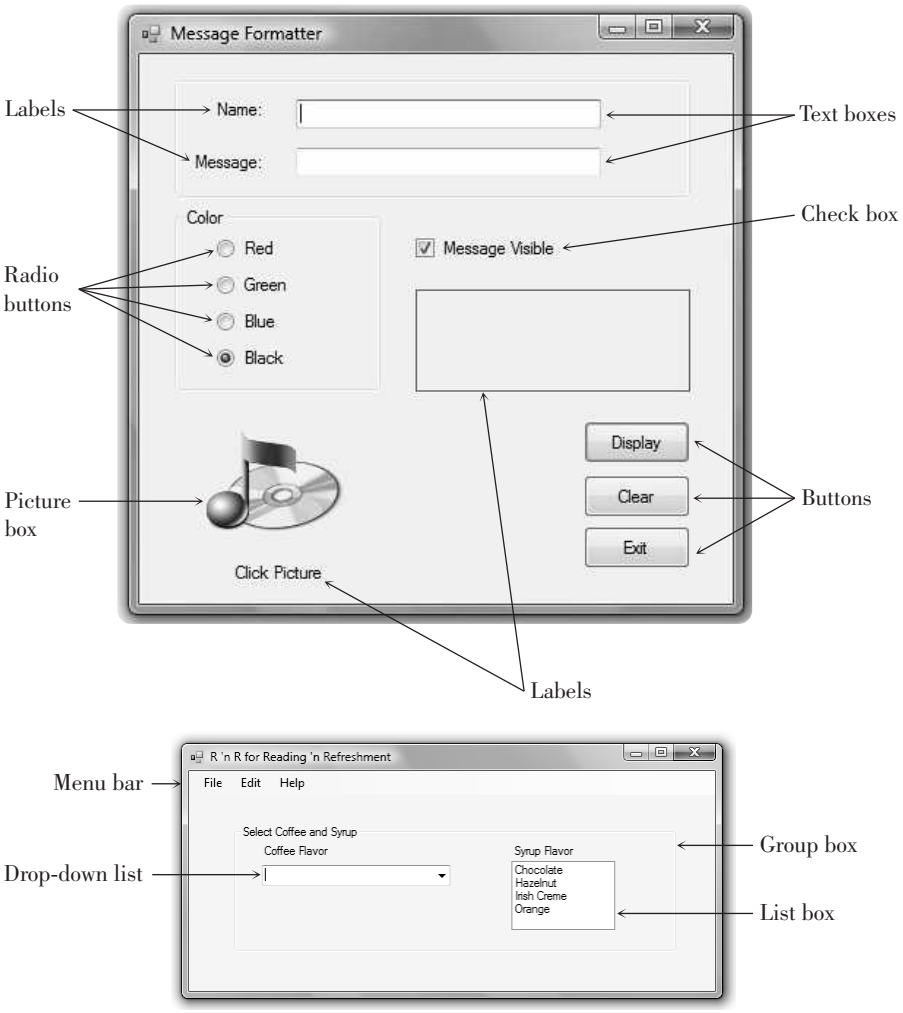


Figure 1.1

Graphical user interfaces for application programs designed with Visual Basic and Windows Forms.

Internet Explorer or Mozilla FireFox, on the Internet, or on a company intranet. Figure 1.2 shows a Web Form application.

You also will become acquainted with Microsoft's new screen design technology, Windows Presentation Foundation (WPF), which is covered in Chapter 14. WPF uses its own designer and design elements, which are different from those used for Windows forms.

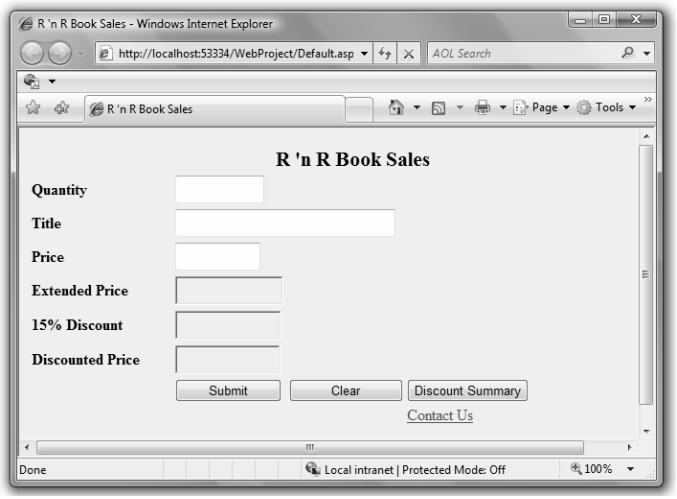


Figure 1.2

A Web Form application created with Visual Web Developer, running in a browser.

The Windows Graphical User Interface

Microsoft Windows uses a **graphical user interface**, or **GUI** (pronounced "gooey"). The Windows GUI defines how the various elements look and function. As a Visual Basic programmer, you have available a toolbox of these elements. You will create new windows, called ***forms***. Then you will use the toolbox to add the various elements, called ***controls***. The projects that you will write follow a programming technique called ***object-oriented programming (OOP)***.

Programming Languages—Procedural, Event Driven, and Object Oriented

There are literally hundreds of programming languages. Each was developed to solve a particular type of problem. Most traditional languages, such as BASIC, C, COBOL, FORTRAN, PL/I, and Pascal, are considered *procedural* languages. That is, the program specifies the exact sequence of all operations. Program logic determines the next instruction to execute in response to conditions and user requests.

The newer programming languages, such as Visual Basic, C#, and Java, use a different approach: object-oriented programming. As a stepping stone between procedural programming and object-oriented programming, the early versions of Visual Basic provided many (but not all) elements of an object-oriented language. For that reason, Microsoft referred to Visual Basic (version 6 and earlier) as an event-driven programming language rather than an object-oriented language. But with Visual Studio, which includes Visual Basic, C#, and F#, we have programming languages that are truly object oriented. (Another language, C++, has elements of OOP and of procedural programming and doesn't conform fully to either paradigm.) F#, introduced in 2007, applies the object-oriented paradigm to scripting languages for cross-platform development.

In the OOP model, programs are no longer procedural. They do not follow a sequential logic. You, as the programmer, do not take control and determine the sequence of execution. Instead, the user can press keys and click various buttons and boxes in a window. Each user action can cause an event to occur, which triggers a Basic procedure that you have written. For example, the user clicks on a button labeled Calculate. The clicking causes the button's Click event to occur, and the program automatically jumps to a procedure you have written to do the calculation.

The Object Model

In Visual Basic you will work with **objects**, which have **properties**, **methods**, and **events**. Each object is based on a **class**.

Objects

Think of an object as a thing, or a noun. Examples of objects are forms and controls. *Forms* are the windows and dialog boxes you place on the screen; *controls* are the components you place inside a form, such as text boxes, buttons, and list boxes.

Properties

Properties tell something about or control the behavior of an object, such as its name, color, size, or location. You can think of properties as adjectives that describe objects.

When you refer to a property, you first name the object, add a period, and then name the property. For example, refer to the Text property of a form called SalesForm as SalesForm.Text (pronounced "sales form dot text").

Methods

Actions associated with objects are called *methods*. Methods are the verbs of object-oriented programming. Some typical methods are `Close`, `Show`, and `Clear`. Each of the predefined objects has a set of methods that you can use. You will learn to write additional methods to perform actions in your programs.

You refer to methods as Object.Method ("object dot method"). For example, a `Show` method can apply to different objects: `BillingForm.Show` shows the form object called BillingForm; `ExitButton.Show` shows the button object called ExitButton.

Events

You can write procedures that execute when a particular event occurs. An event occurs when the user takes an action, such as clicking a button, pressing a key, scrolling, or closing a window. Events also can be triggered by actions of other objects, such as repainting a form or a timer reaching a preset point.

The term *members* is used to refer to both properties and methods. ■

Classes

A class is a template or blueprint used to create a new object. Classes contain the definition of all available properties, methods, and events.

Each time that you create a new object, it must be based on a class. For example, you may decide to place three buttons on your form. Each button is based on the Button class and is considered one object, called an *instance* of the class. Each button (or instance) has its own set of properties, methods, and events. One

button may be labeled "OK", one "Cancel", and one "Exit". When the user clicks the OK button, that button's Click event occurs; if the user clicks on the Exit button, that button's Click event occurs. And, of course, you have written different program instructions for each of the buttons' Click events.

An Analogy

If the concepts of classes, objects, properties, methods, and events are still a little unclear, maybe an analogy will help. Consider an Automobile class. When we say *automobile*, we are not referring to a particular auto, but we know that an automobile has a make and model, a color, an engine, and a number of doors. These elements are the *properties* of the Automobile class.

Each individual auto is an object, or an instance of the Automobile class. Each Automobile object has its own settings for the available properties. For example, each object has a Color property, such as MyAuto.Color = Blue and YourAuto.Color = Red.

The methods, or actions, of the Automobile class might be `Start`, `SpeedUp`, `SlowDown`, and `Stop`. To refer to the methods of a specific object of the class, use `MyAuto.Start` and `YourAuto.Stop`.

The events of an Automobile class could be Arrive or Crash. In a VB program you write procedures that specify the actions you want to take when a particular event occurs for an object. For example, you might write a procedure for the YourAuto.Crash event.

Note: Chapter 12 presents object-oriented programming in greater depth.

Microsoft's Visual Studio

The latest version of Microsoft's Visual Studio, called Visual Studio 2008, includes Visual Basic, Visual C++, Visual C# (C sharp), and the .NET 3.5 Framework.

The .NET Framework

The programming languages in Visual Studio run in the .NET Framework. The Framework provides for easier development of Web-based and Windows-based applications, allows objects from different languages to operate together, and standardizes how the languages refer to data and objects. Several third-party vendors have announced or have released versions of other programming languages to run in the .NET Framework, including .NET versions of APL by Dyalog, FORTRAN by Lahey Computer Systems, COBOL by Fujitsu Software Corporation, Pascal by the Queensland University of Technology (free), PERL by ActiveState, RPG by ASNA, and Java, known as IKVM.NET.

The .NET languages all compile to (are translated to) a common machine language, called Microsoft Intermediate Language (MSIL). The MSIL code, called *managed code*, runs in the Common Language Runtime (CLR), which is part of the .NET Framework.

Visual Basic

Microsoft Visual Basic comes with Visual Studio. You also can purchase VB by itself (without the other languages but *with* the .NET Framework). VB is available in an **Express Edition**, a **Standard Edition**, a **Professional Edition**, and a **Team System Edition**. Anyone planning to do professional

application development that includes the advanced features of database management should use the Professional Edition or the Team System Edition. You can find a matrix showing the features of each edition in Help. The Professional Edition is available to educational institutions through the Microsoft Academic Alliance program and is the best possible deal. When a campus department purchases the Academic Alliance, the school can install Visual Studio on all classroom and lab computers and provide the software to all students and faculty at no additional charge.

Microsoft provides an Express Edition of each of the programming languages, which you can download for free (www.microsoft.com/express/download/). You can use Visual Basic Express for Windows development and Visual Web Developer Express for the Web applications in Chapter 9. This text is based on the Professional Edition of Visual Studio 2008. However, you can do the projects using Visual Basic 2008 Express Edition and Visual Web Developer 2008 Express Edition, all of which are the current versions. This version of Visual Basic is called both Visual Basic 2008 and Visual Basic 9. You cannot run the projects in this text in any earlier version of VB.

Writing Visual Basic Projects

When you write a Visual Basic application, you follow a three-step process for planning the project and then repeat the three-step process for creating the project. The three steps involve setting up the user interface, defining the properties, and then creating the code.

The Three-Step Process

Planning

1. *Design the user interface*. When you plan the **user interface**, you draw a sketch of the screens the user will see when running your project. On your sketch, show the forms and all the controls that you plan to use. Indicate the names that you plan to give the form and each of the objects on the form. Refer to Figure 1.1 for examples of user interfaces.

   Before you proceed with any more steps, consult with your user and make sure that you both agree on the look and feel of the project.
2. *Plan the properties*. For each object, write down the properties that you plan to set or change during the design of the form.
3. *Plan the Basic code*. In this step, you plan the classes and procedures that will execute when your project runs. You will determine which events require action to be taken and then make a step-by-step plan for those actions.

   Later, when you actually write the Visual Basic **code**, you must follow the language syntax rules. But during the planning stage, you will write out the actions using **pseudocode**, which is an English expression or comment that describes the action. For example, you must plan for the event that occurs when the user clicks on the Exit button. The pseudocode for the event could be *Terminate the project* or *Quit*.

Programming

After you have completed the planning steps and have approval from your user, you are ready to begin the actual construction of the project. Use the same three-step process that you used for planning.

1. *Define the user interface*. When you define the user interface, you create the forms and controls that you designed in the planning stage.

   Think of this step as defining the objects you will use in your application.
2. *Set the properties*. When you set the properties of the objects, you give each object a name and define such attributes as the contents of a label, the size of the text, and the words that appear on top of a button and in the form's title bar.

   You might think of this step as describing each object.
3. *Write the Basic code*. You will use Basic programming statements (called *Basic code*) to carry out the actions needed by your program. You will be surprised and pleased by how few statements you need to create a powerful Windows program.

   You can think of this third step as defining the actions of your program.

Visual Basic Application Files

A Visual Basic application, called a ***solution***, can consist of one or more projects. Since all of the solutions in this text have only one project, you can think of one solution = one project. Each project can contain one or more form files. In Chapters 1 through 5, all projects have only one form, so you can think of one project = one form. Starting in Chapter 6, your projects will contain multiple forms and additional files. As an example, the HelloWorld application that you will create later in this chapter creates the following files:

File Name	File Icon	Description
HelloWorld.sln		The solution file. A text file that holds information about the solution and the projects it contains. This is the primary file for the solution—the one that you open to work on or run your project. Note the "9" on the icon, which refers to VB version 9.
HelloWorld.suo		Solution user options file. Stores information about the state of the integrated development environment (IDE) so that all customizations can be restored each time you open the solution.
HelloForm.vb		A .vb file that holds the code procedures that you write. This is a text file that you can open in any editor. Warning: You should not modify this file unless you are using the editor in the Visual Studio environment.
HelloForm.resx		A resource file for the form. This text file defines all resources used by the form, including strings of text, numbers, and any graphics.

File Name	File Icon	Description
HelloForm.Designer.vb		A file created by the Form Designer that holds the definition of the form and its controls. You should not modify this file directly, but make changes in the Designer and allow it to update the file.
HelloWorld.vbproj.user		The project user option file. This text file holds IDE option settings so that the next time you open the project, all customizations will be restored.

Note: You can display file extensions. In Windows Vista, open the Explorer and select *Organize / Folders and Search Options*, click on the *View* tab, and deselect the check box for *Hide extensions for known file types*. In Windows XP, in the My Computer *Tools* menu, select *Folder Options* and the *View* tab, Deselect the check box for *Hide extensions for known file types*. If you do not display the extensions, you can identify the file types by their icons.

After you run your project, you will find several more files created by the system. These include the AssemblyInfo.vb, MyApplication.myapp, MyEvents.vb, Resources.resx, and Resources.vb. The only file that you open directly is the .sln, or solution file.

The Visual Studio Environment

The **Visual Studio environment** is where you create and test your projects. A development environment, such as Visual Studio, is called an ***integrated development environment*** **(IDE)**. The IDE consists of various tools, including a form designer, which allows you to visually create a form; an editor, for entering and modifying program code; a compiler, for translating the Visual Basic statements into the intermediate machine code; a debugger, to help locate and correct program errors; an object browser, to view available classes, objects, properties, methods, and events; and a Help facility.

In versions of Visual Studio prior to .NET, each language had its own IDE. For example, to create a VB project you would use the VB IDE, and to create a C++ project you would use the C++ IDE. But in Visual Studio, you use one IDE to create projects in any of the supported languages.

Note that this text is based on the Express Edition of Visual Studio. If you are using the Professional Edition, the screens differ somewhat from those that you see.

Default Environment Settings

The full version of Visual Studio 2008 provides an option to allow the programmer to select the default profile for the IDE. The first time you open Visual Studio, you are presented with the *Choose Default Environment Settings* dialog box (Figure 1.3), where you can choose *Visual Basic Development Settings*. Notice the instructions in the dialog box: you can make a different selection later from the *Tools* menu.

Note: If you are using the Express Edition of Visual Basic, you won't see this dialog box.

Figure 1.3

The first time you open the Visual Studio IDE, you must select the default environment settings for a Visual Basic developer.

The IDE Initial Screen

When you open the Visual Studio IDE, you generally see an empty environment with a Start Page (Figure 1.4). However, it's easy to customize the environment, so you may see a different view. In the step-by-step exercise later in this chapter, you will learn to reset the IDE layout to its default view.

The contents of the Start Page vary, depending on whether you are connected to the Internet. Microsoft has added links that can be updated, so you may find new and interesting information on the Start Page each time you open it. To display or hide the Start Page, select *View / Other Windows / Start Page*.

You can open an existing project or begin a new project using the Start Page or the *File* menu.

The New Project Dialog

You will create your first Visual Basic projects by selecting *File / New Project* on the menu bar or clicking *Create: Project* on the Start Page, either of which opens the *New Project* dialog (Figure 1.5). In the *New Project* dialog, select *Windows*

Figure 1.4

The Visual Studio IDE with the Start Page open, as it first appears in Windows Vista, without an open project.

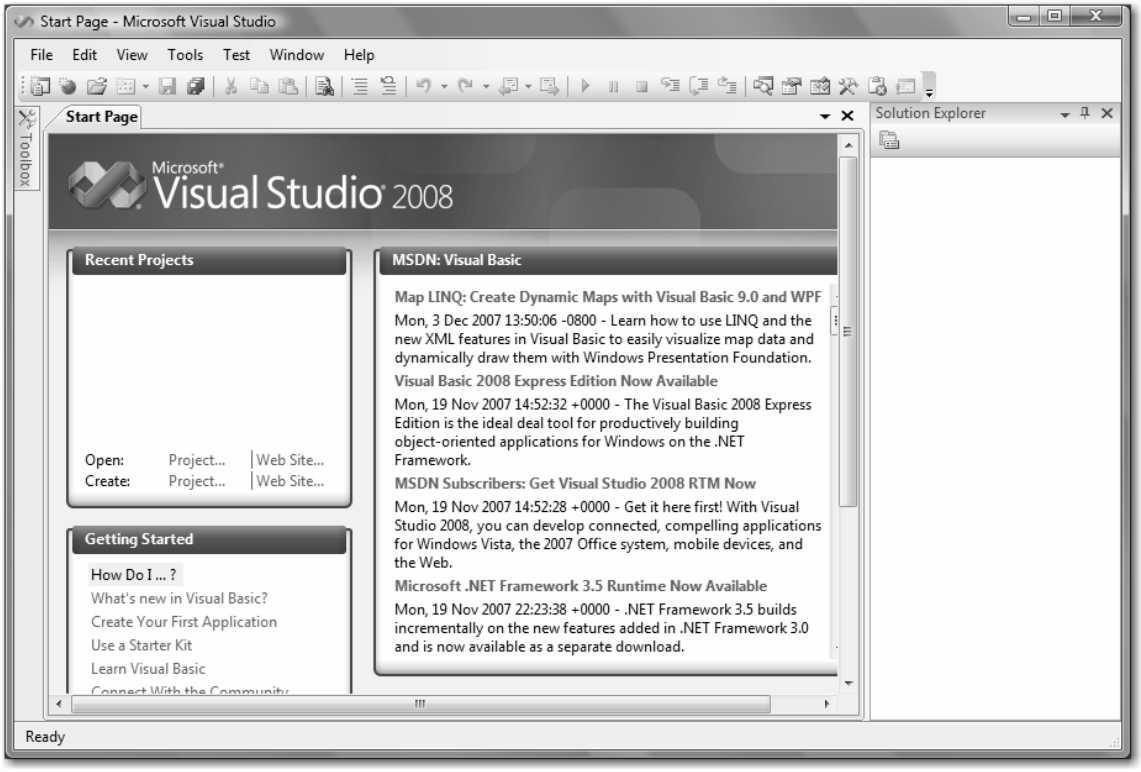
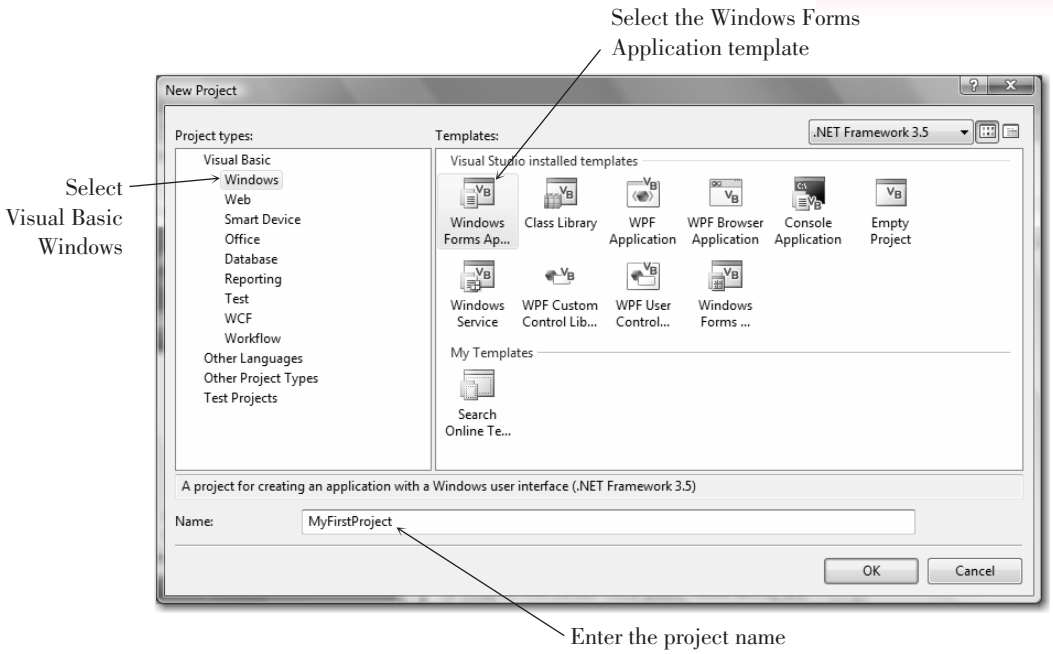


Figure 1.5

Begin a new VB Windows project using the Windows Forms Application template.



Forms Application if you are using the VB Express Edition. In the Professional Edition, first select *Visual Basic* and *Windows* in the *Project Types* box and *Windows Application* in the *Templates* box. You also give the project a name on this dialog box.

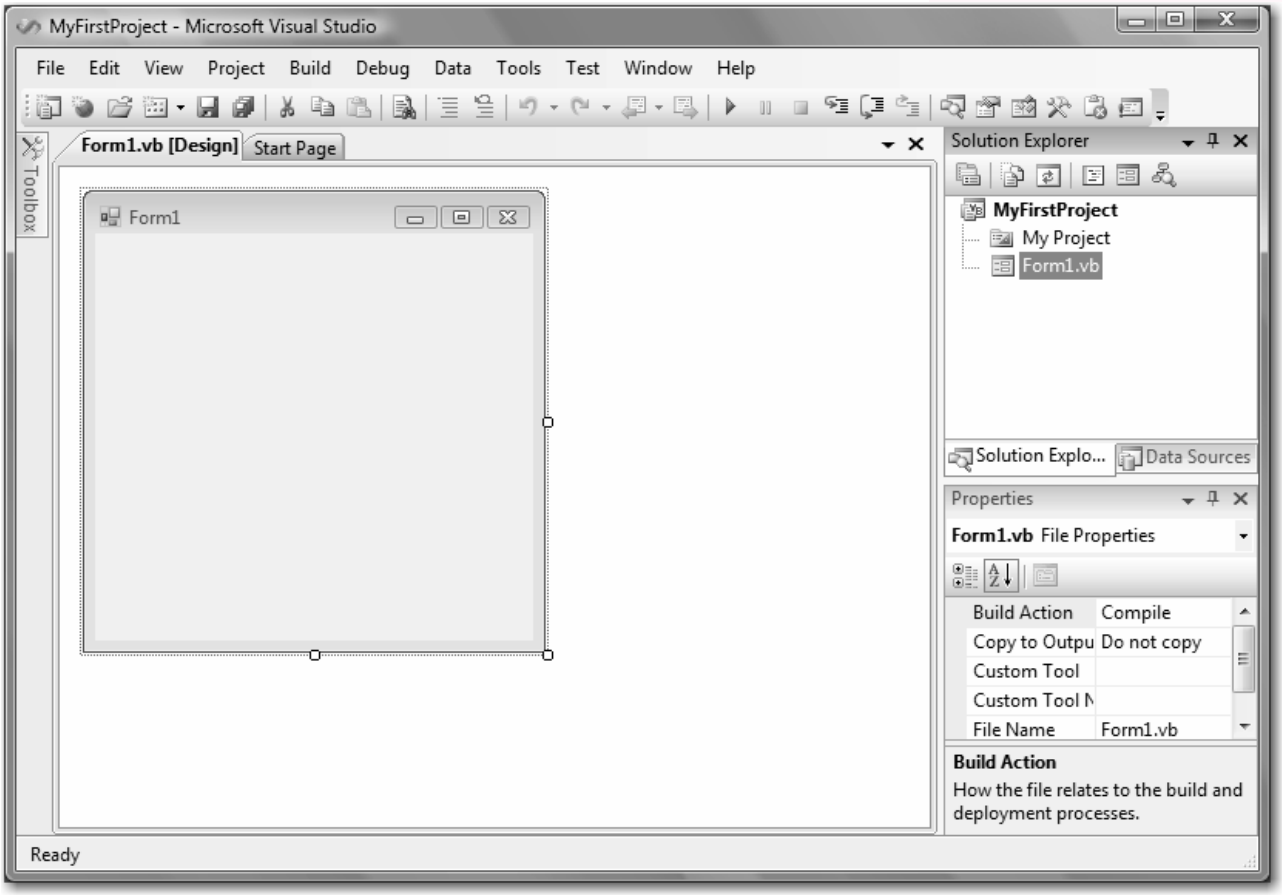
The IDE Main Window

Figure 1.6 shows the Visual Studio environment's main window and its various child windows. Note that each window can be moved, resized, opened, closed, and customized. Some windows have tabs that allow you to display different contents. Your screen may not look exactly like Figure 1.6; in all likelihood you will want to customize the placement of the various windows. The windows in the IDE are considered either document windows or tool windows. The Designer and Editor windows are generally displayed in tabs in the center of the screen (the Document window), and the various tool windows are docked along the edges and bottom of the IDE, but the locations and docking behavior are all customizable.

The IDE main window holds the Visual Studio menu bar and the toolbars. You can display or hide the various windows from the *View* menu.

Figure 1.6

The Visual Studio environment. Each window can be moved, resized, closed, or customized.

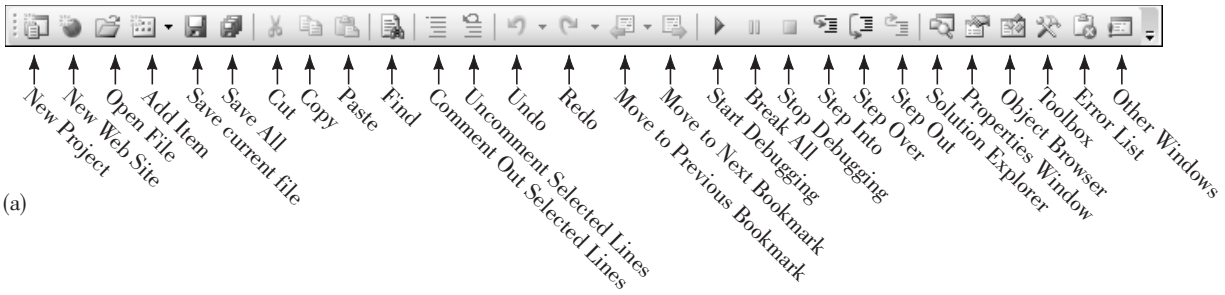


The Toolbars

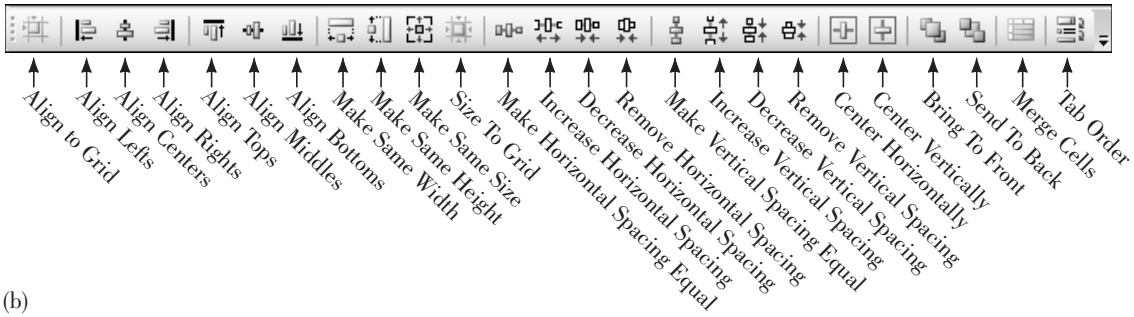
You can use the buttons on the **toolbars** as shortcuts for frequently used operations. Each button represents a command that also can be selected from a menu. Figure 1.7*a* shows the toolbar buttons on the Standard toolbar for the Professional Edition, which displays in the main window of the IDE; Figure 1.7*b* shows the Layout toolbar, which is useful for designing forms in the Form Designer; and Figure 1.7*c* shows the Text Editor toolbar, which contains buttons to use in the Editor window. Select *View / Toolbars* to display or hide these and other toolbars.

Figure 1.7

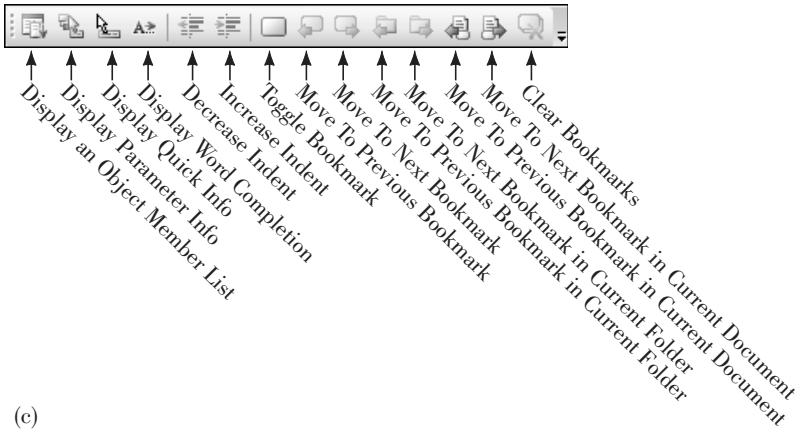
The Visual Studio toolbars contain buttons that are shortcuts for menu commands. You can display or hide each of the toolbars: a. the Standard toolbar; b. the Layout toolbar; and c. the Text Editor toolbar.



(a)



(b)



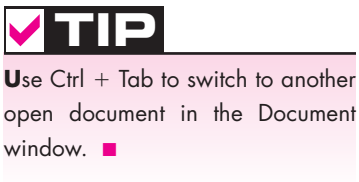
(c)

The Document Window

The largest window in the center of the screen is the **Document window**. Notice the tabs across the top of the window, which allow you to switch between

open documents. The items that display in the Document window include the Form Designer, the Code Editor, the Database Designer, and the Object Browser.

You can switch from one tab to another, or close any of the documents using its Close button.



Use Ctrl + Tab to switch to another open document in the Document window. ■

The Form Designer

The **Form Designer** is where you design a form that makes up your user interface. In Figure 1.6, the Form Designer for Form1 is currently displaying. You can drag the form's sizing **handle** or selection border to change the size of the form.

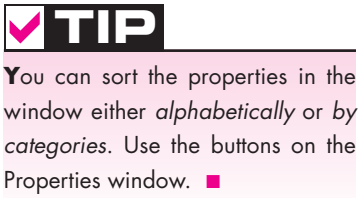
When you begin a new Visual Basic Windows application, a new form is added to the project with the default name Form1. In the step-by-step exercise later in the chapter, you will learn to change the form's name.

The Solution Explorer Window

The **Solution Explorer window** holds the filenames for the files included in your project and a list of the classes it references. The Solution Explorer window and the Window's title bar hold the name of your solution (.sln) file, which is WindowsApplication1 by default unless you give it a new value in the *New Project* dialog box. In Figure 1.6, the name of the solution is MyFirstProject.

The Properties Window

You use the **Properties window** to set the properties for the objects in your project. See "Set Properties" later in this chapter for instructions on changing properties.



You can sort the properties in the window either *alphabetically* or *by categories*. Use the buttons on the Properties window. ■

The Toolbox

The **toolbox** holds the tools you use to place controls on a form. You may have more or different tools in your toolbox, depending on the edition of Visual Basic you are using (Express, Standard, Professional, or Team System). Figure 1.8 shows the Express Edition toolbox.

Help

Visual Studio has an extensive **Help** feature, which includes the Microsoft Developer Network library (MSDN). You can find reference materials for Visual Basic, C++, C#, and Visual Studio; several books; technical articles; and the Microsoft Knowledge Base, a database of frequently asked questions and their answers.

Help includes the entire reference manual, as well as many coding examples. See the topic "Visual Studio Help" later in this chapter for help on Help.

When you make a selection from the *Help* menu, the requested item appears in a new window that floats on top of the IDE window (Figure 1.9), so you can keep both open at the same time. It's a good idea to set the *Filtered By* entry to *Visual Basic* or *Visual Basic Express Edition*, depending on the edition you are using.

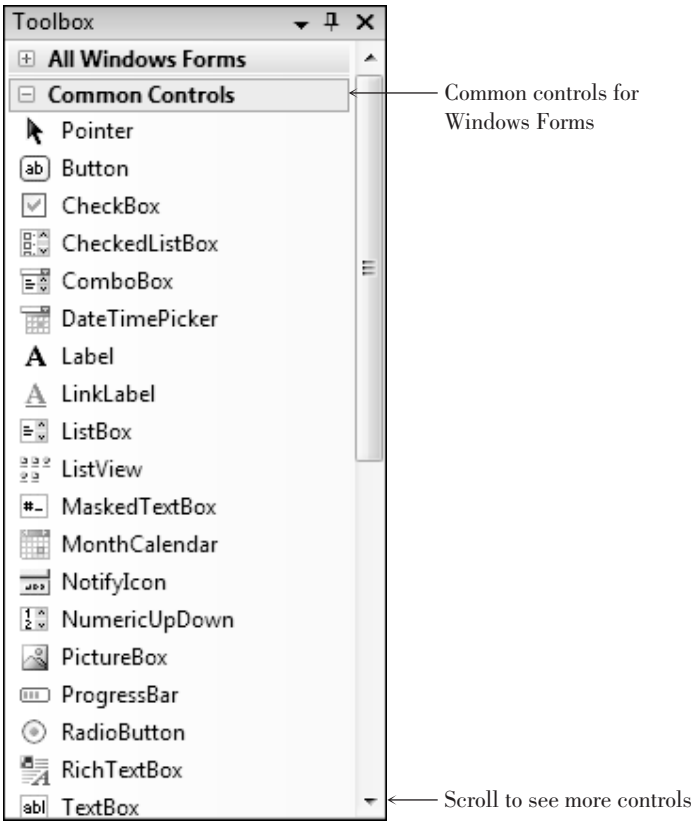


Figure 1.8

The toolbox for Visual Studio Windows Forms. Your toolbox may have more or fewer tools, depending on the edition you are using.

TIP

You can sort the tools in the toolbox: Right-click the toolbox and select *Sort Items Alphabetically* from the context menu (the shortcut menu). ■

Design Time, Run Time, and Debug Time

Visual Basic has three distinct modes. While you are designing the user interface and writing code, you are in **design time**. When you are testing and running your project, you are in **run time**. If you get a run-time error or pause program execution, you are in **debug time**. The IDE window title bar indicates (Running) or (Debugging) to indicate that a project is no longer in design time.

Writing Your First Visual Basic Project

For your first VB project, you will create a form with three controls (see Figure 1.10). This simple project will display the message "Hello World" in a label when the user clicks the *Push Me* button and will terminate when the user clicks the *Exit* button.

Set Up Your Workspace

Before you can begin a project, you must run the Visual Studio IDE. You also may need to customize your workspace.

Figure 1.9

Help displays in a new window, independent of the Visual Studio IDE window.

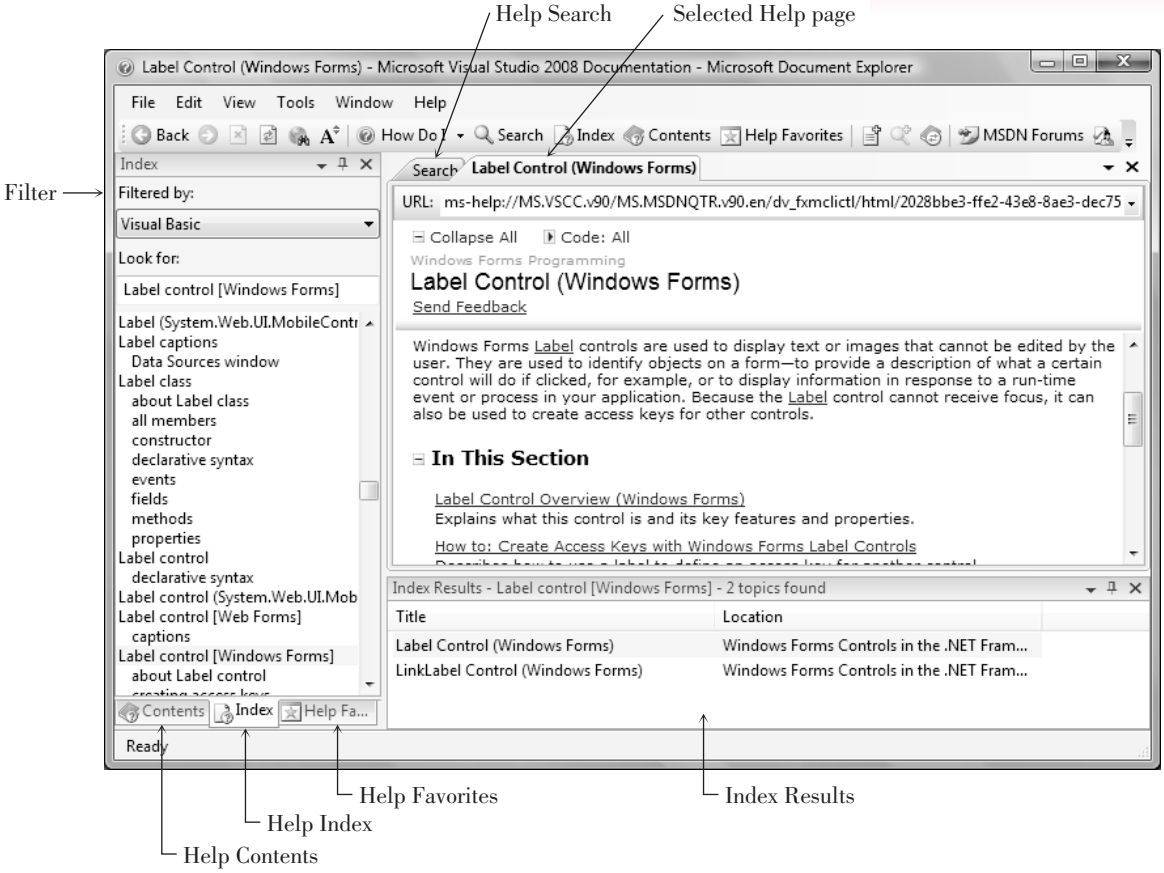
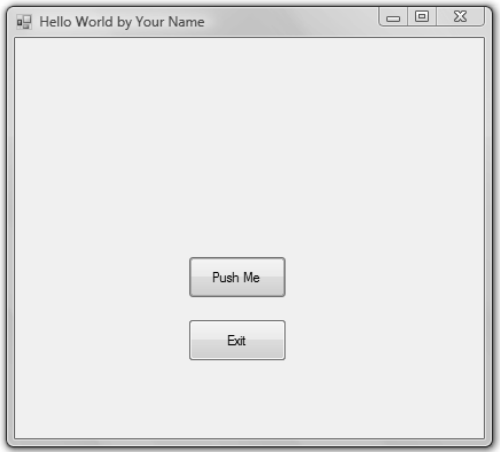


Figure 1.10

The Hello World form. The "Hello World" message will appear in a label when the user clicks on the Push Me *button. The label does not appear until the button is pressed.*



Run Visual Studio

These instructions assume that Visual Studio is installed in the default location. If you are running in a classroom or lab, the program may be installed in an alternate location, such as directly on the desktop.

STEP 1: Click the Windows *Start* button and move the mouse pointer to *All Programs*.

STEP 2: Locate *Microsoft Visual Basic 2008 Express Edition* or *Microsoft Visual Studio 2008*.

STEP 3: If a submenu appears, select *Microsoft Visual Studio 2008*. Visual Studio (VS) will start and display the Start Page (refer to Figure 1.4). If you are using Visual Studio Professional Edition and this is the first time that VS has been opened on this computer, you may need to select *Visual Basic Development Settings* from the *Choose Default Environment Setting* dialog box (refer to Figure 1.3).

Note: The VS IDE can be customized to not show the Start Page when it opens.

Start a New Project

STEP 1: Select *File / New Project*. The *New Project* dialog box opens (refer to Figure 1.5). Make sure that *Visual Basic* and *Windows* are selected for *Project types* and *Windows Forms Application* is selected for the template. If you are using Visual Basic Express, the dialog box differs slightly and you don't have to choose the language, but you can still choose a Windows Forms Application.

STEP 2: Enter "HelloWorld" (without the quotes) for the name of the new project (Figure 1.11) and click the *OK* button. The new project opens (Figure 1.12). At this point, your project is stored in a temporary directory. You specify the location for the project later when you save it.

Note: Your screen may look significantly different from the figure since the environment can be customized.

Figure 1.11

Enter the name for the new project.

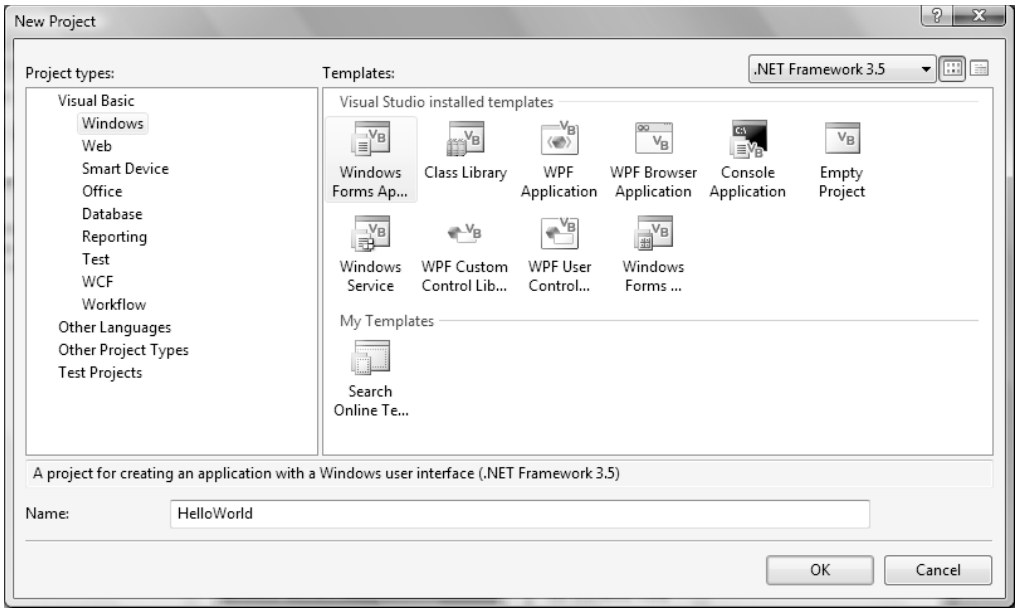
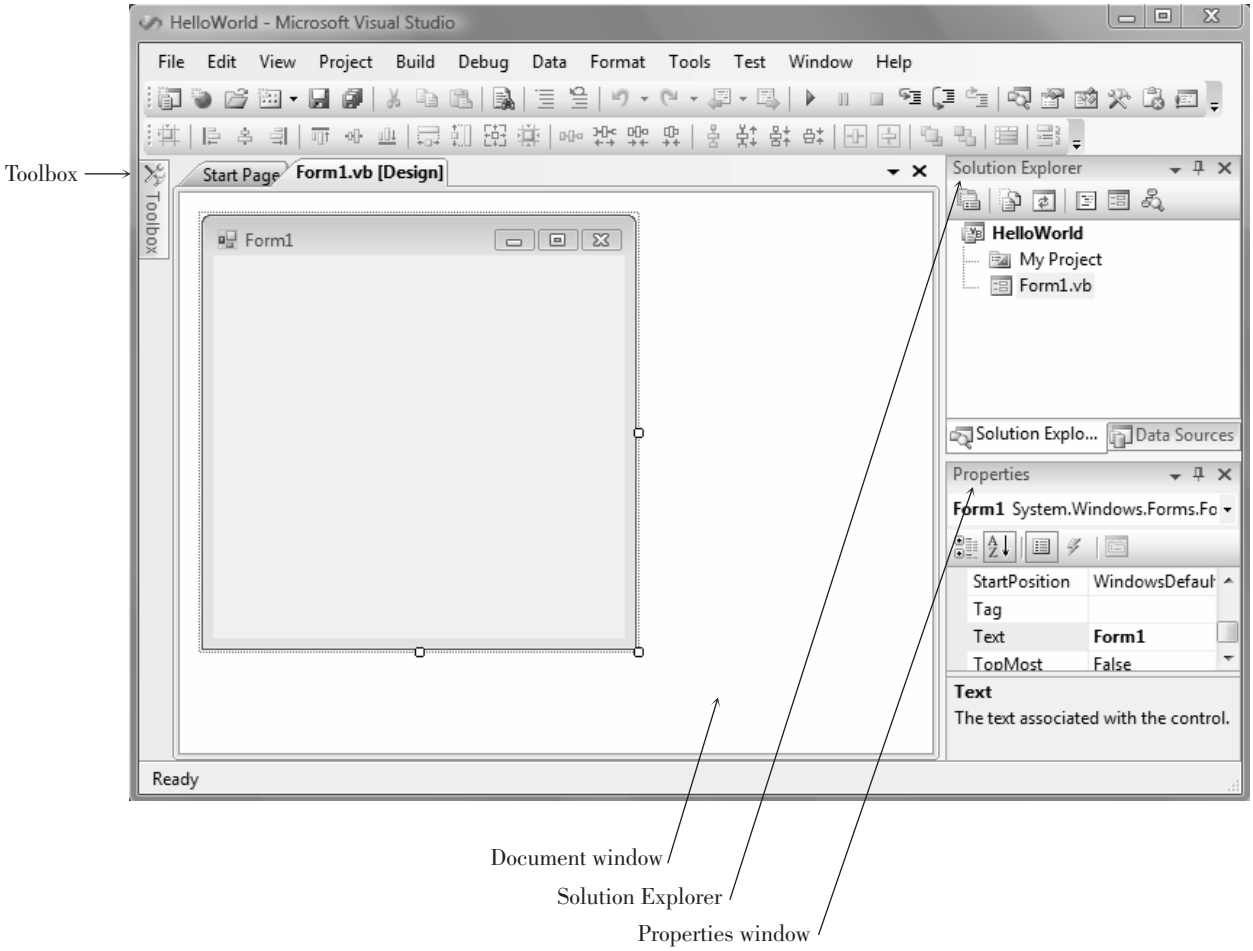


Figure 1.12

The Visual Studio IDE with the new HelloWorld project.



Set Up Your Environment

In this section, you will customize the environment. For more information on customizing windows, floating and docking windows, and altering the location and contents of the various windows, see Appendix C.

STEP 1: Reset the IDE's default layout by choosing *Window / Reset Window Layout* and respond Yes to the confirmation. The IDE should now match Figure 1.12.

Note: If the Data Sources window appears on top of the Solution Explorer window, click on the Solution Explorer tab to make it appear on top.

STEP 2: Point to the icon for the toolbox at the left of the IDE window. The Toolbox window pops open. Notice the pushpin icon at the top of the window (Figure 1.13); clicking this icon pins the window open rather than allowing it to AutoHide.

STEP 3: Click the AutoHide pushpin icon for the Toolbox window; the toolbox will remain open.

Figure 1.13

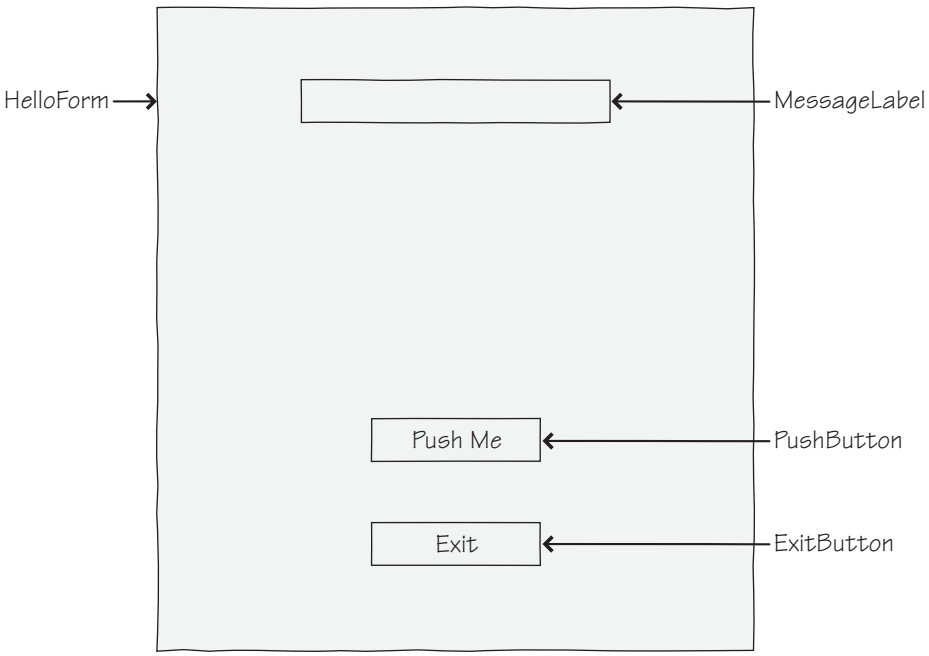
The Toolbox window.

Plan the Project

The first step in planning is to design the user interface. Figure 1.14 shows a sketch of the form that includes a label and two buttons. You will refer to the sketch as you create the project.

Figure 1.14

A sketch of the HelloWorld form for planning.



The next two steps, planning the properties and the code, have already been done for this first sample project. You will be given the values in the steps that follow.

Define the User Interface

Set Up the Form

Notice that the new form in the Document window has all the standard Windows features, such as a title bar, maximize and minimize buttons, and a close button.

STEP 1: Resize the form in the Document window: Drag the handle in the lower-right corner down and to the right (Figure 1.15).

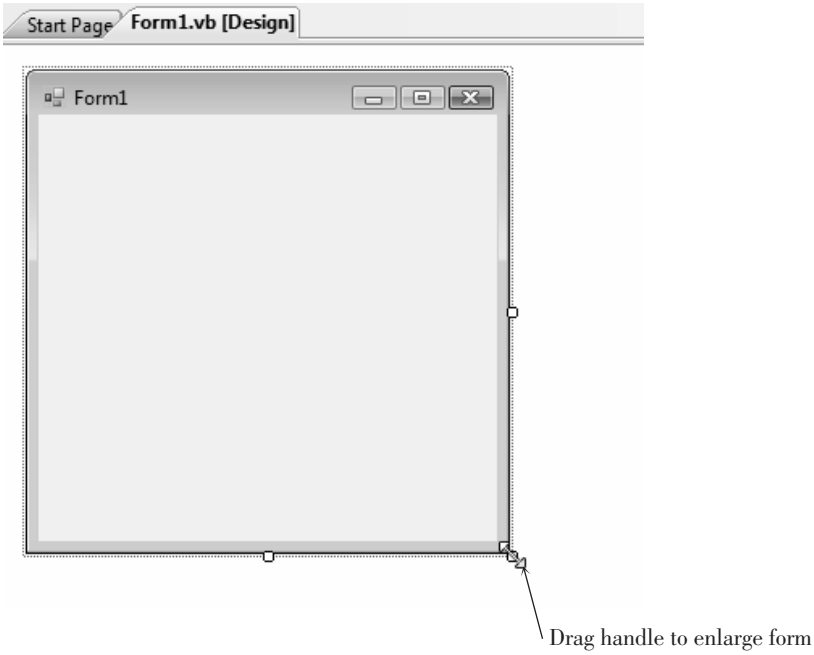


Figure 1.15

Make the form larger by dragging its lower-right handle diagonally. The handles disappear as you drag the corner of the form.

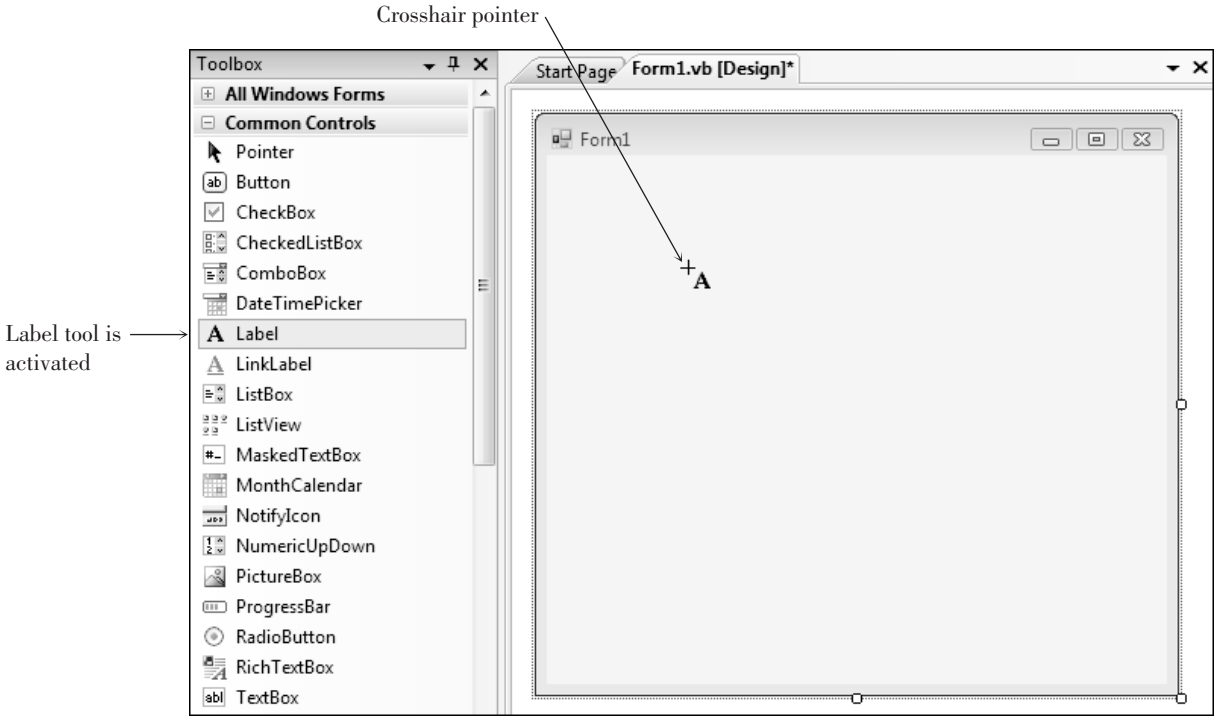
Place Controls on the Form

You are going to place three controls on the form: a **Label** and two **Buttons**.

STEP 1: Point to the Label tool in the toolbox and click. Then move the pointer over the form. Notice that the pointer becomes a crosshair with a big A and the Label tool appears selected, indicating it is the active tool (Figure 1.16).

Figure 1.16

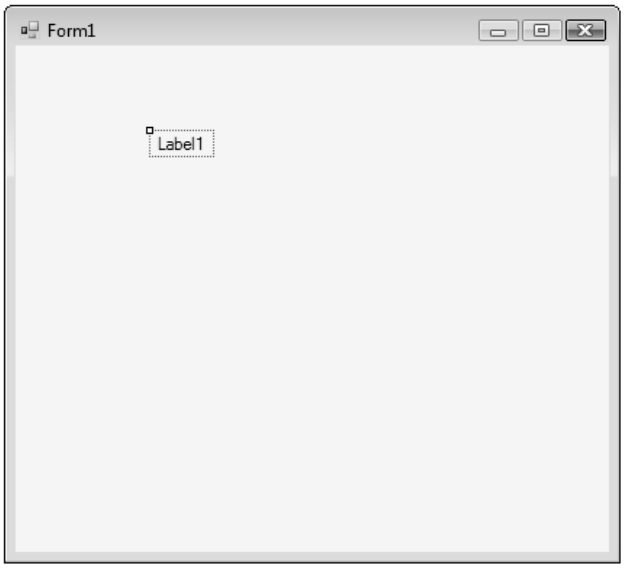
When you click on the Label tool in the toolbox, the tool's button is activated and the mouse pointer becomes a crosshair.



STEP 2: Point to a spot where you want the left edge of the label and click. The label and its default contents (Label1) will appear (Figure 1.17).

Figure 1.17

The newly created label appears outlined, indicating that it is selected. Notice that the contents of the label are set to Label1 by default.



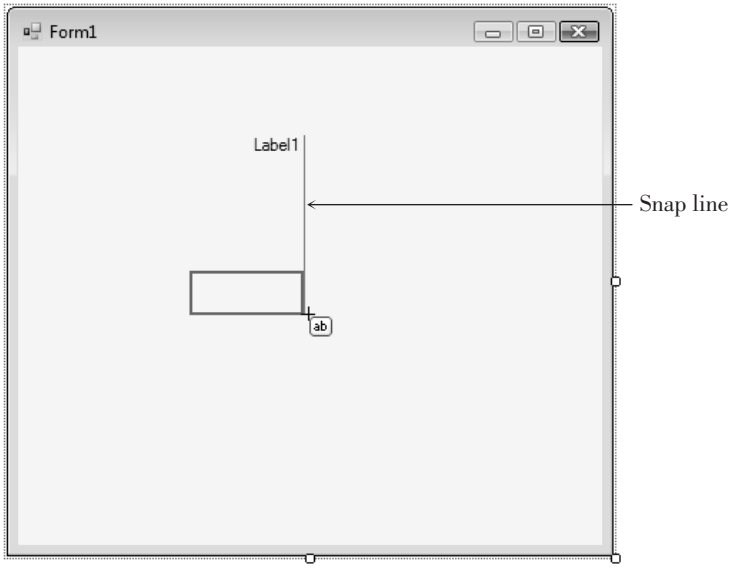
As long as the label is selected, you can press the Delete key to delete it, or drag it to a new location.

You can tell that a label is selected; it has a dotted border as shown in Figure 1.17 when the AutoSize property is True [the default] or sizing handles if you set the AutoSize property to False.

STEP 3: Place a button on the form using one of two techniques: (1) You can click on the Button tool in the toolbox, position the crosshair pointer for one corner of the button, and drag to the diagonally opposite corner (Figure 1.18); or (2) you can drag and drop the tool from the toolbox, which creates a button of the default size. The new button should appear selected and have **resizing handles**. The blue lines that appear are called **snap lines**, which can help you align your controls.

Figure 1.18

Select the Button tool and drag diagonally to create a new Button control. The blue snap lines help to align controls.



While a control is selected, you can delete it or move it. If it has resizing handles, you can also resize it. Refer to Table 1.1 for instructions for selecting, deleting, resizing, and moving controls. Click outside of a control to deselect it.

Table 1.1 **Selecting, Deleting, Moving, and Resizing Controls on a Form**

Select a control	Click on the control.
Delete a control	Select the control and then press the Delete key on the keyboard.
Move a control	Select the control, point inside the control (not on a handle), press the mouse button, and drag it to a new location.
Resize a control	Make sure the control is selected and has resizing handles; then either point to one of the handles, press the mouse button, and drag the handle; or drag the form's bottom border to change the height or the side border to change the width. Note that the default format for Labels does not allow resizing.

STEP 4: Create another button using another technique: While the first button is still selected, point to the Button tool in the toolbox and double-click. A new button of the default size will appear on top of the last-drawn control (Figure 1.19).

STEP 5: Keep the new button selected, point anywhere inside the button (not on a handle), and drag the button below your first button (Figure 1.20).

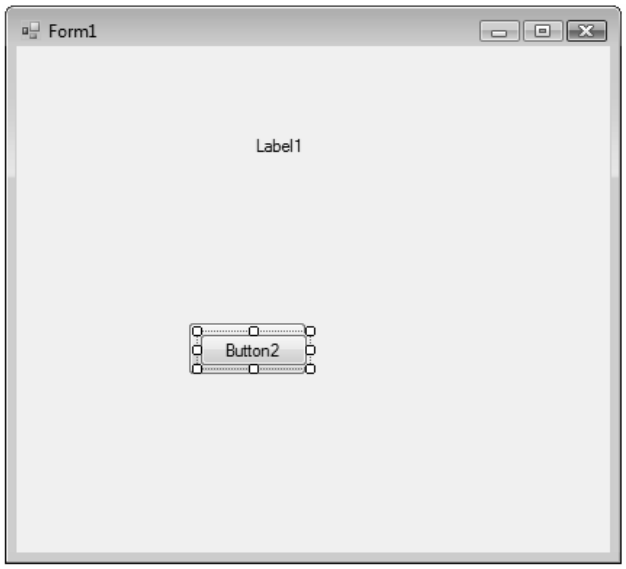


Figure 1.19

Place a new button on the form by double-clicking the Button tool in the toolbox. The new button appears on top of the previously selected control.

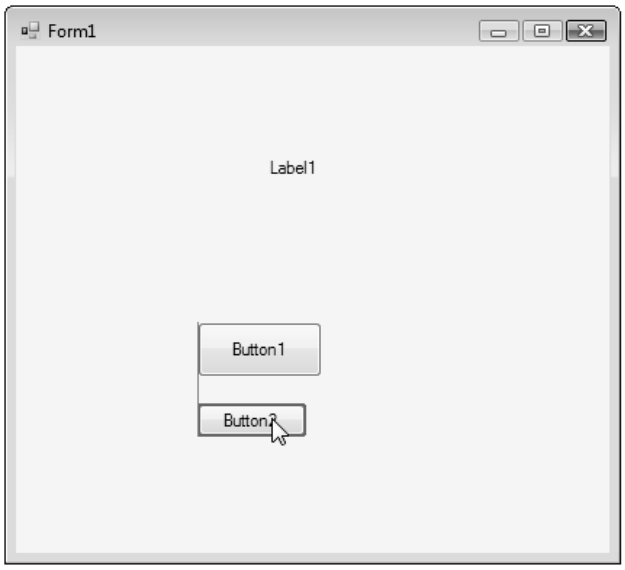


Figure 1.20

Drag the new button (Button2) below Button1.

TIP

If no control is selected when you double-click a tool, the new control is added to the upper-left corner of the form. ■

STEP 6: Select each control and move and resize the controls as necessary. Make the two buttons the same size and line them up. Use the snap lines to help with the size and alignment. Note that you can move but not resize the label.

STEP 7: Point to one of the controls and click the right mouse button to display a **context menu**. On the context menu, select *Lock Controls* (Figure 1.21). Locking prevents you from accidentally moving the controls. When your controls are locked, a selected control has no handles, but instead has a small lock symbol in the upper-left corner.

Note: You can unlock the controls at any time if you wish to redesign the form. Just click again on *Lock Controls* on the context menu to deselect it.

At this point you have designed the user interface and are ready to set the properties.

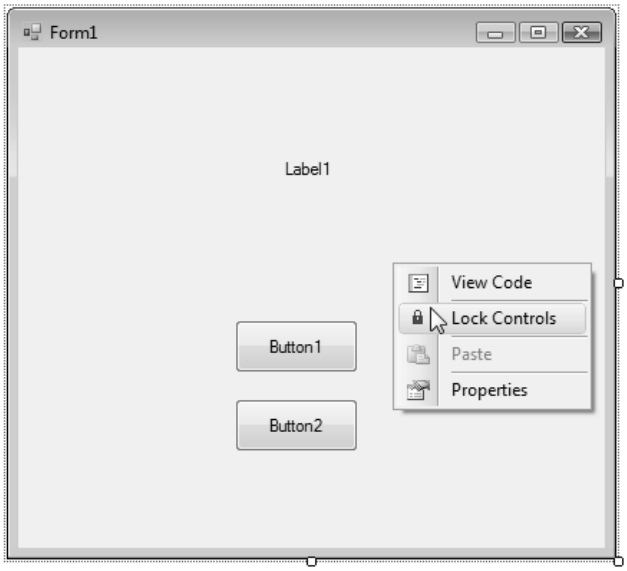


Figure 1.21

After the controls are placed into the desired location, lock them in place by selecting Lock Controls from the context menu. Remember that context menus differ depending on the current operation and system setup.

Set Properties

Set the Name and Text Properties for the Label

STEP 1: Click on the label you placed on the form; an outline appears around the control. Next click on the title bar of the Properties window to make it the active window (Figure 1.22). *Note*: If the Properties window is not displaying, select *View / Properties Window*.

Notice that the Object box at the top of the Properties window is showing *Label1* (the name of the object) and *System.Windows.Forms.Label* as the class of the object. The actual class is Label; System.Windows.Forms is called the ***namespace***, or the hierarchy used to locate the class.

STEP 2: In the Properties window, click on the Alphabetic button to make sure the properties are sorted in alphabetic order. Then select the Name property, which appears near the top of the list. Click on *(Name)* and notice that the Settings box shows *Label1*, the default name of the label (Figure 1.23).

TIP

If the Properties window is not visible, you can choose *View / Properties Window* from the menu or press the F4 shortcut key to show it. ■

Figure 1.22

The currently selected control is shown in the Properties window.

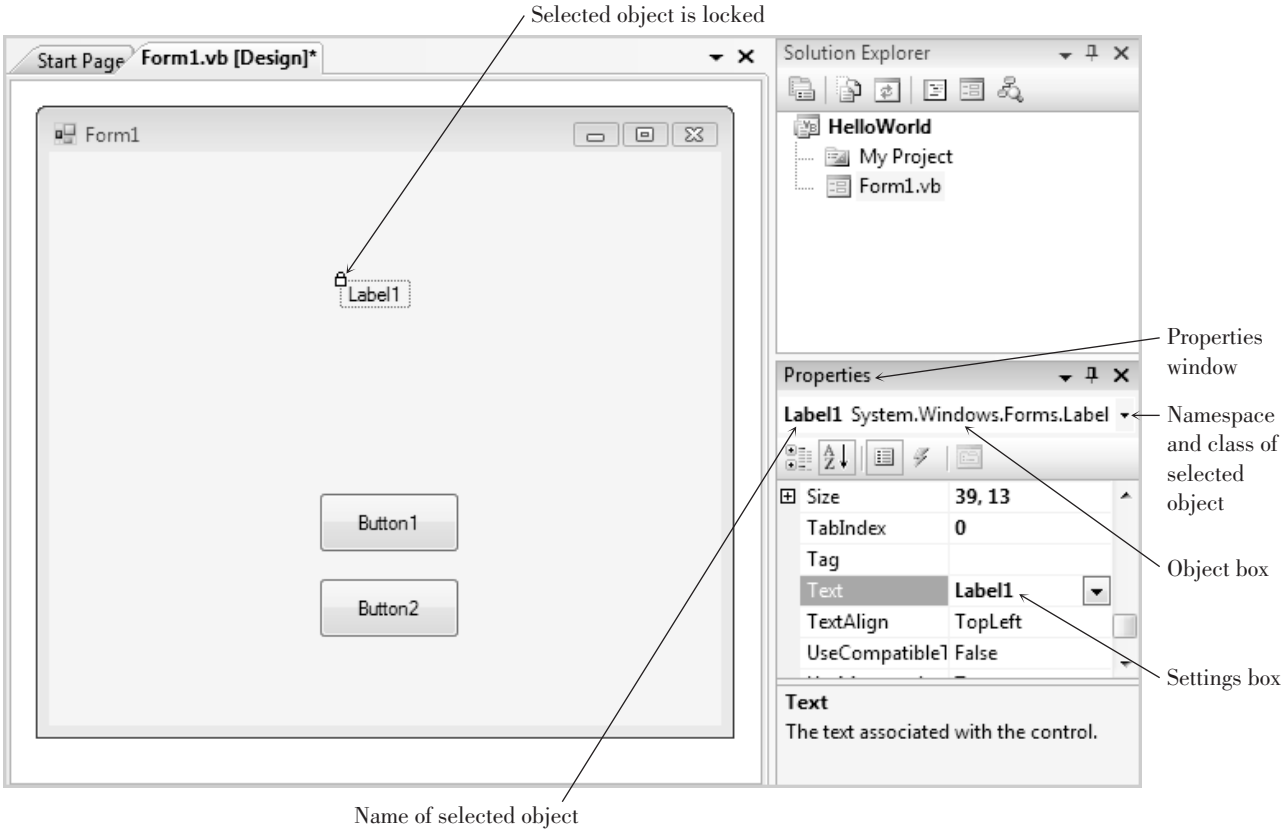
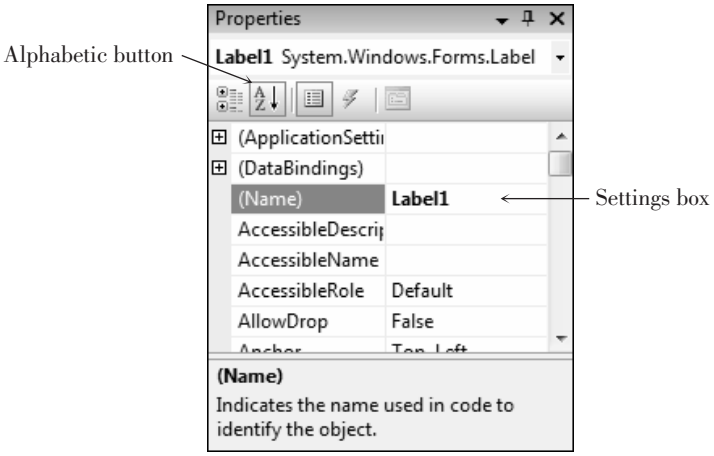


Figure 1.23

The Properties window. Click on the Name property to change the value in the Settings box.

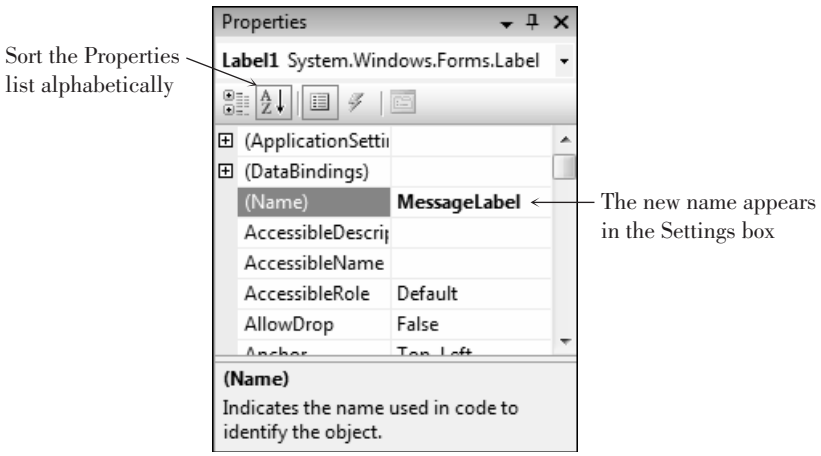


STEP 3: Type "MessageLabel" (without the quotation marks). See Figure 1.24. As a shortcut, you may wish to delete the 1 from the end of Label1, press the Home key to get to the beginning of the word, and then type "Message".

After you change the name of the control and press Enter or Tab, you can see the new name in the Object box's drop-down list.

Figure 1.24

Type "MessageLabel" into the Settings box for the Name property.



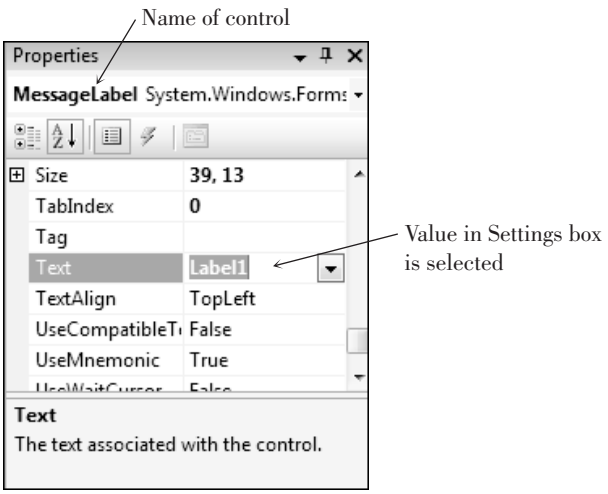
STEP 4: Click on the Text property to select it. (Scroll the Properties list if necessary.)

The **Text property** of a control determines what will be displayed on the form. Because nothing should display when the program begins, you must delete the value of the Text property (as described in the next two steps).

STEP 5: Double-click on *Label1* in the Settings box; the entry should appear selected (highlighted). See Figure 1.25.

Figure 1.25

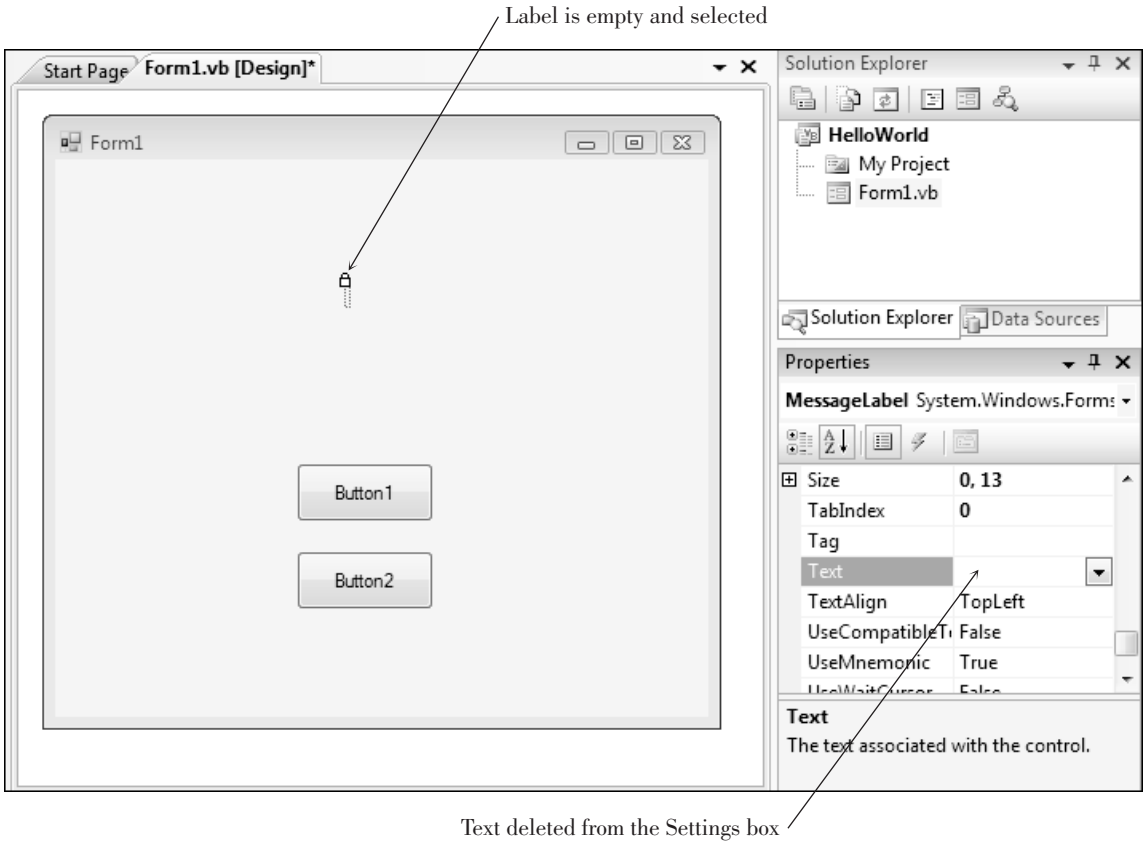
Double-click in the Settings box to select the entry.



STEP 6: Press the Delete key to delete the value of the Text property. Then press Enter and notice that the label on the form nearly disappears. All you see is the lock symbol and a very small dotted line (Figure 1.26), and if you click anywhere else on the form, which deselects the label, you cannot see it at all.

Figure 1.26

Delete the value for the Text property from the Settings box; the label on the form also appears empty and the control shrinks in size because the AutoSize property is set to True.



Labels have an AutoSize property, which is set to True by default. Labels shrink or grow to adjust for the Text property. You can set the AutoSize property to False if you want to specify the Label's size, in which case you can see the outline of the Label on the form.

Note that if you want text to flow to multiple lines in a label, you should set its AutoSize property to False and use the sizing handle to make the label large enough.

If you need to select the label after deselecting it, use the Properties window: Drop down the Object list at the top of the window; you can see a list of all controls on the form and can make a selection (Figure 1.27).

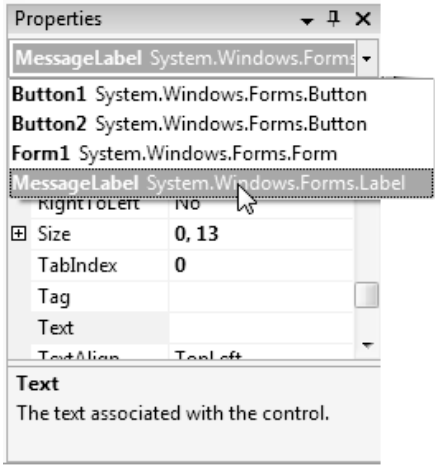


Figure 1.27

Drop down the Object box in the Properties window to select any control on the form.

Note: As an alternate technique for deleting a property, you can double-click on the property name, which automatically selects the entry in the Settings box. Then you can press the Delete key or just begin typing to change the entry.

TIP

Don't confuse the Name property with the Text property. You will use the Name property to refer to the control in your Basic code. The Text property determines what the user will see on the form. Visual Basic sets both of these properties to the same value by default, and it is easy to confuse them. ■

Set the Name and Text Properties for the First Button

STEP 1: Click on the first button (Button1) to select it and then look at the Properties window. The Object box should show the name (*Button1*) and class (*System.Windows.Forms.Button*) of the button. See Figure 1.28.

Problem? If you should double-click and code appears in the Document window, simply click on the *Form1.vb [Design]* tab at the top of the window.

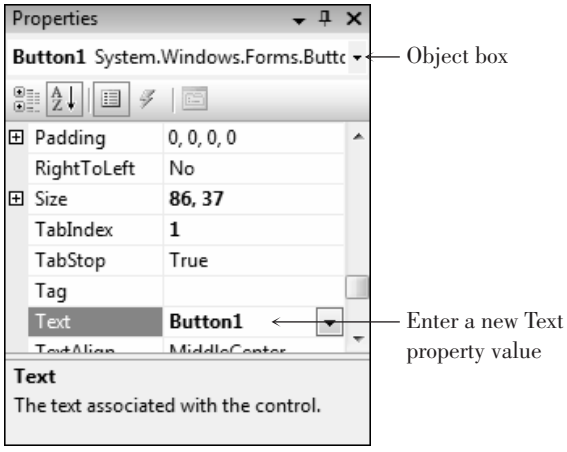


Figure 1.28

Change the properties of the first button.

STEP 2: Change the Name property of the button to "PushButton" (without the quotation marks).

Although the project would work fine without this step, we prefer to give this button a meaningful name, rather than use Button1, its

default name. The guidelines for naming controls appear later in this chapter in the section "Naming Rules and Conventions for Objects."

STEP 3: Change the Text property to "Push Me" (without the quotation marks). This step changes the words that appear on top of the button.

Set the Name and Text Properties for the Second Button

STEP 1: Select Button2 and change its Name property to "ExitButton".

STEP 2: Change the Text property to "Exit".

Change Properties of the Form

STEP 1: Click anywhere on the form, except on a control. The Properties window Object box should now show the form as the selected object (*Form1* as the object's name and *System.Windows.Forms.Form* as its class).

STEP 2: Change the Text property to "Hello World by Your Name" (again, no quotation marks and use your own name).

The Text property of a form determines the text to appear in the title bar. Your screen should now look like Figure 1.29.

TIP

Always set the Name property of controls before writing code. Although the program will still work if you reverse the order, the method names won't match the control names, which can cause confusion. ■

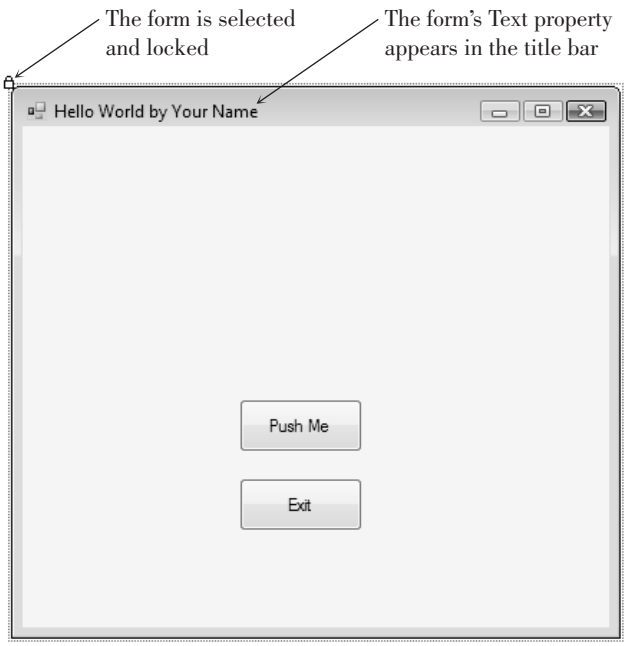


Figure 1.29

Change the form's Text property to set the text that appears in the form's title bar.

STEP 3: In the Properties window, click on the StartPosition property and notice the arrow on the property setting, indicating a drop-down list. Drop down the list and select *CenterScreen*. This will make your form appear in the center of the screen when the program runs.

STEP 4: In the Solution Explorer, right-click on Form1.vb and choose *Rename* from the context menu. Change the filename to "HelloForm.vb", making sure to retain the .vb extension. Press Enter when finished and click *Yes* on the confirmation dialog box. This changes the name of the file that saves to disk as well as the name of the class. (See Figure 1.30.)

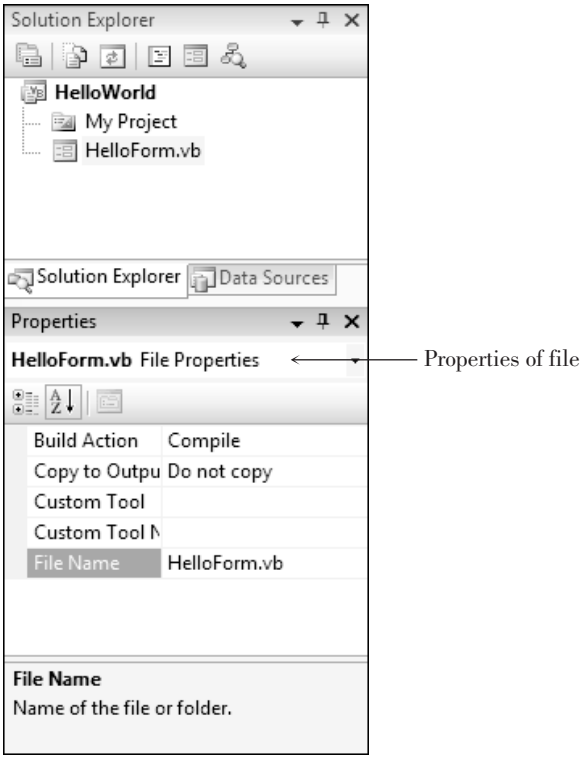


Figure 1.30

The Properties window shows the file's properties with the new name for the file. You can change the filename in the Properties window or the Solution Explorer.

STEP 5: Click on the form in the Document window, anywhere except on a control. The name of the file appears on the tab at the top of the Designer window, and the Properties window shows properties for the form's class, not the file. The VB designer changed the name of the form's class to match the name of the file (Figure 1.31).

TIP

If you change the form's filename before changing the form's class name, the IDE automatically changes the form's class name to match the filename. It does not make the change if you have changed the form's class name yourself. ■

Write Code

Visual Basic Events

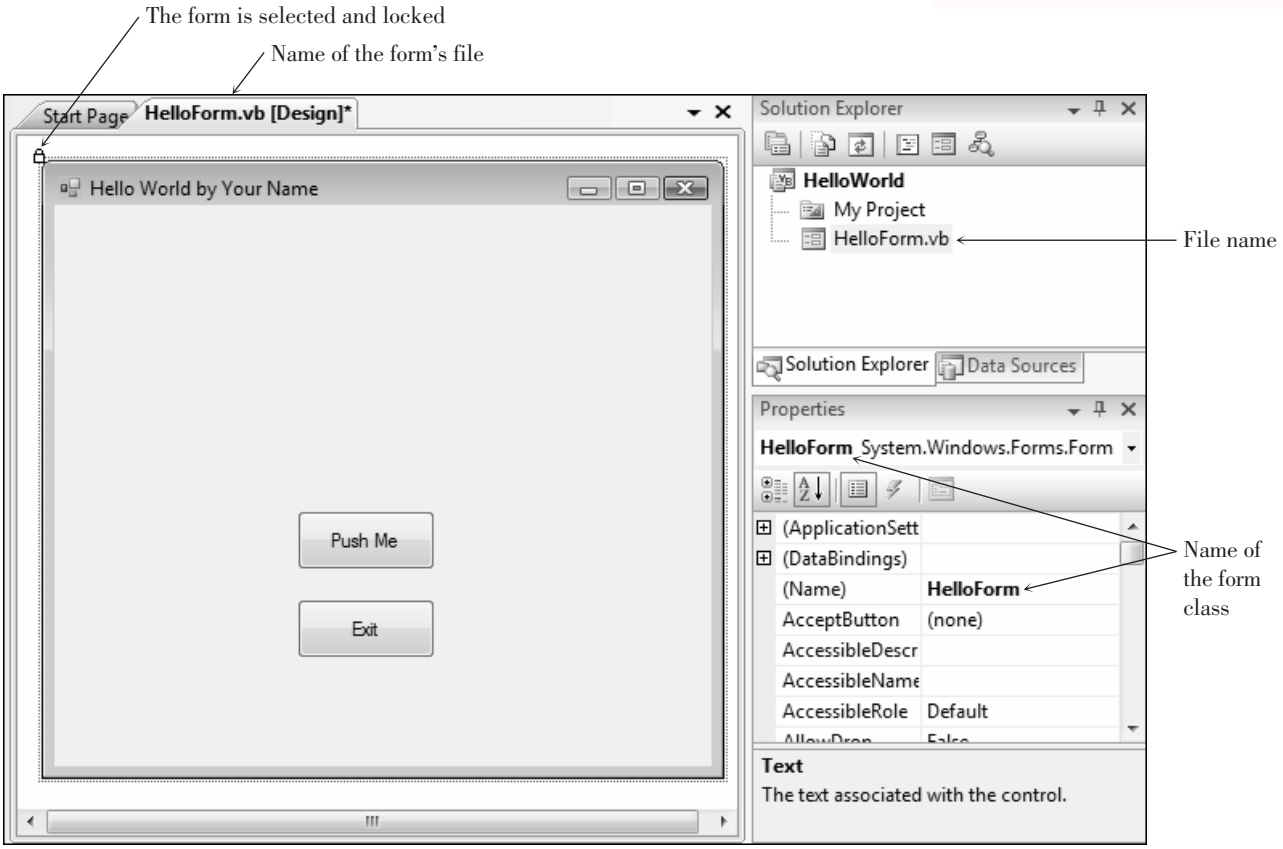
While your project is running, the user can do many things, such as move the mouse around; click on either button; move, resize, or close your form's window; or jump to another application. Each action by the user causes an event to occur in your Visual Basic project. Some events (like clicking on a button) you care about, and some events (like moving the mouse and resizing the window) you do not care about. If you write Basic code for a particular event, then Visual Basic will respond to the event and automatically execute your procedure. *VB ignores events for which no procedures are written.*

Visual Basic Event Procedures

You write code in Visual Basic in **procedures**. For now, each of your procedures will be a **sub procedure**, which begins with the words `Private Sub` and ends with `End Sub`. (Later you will also learn about other types of procedures.) Note that many programmers refer to sub procedures as subprograms or

Figure 1.31

The Properties window for the form. The form's class name now matches the name of the form's file.



subroutines. Subprogram is acceptable; subroutine is not because Basic actually has a different statement for a subroutine, which is not the same as a sub procedure. You also can refer to procedures as methods.

Visual Basic automatically names your **event procedures**. The name consists of the object name, an underscore (_), and the name of the event. For example, the Click event for your button called PushButton will be PushButton_Click. For the sample project you are writing, you will have a PushButton_Click procedure and an ExitButton_Click procedure. Note that another way to refer to these methods is to call them "event-handling methods," such as the PushButton_Click event-handling method.

Visual Basic Code Statements

This first project requires two Visual Basic statements: the **remark** and the **assignment statement**. You also will execute a method of an object.

The Remark Statement

Remark statements, sometimes called *comments*, are used for project documentation only. They are not considered "executable" and have no effect when the project runs. The purpose of remarks is to make the project more readable and understandable by the people who read it.

Good programming practices dictate that programmers include remarks to clarify their projects. Every procedure should begin with a remark that describes its purpose. Every project should have remarks that explain the purpose of the program and provide identifying information such as the name of the programmer and the date the program was written and/or modified. In addition, it is a good idea to place remarks within the logic of a project, especially if the purpose of any statements might be unclear.

When you try to read someone else's code, or your own after a period of time, you will appreciate the generous use of remarks.

Visual Basic remarks begin with an apostrophe. Most of the time your remarks will be on a separate line that starts with an apostrophe. You can also add an apostrophe and a remark to the right end of a line of code.

The Remark Statement—Examples

Examples

```
' This project was written by Jonathon Edwards.
' Exit the project.
MessageLabel.Text = "Hello World" ' Assign the message to the Text property.
```

The Assignment Statement

The assignment statement assigns a value to a property or variable (you learn about variables in Chapter 3). Assignment statements operate from right to left; that is, the value appearing on the right side of the equal sign is assigned to the property named on the left of the equal sign. It is often helpful to read the equal sign as "is replaced by." For example, the following assignment statement would read "MessageLabel.Text is replaced by Hello World."

```
MessageLabel.Text = "Hello World"
```

The Assignment Statement—General Form

General Form

```
Object.Property = value
```

The value named on the right side of the equal sign is assigned to (or placed into) the property named on the left.

The Assignment Statement—Examples

Examples

```
TitleLabel.Text = "A Snazzy Program"
AddressLabel.Text = "1234 South North Street"
MessageLabel.AutoSize = True
NumberInteger = 12
```

Notice that when the value to assign is some actual text (called a *literal*), it is enclosed in quotation marks. This convention allows you to type any combination of alpha and numeric characters. If the value is numeric, do not enclose it in quotation marks. And do not place quotation marks around the terms True and False, which Visual Basic recognizes as special key terms.

Ending a Program by Executing a Method

To execute a method of an object, you write:

```
Object.Method()
```

Notice that methods always have parentheses. Although this might seem like a bother, it's helpful to distinguish between properties and methods: Methods always have parentheses; properties don't.

Examples

```
HelloButton.Hide()
MessageLabel.Show()
```

To execute a method of the current object (the form itself), you use the `Me` keyword for the object. And the method that closes the form and terminates the project execution is `Close`.

```
Me.Close()
```

In most cases, you will include `Me.Close()` in the sub procedure for an Exit button or an *Exit* menu choice.

Note: The keyword `Me` refers to the current object. You can omit `Me` since a method without an object reference defaults to the current object.

TIP

If you don't type the parentheses after a method, the editor adds it for you, for most (but not all) methods. ■

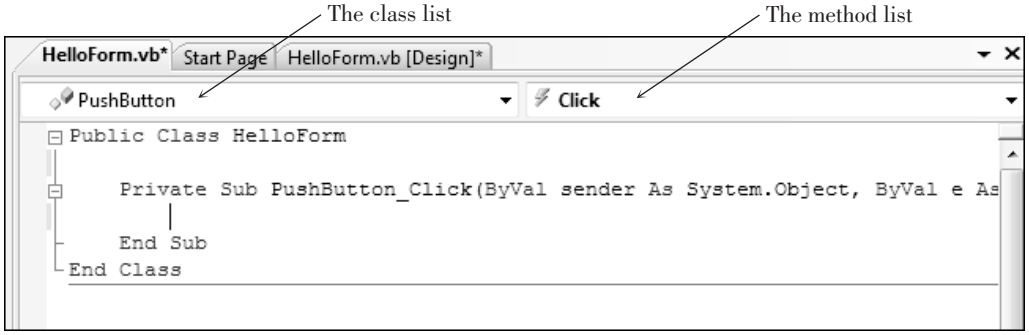
Code the Event Procedures for Hello World

Code the Click Event for the Push Me Button

STEP 1: Double-click the *Push Me* button. The Visual Studio editor opens with the first and last lines of your sub procedure already in place, with the insertion point indented inside the sub procedure (Figure 1.32).

Figure 1.32

The Editor window, showing the first and last lines of the PushButton_Click event procedure.



STEP 2: Type this remark statement:

```
' Display the Hello World message.
```

Notice that the editor automatically displays remarks in green (unless you or someone else has changed the color with an Environment option).

Follow good coding conventions and indent all lines between `Private Sub` and `End Sub`. The smart editor attempts to help you follow this convention. Also, always leave a blank line after the remarks at the top of a sub procedure.

STEP 3: Press Enter twice and then type this assignment statement:

```
MessageLabel.Text = "Hello World"
```

Note: When you type the names of objects and properties, allow IntelliSense to help you. When you type the first character of a name, such as the "M" of "MessageLabel", IntelliSense pops up a list of possible object names from your program (Figure 1.33). When several items match the first letter, you can type additional characters until you get a match, or you can use your keyboard down arrow or the mouse to highlight the correct item. To accept the correct item when it is highlighted, press the punctuation character that should follow the item, such as the period, spacebar, equal sign, Tab key, or Enter key, or double-click the item with your mouse. For example, accept "MessageLabel" by pressing the period and accept "Text" by pressing the spacebar, because those are the characters that follow the selected items.

Figure 1.33

IntelliSense pops up to help you. Select the correct item from the list and press the period, spacebar, Tab key, or Enter key to accept the text.

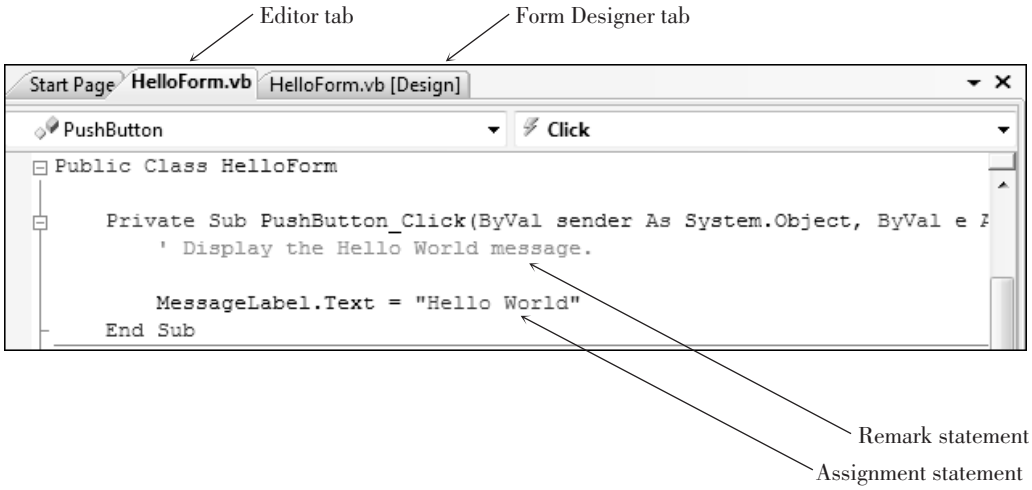
The assignment statement

```
MessageLabel.Text = "Hello World"
```

assigns the literal "Hello World" to the Text property of the control called MessageLabel. Compare your screen to Figure 1.34.

Figure 1.34

Type the remark and assignment statement for the PushButton_Click event procedure.



STEP 4: Return to the form's design view (Figure 1.29) by clicking on the *HelloForm.vb [Design]* form designer tab on the Document window (refer to Figure 1.34).

Code the Click Event for the Exit Button

STEP 1: Double-click the *Exit* button to open the editor for the ExitButton_Click event.

STEP 2: Type this remark:

```
' Exit the project.
```

STEP 3: Press Enter twice and type this Basic statement:

```
Me.Close()
```

Note: You can omit the parentheses; the smart editor will add them for you.

STEP 4: Make sure your code looks like the code shown in Figure 1.35.

TIP

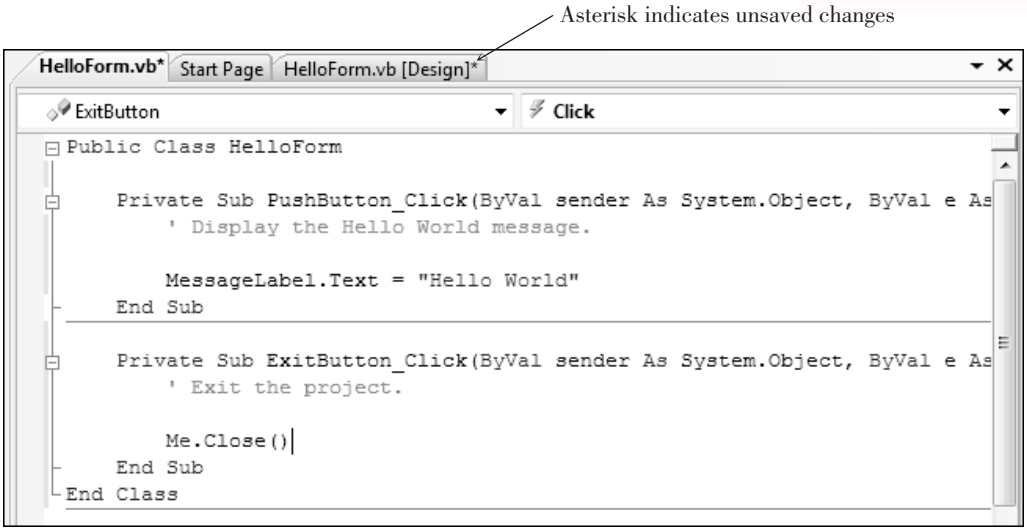
Allow the Editor and IntelliSense to help you. If the IntelliSense list does not pop up, you probably misspelled the name of the control. And don't worry about capitalization when you type the name of an object; if the name matches a defined object, the Editor fixes the capitalization. ■

TIP

Accept an entry from the IntelliSense popup list by typing the punctuation that follows the entry or by pressing the Enter key. You can also scroll the list and select with your mouse. ■

Figure 1.35

Type the code for the ExitButton_Click event procedure. Notice that an asterisk appears on the tab at the top of the window, indicating that there are unsaved changes in the file.



Run the Project

After you have finished writing the code, you are ready to run the project. Use one of these three techniques:

1. Open the *Debug* menu and choose *Start Debugging*.
2. Press the *Start Debugging* button on the toolbar.
3. Press F5, the shortcut key for the *Start Debugging* command.

Start the Project Running

STEP 1: Choose one of the three methods previously listed to start your project running (Figure 1.36).

Problems? See "Finding and Fixing Errors" later in this chapter. You must correct any errors and restart the program.

If all went well, the Visual Studio title bar now indicates that you are running.

Click the Push Me Button

STEP 1: Click the *Push Me* button. Your "Hello World" message appears in the label (Figure 1.37).

Click the Exit Button

STEP 1: Click the *Exit* button. Your project terminates, and you return to design time.

TIP

If your form disappears during run time, click its button on the Windows task bar. ■

Figure 1.36

The form of the running application.

Figure 1.37

Click the Push Me button and "Hello World" appears in the label.

Save Your Work

Of course, you must always save your work often. Except for a very small project like this one, you will usually save your work as you go along. Unless you (or someone else) has changed the setting in the IDE's *Options* dialog box, your files are automatically saved each time you build (compile) or execute (run) your project *after* your initial save. You also can save the files as you work.

TIP

Click the *Save All* toolbar button to quickly save all of your work. ■

Save the Files

STEP 1: Open the Visual Studio *File* menu and choose *Save All.* This option saves the current form, project, and solution files. You already selected the name for the project when you first created the project. Make sure to set the location to the folder in which you want to store the project. Press the *Browse* button to select a location other than the one specified.

Clear the check box for *Create directory for solution.* The IDE automatically creates a new folder for the solution; checking this check box creates a folder within a folder.

When you have set the name and location and cleared the check box, click *Save.*

Note: Do not attempt to choose a new name for the project to save a modified version. If you want to move or rename a project, close it first. See Appendix C for help.

Close the Project

STEP 1: Open the *File* menu and choose *Close Project.* If you haven't saved since your last change, you will be prompted to save.

Open the Project

Now is the time to test your save operation by opening the project from disk. You can choose one of three ways to open a saved project:

- Select *Open Project* from the Visual Studio *File* menu and browse to find your .sln file.
- Choose the project from the *Files / Recent Projects* menu item.
- Choose the project from the Start Page.

Open the Project File

STEP 1: Open your project by choosing one of the previously listed methods. Remember that the file to open is the solution (.sln) file.

If you do not see your form on the screen, check the Solution Explorer window—it should say *HelloWorld* for the project. Select the icon for your form: HelloForm.vb. You can double-click the icon or single-click and click on the *View Designer* button at the top of the Solution Explorer (Figure 1.38); your form will appear in the Designer window. Notice that you also can click on the *View Code* button to display your form's code in the Editor window.

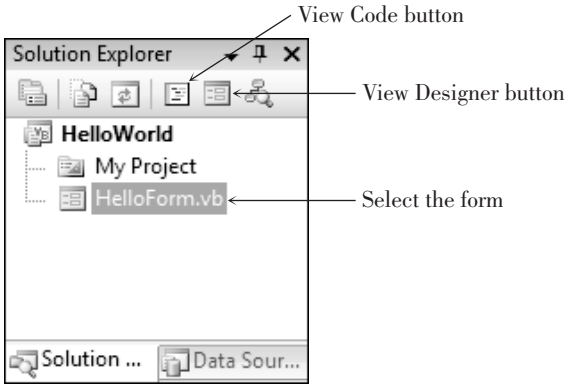


Figure 1.38

To display the form layout, select the form name and click on the View Designer button, or double-click on the form name. Click on the View Code button to display the code in the editor.

Modify the Project

Now it's time to make some changes to the project. We'll change the size of the "Hello World" message, display the message in two different languages, add a *Print* button, and display the programmer name (that's you) on the form.

Change the Size and Alignment of the Message

STEP 1: Right-click one of the form's controls to display the context menu. If your controls are currently locked, select *Lock Controls* to unlock the controls so that you can make changes.

STEP 2: Drop down the Object list at the top of the Properties window and select MessageLabel, which will make the tiny label appear selected.

STEP 3: Scroll to the Font property in the Properties window. The Font property is actually a Font object that has a number of properties. To see the Font properties, click on the small plus sign on the left (Figure 1.39); the Font properties will appear showing the current values (Figure 1.40).

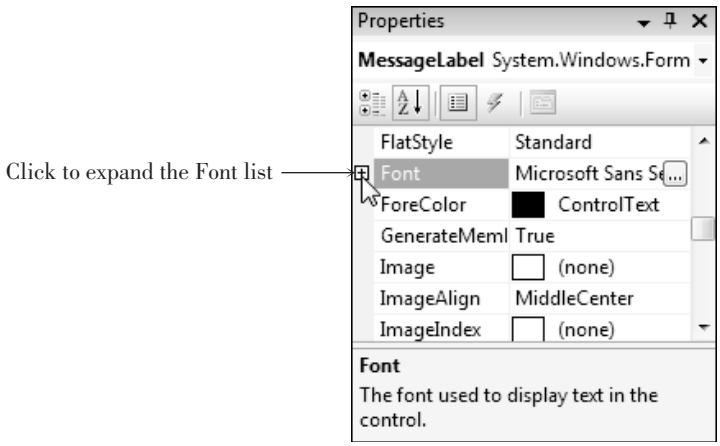


Figure 1.39

Click on the Font's plus sign to view the properties of the Font object.

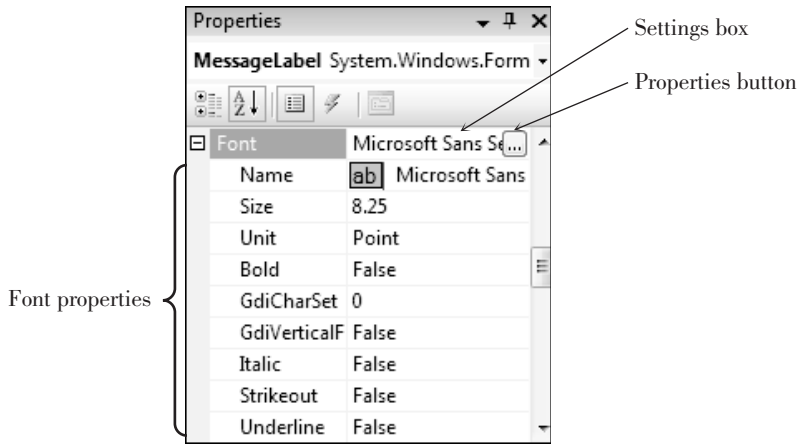


Figure 1.40

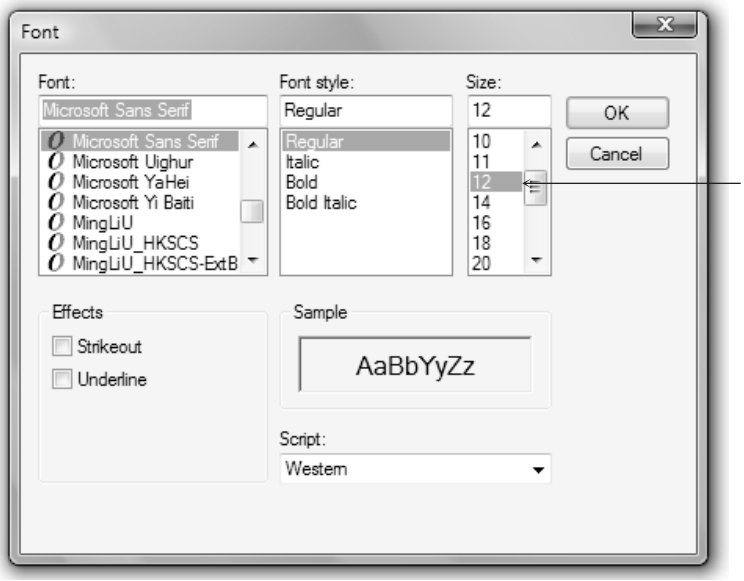
You can change the individual properties of the Font object.

You can change any of the Font properties in the Properties window, such as setting the Font's Size, Bold, or Italic properties. You also can display the *Font* dialog box and make changes there.

STEP 4: Click the Properties button for the font (the button with the ellipsis on top) to display the *Font* dialog box (Figure 1.41). Select 12 point if it is available. (If it isn't available, choose another number larger than the current setting.) Click OK to close the *Font* dialog box.

Figure 1.41

Choose 12 point on the Font dialog box.



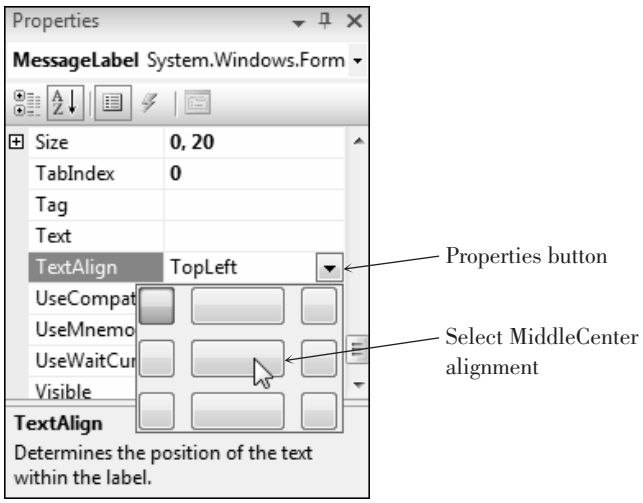
TIP

When you change a property from its default value, the property name appears bolded; you can scan down the property list and easily identify the properties that are changed from their default value. ■

STEP 5: Select the TextAlign property. The Properties button that appears with the down-pointing arrow indicates a drop-down list of choices. Drop down the list (Figure 1.42) and choose the center box; the alignment property changes to *MiddleCenter.*

Figure 1.42

Select the center box for the TextAlign property.



TIP

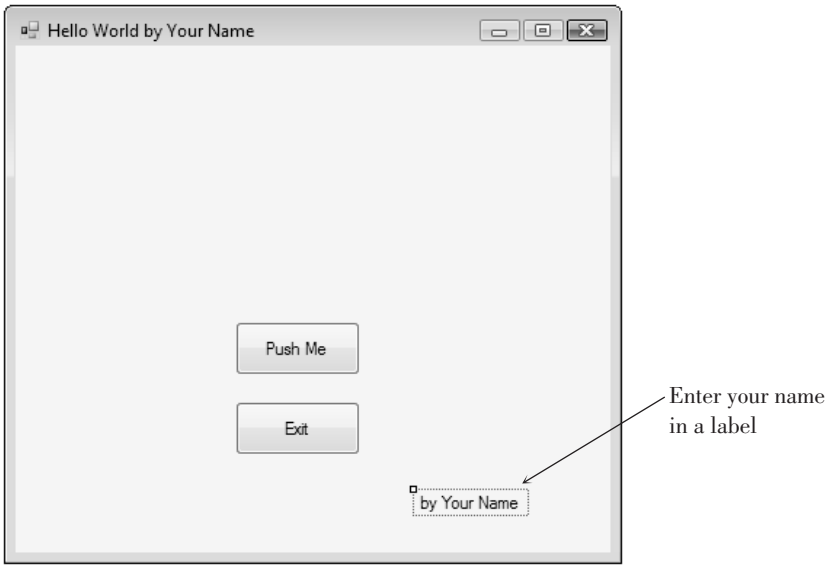
You can change the Font property of the form, which sets the default font for all objects on the form. ■

Add a New Label for Your Name

STEP 1: Click on the Label tool in the toolbox and create a new label along the bottom edge of your form (Figure 1.43). (You can resize the form if necessary, but you must unlock the controls first.)

Figure 1.43

Add a new label for your name at the bottom of the form.



STEP 2: Change the label's Text property to "by Your Name". (Use your name and omit the quotation marks.)

Note: You do not need to change the name of this label because it will never be referred to in the code.

Change the Location and Text of the Push Me Button

Because we plan to display the message in one of two languages, we'll change the text on the *Push Me* button to "English" and move the button to allow for a second button.

STEP 1: Select the *Push Me* button and change its Text property to English.

STEP 2: Move the *English* button to the left to make room for a *Spanish* button (see Figure 1.44).

Note: If you cannot move the button, check your *Lock Controls* setting in the context menu.

Figure 1.44

Move the English button to the left and add a Spanish button.

Add a Spanish Button

STEP 1: Add a new button. Move and resize the buttons as necessary, referring to Figure 1.44.

STEP 2: Change the Name property of the new button to SpanishButton.

STEP 3: Change the Text property of the new button to Spanish.

Add an Event Procedure for the Spanish Button

STEP 1: Double-click on the *Spanish* button to open the editor for SpanishButton_Click.

STEP 2: Add a remark:

```
' Display the Hello World message in Spanish.
```

STEP 3: Press Enter twice and type the following Basic code line:

```
MessageLabel.Text = "Hola Mundo"
```

STEP 4: Return to design view.

Add a Print Button

STEP 1: Add another button and name it PrintButton.

STEP 2: Change the button's Text property to "Print".

STEP 3: Move and resize the buttons as necessary.

Add a PrintForm Component

Visual Basic 2008 includes a **PrintForm** component. This component was not included in previous versions of Visual Basic but was available as a separate download. You will add the PrintForm component to your form, but it is not a visible element, such as the controls you have already added.

TIP

An easy way to create multiple similar controls is to copy an existing control and paste it on the form. You can paste multiple times to create multiple controls. ■

You can choose to send the printer output to the printer or to the Print Preview window, which saves paper while you are testing your program.

STEP 1: Scroll down to the bottom of the toolbox and find the header for *Visual Basic PowerPacks*.

STEP 2: Click on the plus sign to open the section of the toolbox. You should see the PrintForm component listed (Figure 1.45).

STEP 3: Double-click on the PrintForm component. Or you can drag and drop the component on the form. In either case, the component appears in a new pane that opens at the bottom of the Form Designer (Figure 1.46).This pane, called the **component tray**, holds components that do not have a visual representation at run time. You will see more controls that use the component tray later in this text.

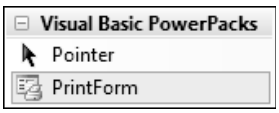


Figure 1.45

Open the Visual Basic PowerPacks section of the toolbox and double-click on the PrintForm component.

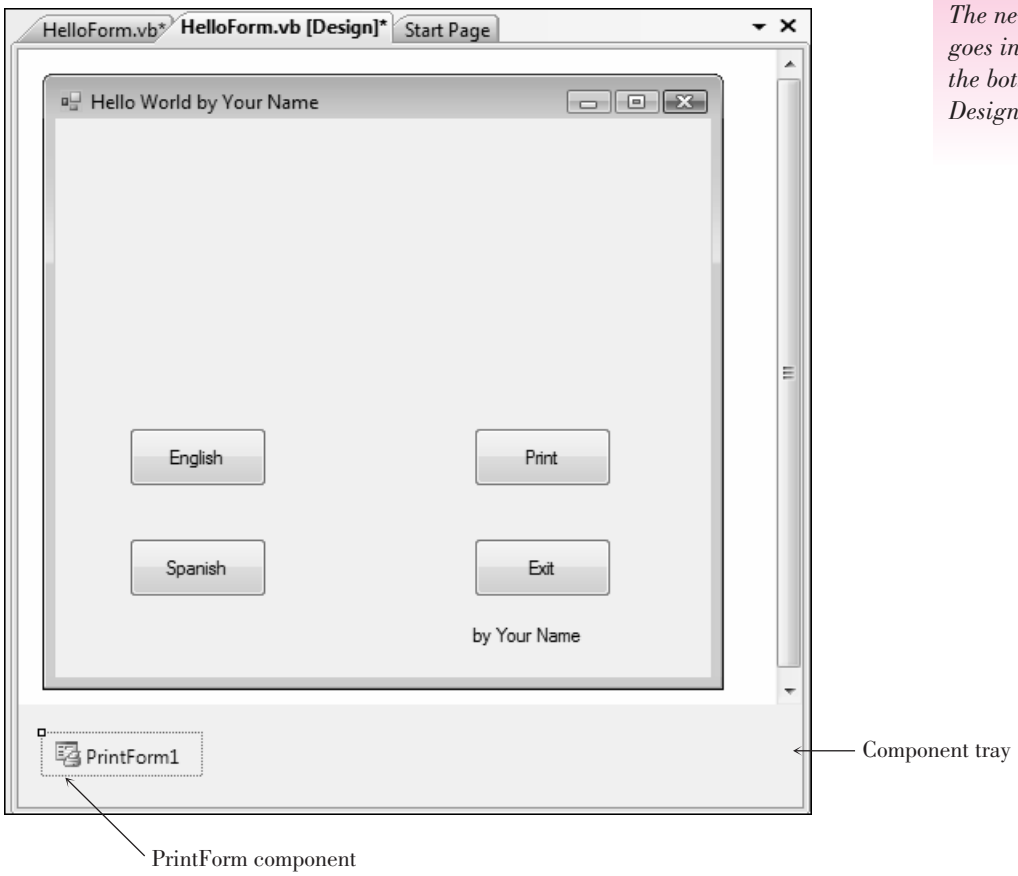


Figure 1.46

The new PrintForm component goes in the component tray at the bottom of the Form Designer window.

Add an Event Procedure for the Print Button

STEP 1: Double-click the *Print* button to open the editor.

STEP 2: Add the remark and press Enter twice.

```
' Print the form on the printer.
```

STEP 3: Allow IntelliSense to help you set the PrintAction property of the PrintForm component: Type "Printf" and the PrintForm1 item is selected in the IntelliSense list. Then press the period to accept the name, and the list of possible properties and methods for that object pops up. Select PrintAction by using the keyboard down arrow, by typing enough letters to automatically select the property, or by clicking with the mouse.

Then accept PrintAction by pressing the spacebar or the equal sign. If you pressed the spacebar, type an equal sign, and the list of possible choices will pop up. Choose `Printing.PrintAction.PrintToPreview` and press the spacebar or the Enter key to accept it. Your line of code should look like this:

```
PrintForm1.PrintAction = Printing.PrintAction.PrintToPreview
```

STEP 4: Add the last line of code, which starts the print operation. The `Print` method sends the output to the device specified in the PrintAction property, which defaults to the printer.

```
PrintForm1.Print()
```

STEP 5: Return to design view.

Lock the Controls

STEP 1: When you are satisfied with the placement of the controls on the form, display the context menu and select *Lock Controls* again.

Save and Run the Project

STEP 1: Save your project again. You can use the *File / Save All* menu command or the *Save All* toolbar button.

STEP 2: Run your project again. Try clicking on the *English* button and the *Spanish* button.

Problems? See "Finding and Fixing Errors" later in this chapter.

STEP 3: Click on the *Print* button to test the Print Preview function.

STEP 4: Click the *Exit* button to end program execution.

Add Remarks

Good documentation guidelines require some more remarks in the project. Always begin each procedure with remarks that tell the purpose of the procedure. In addition, each project file needs identifying remarks at the top.

The **Declarations section** at the top of the file is a good location for these remarks.

STEP 1: Display the code in the editor and click in front of the first line `(Public Class HelloForm)`. Make sure that you have an insertion point; if the entire first line is selected, press the left arrow to set the insertion point.

STEP 2: Press Enter to create a blank line.

Warning: If you accidentally deleted the first line, click Undo (or press Ctrl + Z) and try again.

STEP 3: Move the insertion point up to the blank line and type the following remarks, one per line (Figure 1.47):

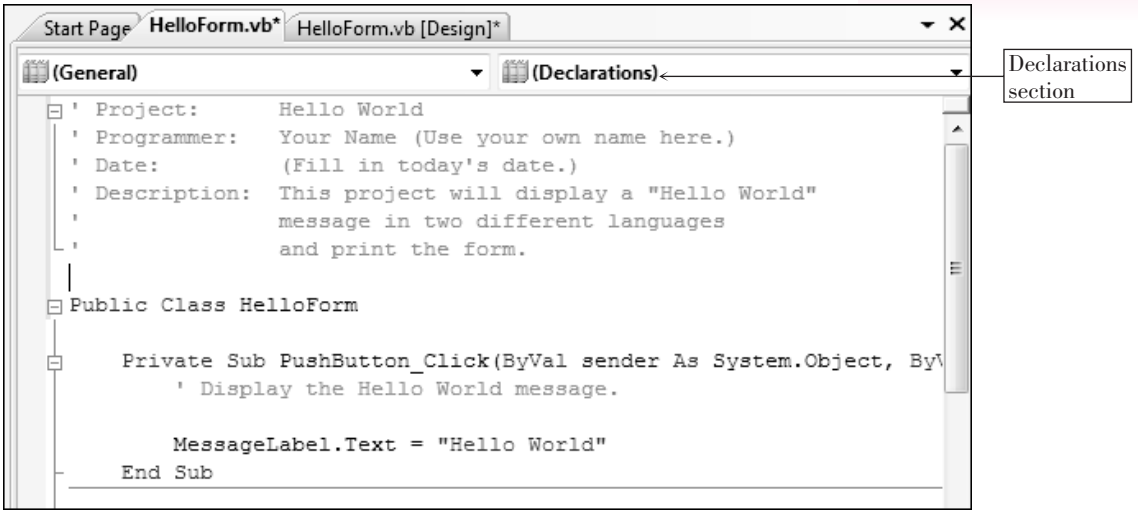
TIP

Press Ctrl + Home to quickly move the insertion point to the top of the file. ■

```
' Project:      Hello World
' Programmer:   Your Name (Use your own name here.)
' Date:         (Fill in today's date.)
' Description:  This project will display a "Hello World"
'               message in two different languages
'               and print the form.
```

Figure 1.47

Enter remarks at the top of the form file.



Explore the Editor Window

STEP 1: Notice the two drop-down list boxes at the top of the Editor window, called the *Class Name list* and the *Method Name list*. You can use these lists to move to any procedure in your code.

STEP 2: Click on the left down-pointing arrow to view the Class Name list. Notice that every object in your form is listed there (Figure 1.48). At the top of the list, you see the name of your form: *HelloForm*.

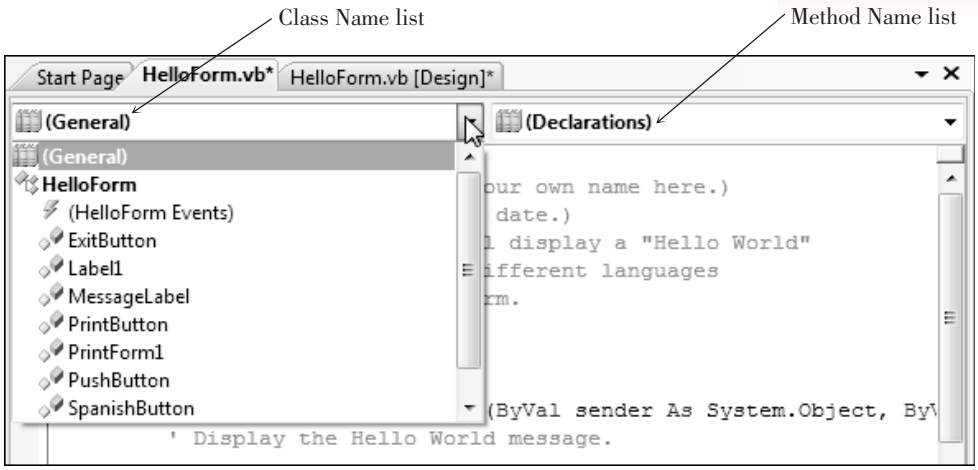
STEP 3: Select SpanishButton from the Class Name list. The insertion point jumps to the first line within the SpanishButton_Click event procedure.

STEP 4: Drop down the Method Name list (the right list); it shows all possible events for a Button control. Notice that the Click event is bold and the rest are not. Any event for which you have written an event procedure appears in bold.

To write code for more than one event for an object, you can use the Method Name drop-down list. When you select a new event from the Method Name list, the editor generates the `Private Sub` and `End Sub` lines for that procedure and moves the insertion point to the new procedure.

Figure 1.48

View the list of objects in this form by dropping down the Class Name list. Select an object from the list to display the sub procedures for that object.



Finish Up

STEP 1: Save the project again.

Print the Code

Select the Printing Options

STEP 1: Make sure that the Editor window is open, showing your form's code. The *File / Print* command is disabled unless the code is displaying and its window selected.

Note: If the *File / Print* command is disabled, click an insertion point in the Editor window.

STEP 2: Open the *File* menu and choose *Print*. Click OK.

A Sample Printout

This output is produced when you print the form's code. Notice the ↙ symbol used to continue long lines on the printout. On the screen, those long lines are not split, but scroll off the right side of the screen.

```
C:\Users\ . . . \HelloWorld\HelloForm.vb                                    1

'Project:              Hello World
'Programmer:           Your Name
'Date:                 Today's Date
'Description:          This project will display a "Hello World"
'                      message in two different languages and print the form.

Public Class HelloForm
```

```
  Private Sub PushButton_Click(ByVal sender As System.Object, ByVal e As System.
    EventArgs) Handles PushButton.Click
      ' Display the Hello World Message.

      MessageLabel.Text = "Hello World"
  End Sub

  Private Sub ExitButton_Click(ByVal sender As System.Object, ByVal e As System.
    EventArgs) Handles ExitButton.Click
      ' Exit the project.

      Me.Close()
  End Sub

  Private Sub SpanishButton_Click(ByVal sender As System.Object, ByVal e As System.
    EventArgs) Handles SpanishButton.Click
      ' Display the Hello World message in Spanish.

      MessageLabel.Text = "Hola Mundo"
  End Sub

  Private Sub PrintButton_Click(ByVal sender As System.Object, ByVal e As
    System.EventArgs) Handles PrintButton.Click
      ' Print the form.

      PrintForm1.PrintAction = Printing.PrintAction.PrintToPreview
      PrintForm1.Print()
  End Sub

End Class
```

Finding and Fixing Errors

You already may have seen some errors as you entered the first sample project. Programming errors come in three varieties: **syntax errors**, **run-time errors**, and **logic errors**.

Syntax Errors

When you break VB's rules for punctuation, format, or spelling, you generate a syntax error. Fortunately, the smart editor finds most syntax errors and even corrects many of them for you. The syntax errors that the editor cannot identify are found and reported by the compiler as it attempts to convert the code into intermediate machine language. A compiler-reported syntax error may be referred to as a *compile error*.

The editor can correct some syntax errors by making assumptions and not even report the error to you. For example, a string of characters must have opening and closing quotes, such as "Hello World". But if you type the opening quote and forget the closing quote, the editor automatically adds the closing quote when you move to the next line. And if you forget the opening and closing parentheses after a method name, such as `Close()`, again the editor will add them for you when you move off the line. Of course, sometimes the editor will make a wrong assumption, but you will be watching, right?

The editor identifies syntax errors as you move off the offending line. A blue squiggly line appears under the part of the line that the editor cannot interpret. You can view the error message by pausing the mouse pointer over the error, which pops up a box that describes the error (Figure 1.49). You also can display an Error List window (*View / Error List*), which appears at the bottom of the Editor window and shows all error messages along with the line number of the statement that caused the error. You can display line numbers on the source code (Figure 1.50) with *Tools / Options*. If *Show All Settings* is selected in the *Options* dialog box, choose *Text Editor / Basic* and check *Line Numbers*; if *Show All Settings* is not checked, then choose *Text Editor Basic / Editor* and check *Line Numbers*.

Figure 1.49

The editor identifies a syntax error with a squiggly blue line, and you can point to an error to pop up the error message.

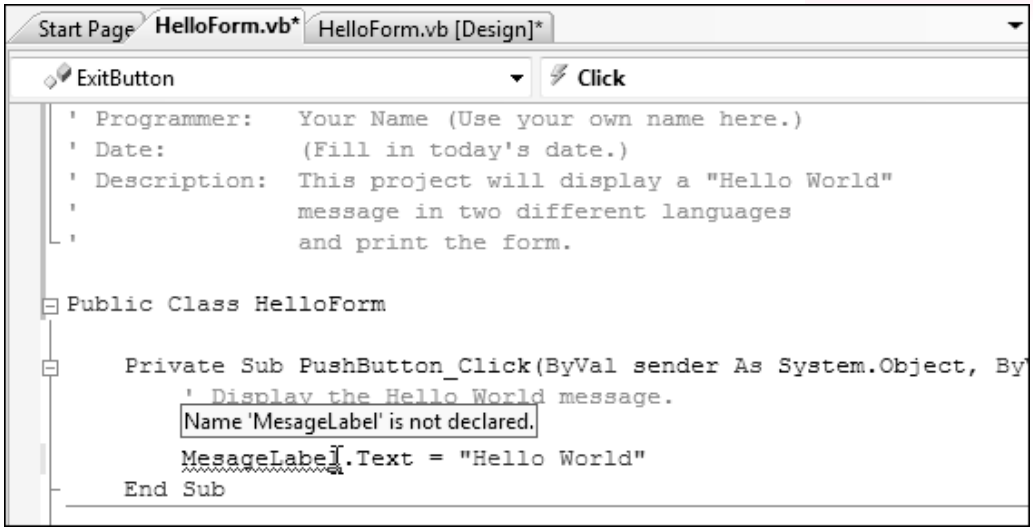
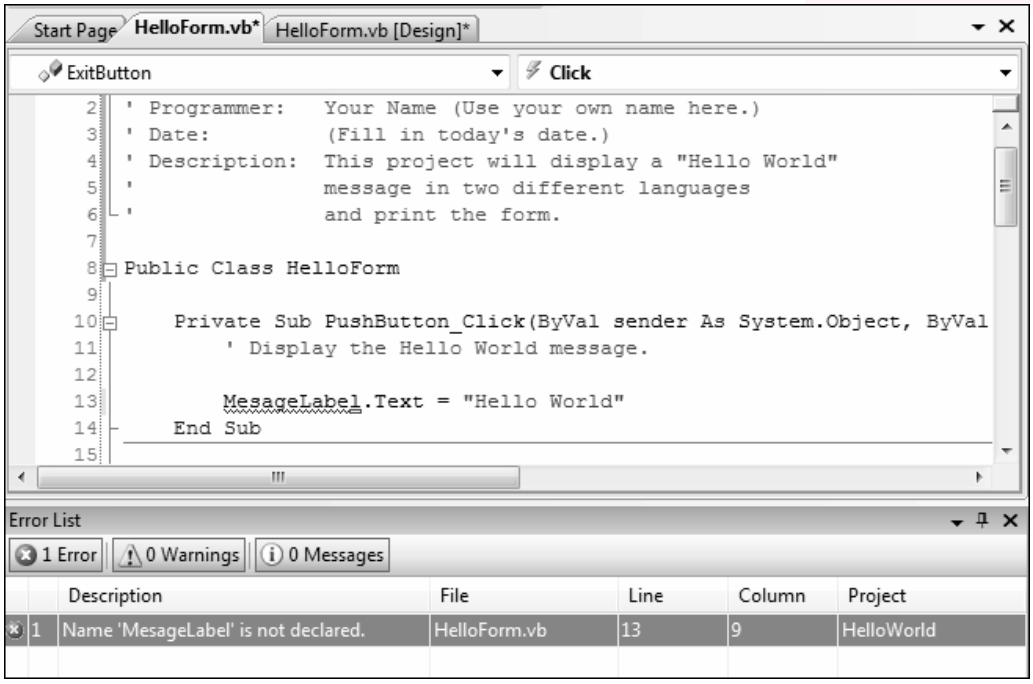


Figure 1.50

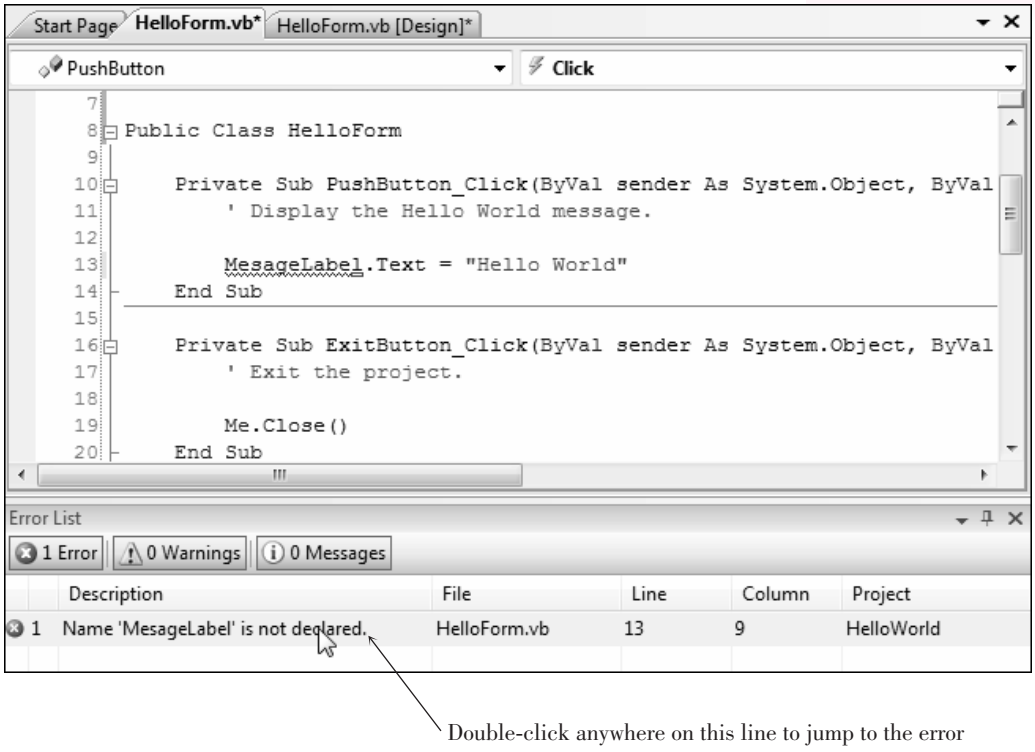
You can display the Error List window and line numbers in the source code to help locate the error lines.



The quickest way to jump to an error line is to point to a message in the Error List window and double-click. The line in error will display in the Editor window with the insertion point in the line (Figure 1.51).

Figure 1.51

Quickly jump to the line in error by double-clicking on the error message in the Error List window.

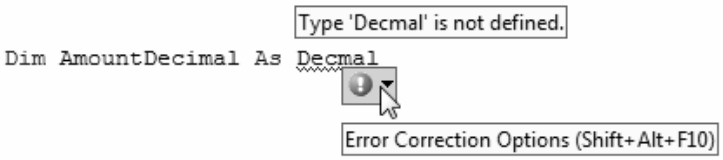


At times the editor can recognize errors and offer suggested solutions. This is more likely to occur in later chapters as you begin to use new keywords. In Chapter 3 you learn to declare elements that can use a data type called *Decimal*. If you accidentally mistype the word Decimal, a small red line appears at the end of the word. Point to the line and an **AutoCorrect** box appears, offering to change the word to the correct spelling. Figures 1.52 and 1.53 show AutoCorrect in action.

TIP

The Visual Basic AutoCorrect feature can suggest corrections for common syntax errors. ■

Figure 1.52



Point to the small red line and the AutoCorrect feature pops up a message and a box with a down arrow. Display the suggestions by clicking the down arrow or pressing Shift + Alt + F10, as suggested in the popup message.

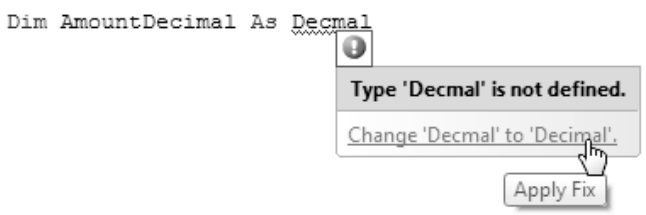


Figure 1.53

The Error Corrections Options box displays suggested corrections. You can make a selection from the list.

If a syntax error is found by the compiler, you will see the dialog box shown in Figure 1.54. Click No and return to the editor, correct your errors, and run the program again.

Figure 1.54

When the compiler identifies syntax errors, it cannot continue. Click No to return to the editor and correct the error.

Run-Time Errors

If your project halts during execution, it is called a *run-time error* or an *exception*. Visual Basic displays a dialog box and highlights the statement causing the problem.

Statements that cannot execute correctly cause run-time errors. The statements are correctly formed Basic statements that pass the syntax checking; however, the statements fail to execute due to some serious issue. You can cause run-time errors by attempting to do impossible arithmetic operations, such as calculate with nonnumeric data, divide by zero, or find the square root of a negative number.

In Chapter 3 you will learn to catch exceptions so that the program does not come to a halt when an error occurs.

Logic Errors

When your program contains logic errors, your project runs but produces incorrect results. Perhaps the results of a calculation are incorrect or the wrong text appears or the text is okay but appears in the wrong location.

Beginning programmers often overlook their logic errors. If the project runs, it must be right—right? All too often, that statement is not correct. You may need to use a calculator to check the output. Check all aspects of the project output: computations, text, and spacing.

For example, the Hello World project in this chapter has event procedures for displaying "Hello World" in English and in Spanish. If the contents of the two procedures were switched, the program would work but the results would be incorrect.

The following code does not give the proper instructions to display the message in Spanish:

```
Private Sub SpanishButton_Click
  ' Display the Hello World Message in Spanish.

  MessageLabel.Text = "Hello World"
End Sub
```

Project Debugging

If you talk to any computer programmer, you will learn that programs don't have errors, but that programs get "bugs" in them. Finding and fixing these bugs is called ***debugging***.

For syntax errors and run-time errors, your job is easier. Visual Basic displays the Editor window with the offending line highlighted. However, you must identify and locate logic errors yourself.

VB 2008 has a very popular feature: edit-and-continue. If you are able to identify the run-time error and fix it, you can continue project execution from that location by clicking on the *Start Debugging* button, pressing F5, or choosing *Debug / Start Debugging*. You also can correct the error and restart from the beginning.

The Visual Studio IDE has some very helpful tools to aid in debugging your projects. The debugging tools are covered in Chapter 4.

A Clean Compile

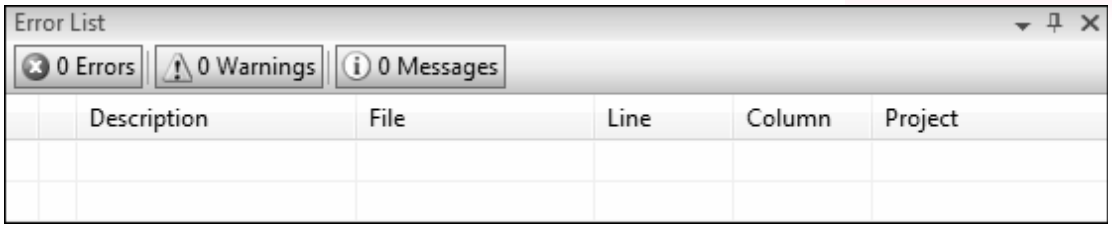
When you start executing your program, the first step is called *compiling*, which means that the VB statements are converted to Microsoft Intermediate Language (MSIL). Your goal is to have no errors during the compile process: a **clean compile**. Figure 1.55 shows the Error List window for a clean compile: 0 Errors; 0 Warnings; 0 Messages.

TIP

If you get the message "There were build errors. Continue?" always say No. If you say Yes, the last cleanly compiled version runs, rather than the current version. ■

Figure 1.55

Zero errors, warnings, and messages means that you have a clean compile.



Naming Rules and Conventions for Objects

Using good consistent names for objects can make a project easier to read and understand, as well as easier to debug. You *must* follow the Visual Basic rules for naming objects, procedures, and variables. In addition, conscientious programmers also follow certain naming conventions.

Most professional programming shops have a set of standards that their programmers must use. Those standards may differ from the ones you find in this book, but the most important point is this: *Good programmers follow standards. You should have a set of standards and always follow them.*

The Naming Rules

When you select a name for an object, Visual Basic requires the name to begin with a letter or an underscore. The name can contain letters, digits, and underscores. An object name cannot include a space or punctuation mark and cannot be a reserved word, such as Button or Close, but can contain one. For example, ExitButton and CloseButton are legal.

The Naming Conventions

This text follows standard naming conventions, which help make projects more understandable. When naming controls, use **Pascal casing**, which means that you begin the name with an uppercase character and capitalize each additional word in the name. Make up a meaningful name and append the full name of the control's class. Do not use an abbreviation unless it is a commonly used term that everyone will understand. All names must be meaningful and indicate the purpose of the object.

Examples
MessageLabel
ExitButton
DataEntryForm
DiscountRateLabel

Do not keep the default names assigned by Visual Basic, such as Button1 and Label3. Also, do not name your objects with numbers. The exception to this rule is for labels or other controls that never change during project execution. Labels usually hold items such as titles, instructions, and labels for other controls. Leaving these labels with their default names is perfectly acceptable and is practiced in this text.

Refer to Table 1.2 for sample object names.

Visual Studio Help

Visual Studio has an extensive Help facility, which contains much more information than you will ever use. You can look up any Basic statement, class, property, method, or programming concept. Many coding examples are available, and you can copy and paste the examples into your own project, modifying them if you wish.

The VS Help facility includes the Microsoft Developer Network library (MSDN), which contains several books, technical articles, and the Microsoft Knowledge Base, a database of frequently asked questions and their answers. MSDN includes reference materials for the VS IDE, the .NET Framework, Visual Basic, C#, and C++. You will want to filter the information to display only the VB information.

Recommended Naming Conventions for Visual Basic Objects **Table 1.2**

Object Class	Example
Form	DataEntryForm
Button	ExitButton
Label	TotalLabel
TextBox	PaymentAmountTextBox
Radio button	BoldRadioButton
CheckBox	PrintSummaryCheckBox
Horizontal scroll bar	RateHorizontalScrollBar
Vertical scroll bar	TemperatureVerticalScrollBar
PictureBox	LandscapePictureBox
ComboBox	BookListComboBox
ListBox	IngredientsListBox
SoundPlayer	IntroPageSoundPlayer

Installing and Running MSDN

You can run MSDN from a local hard drive or from the Web. Of course, if you plan to access MSDN from the Web, you must have a live Internet connection as you work.

Depending on how you install Visual Basic, you are given the option to refer first to local, first to online, or only to local. You can change this setting later in the *Options* dialog box. Select *Tools / Options* and check the *Show All Settings* check box. Then expand the *Environment* node and the *Help* node and click on *Online*. You can choose the options to *Try online first, then local*; *Try local first, then online*; or *Try local only, not online*. Notice also that you can select sites to include in Help topics.

The extensive Help is a two-edged sword: You have available a wealth of materials, but it may take some time to find the topic you want.

Viewing Help Topics

The Help system in Visual Studio 2008 allows you to view the Help topics in a separate window from the VS IDE, so you can have both windows open at the same time. When you choose *How Do I*, *Search*, *Contents*, *Index*, or *Help Favorites* from the *Help* menu, a new window opens on top of the IDE window (Figure 1.56). You can switch from one window to the other, or resize the windows to view both on the screen if your screen is large enough.

You can choose to filter the Help topics so that you don't have to view topics for all of the languages when you search for a particular topic. In the Index or Contents window, drop down the *Filtered By* list and choose *Visual Basic Express Edition* for the Express Edition or *Visual Basic* for the Professional Edition (Figure 1.57).

Figure 1.56

The Help window. Search appears in a tabbed window in the main Document window; Contents, Index, and Help Favorites appear in tabbed windows docked at the left of the main window.

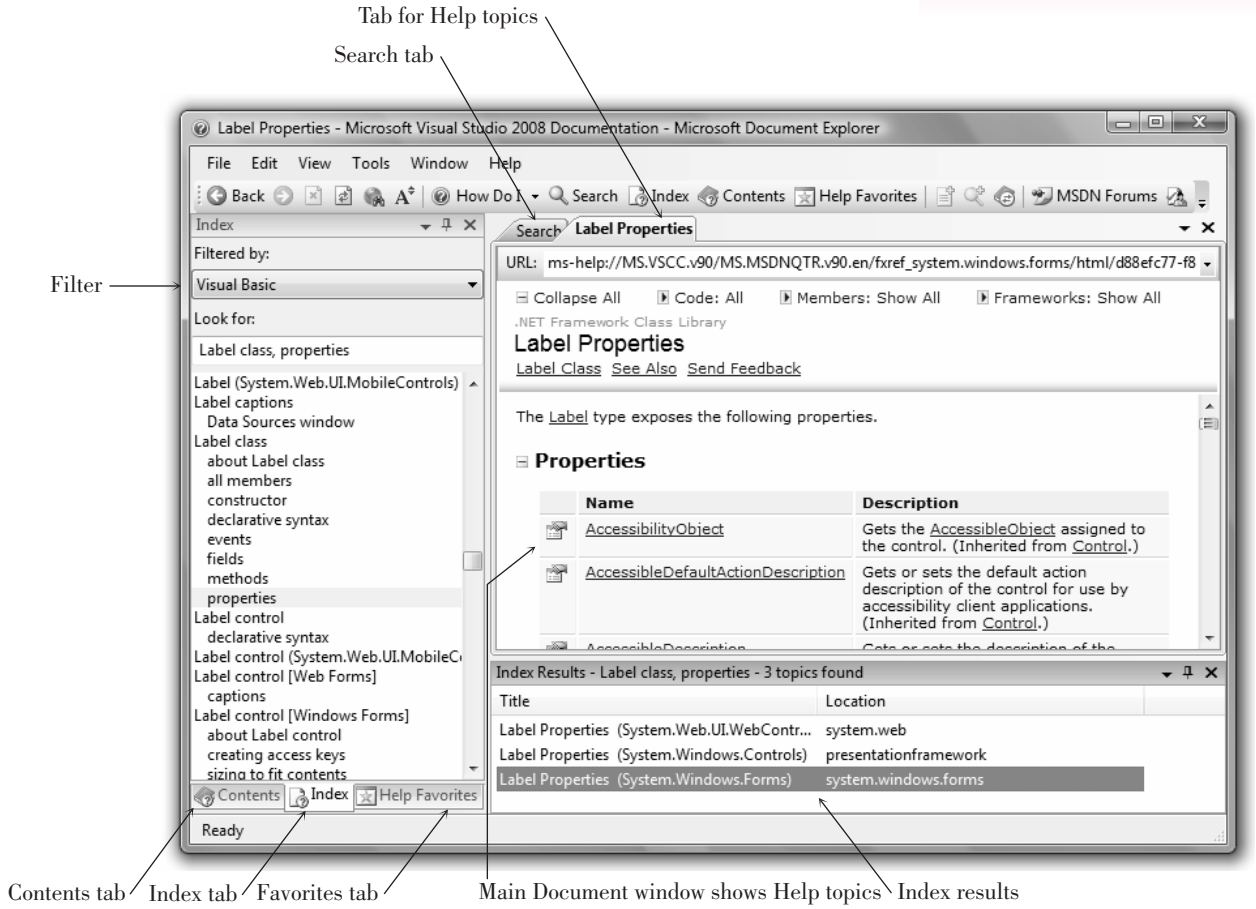
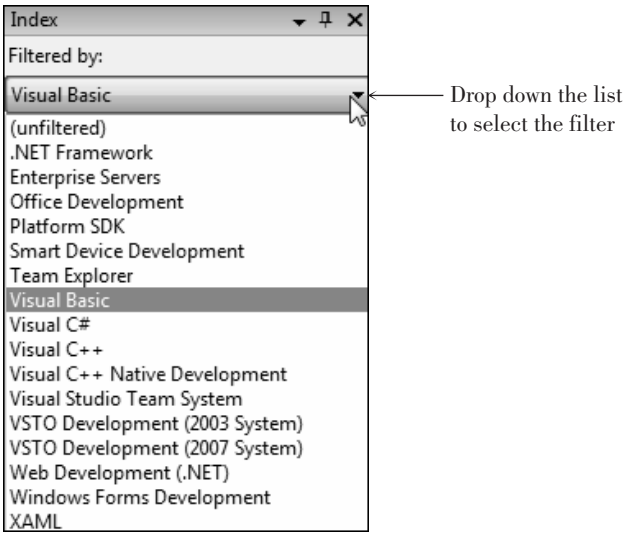


Figure 1.57

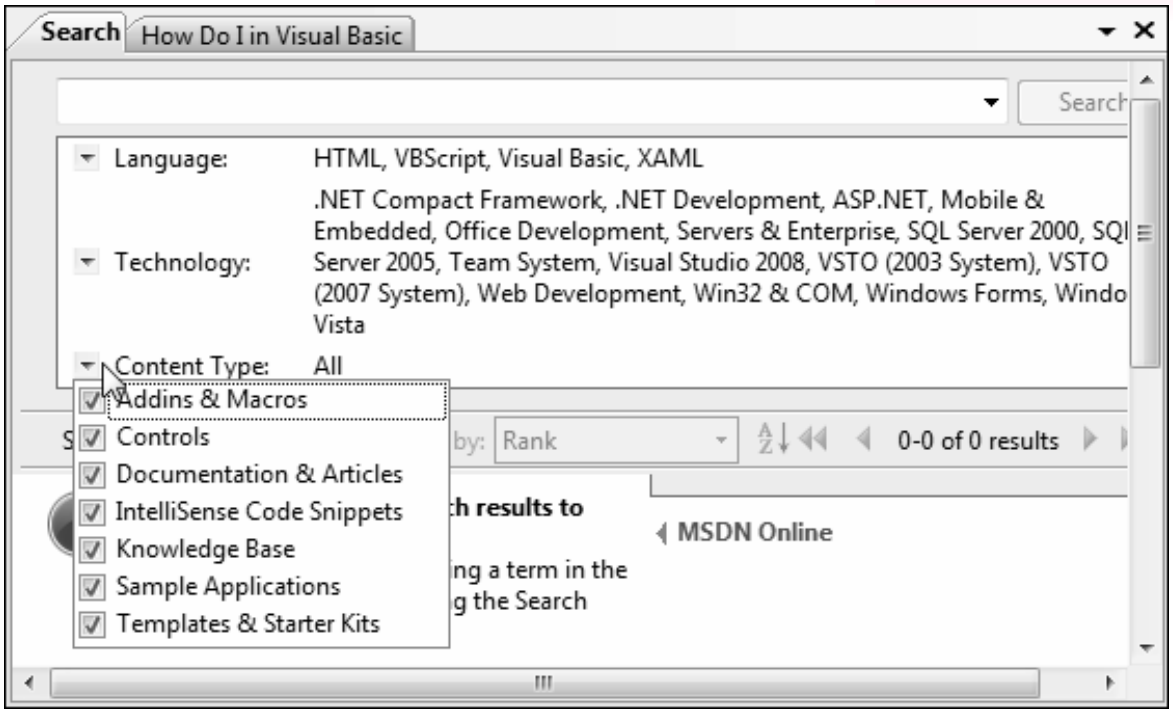
Filter the Help topics so that only the Visual Basic topics appear.



In the Search window, you can choose additional filter options, such as the technology and topic type. Drop down a list and select any desired options (Figure 1.58).

Figure 1.58

Drop down the Content Type list to make selections for the Search window.



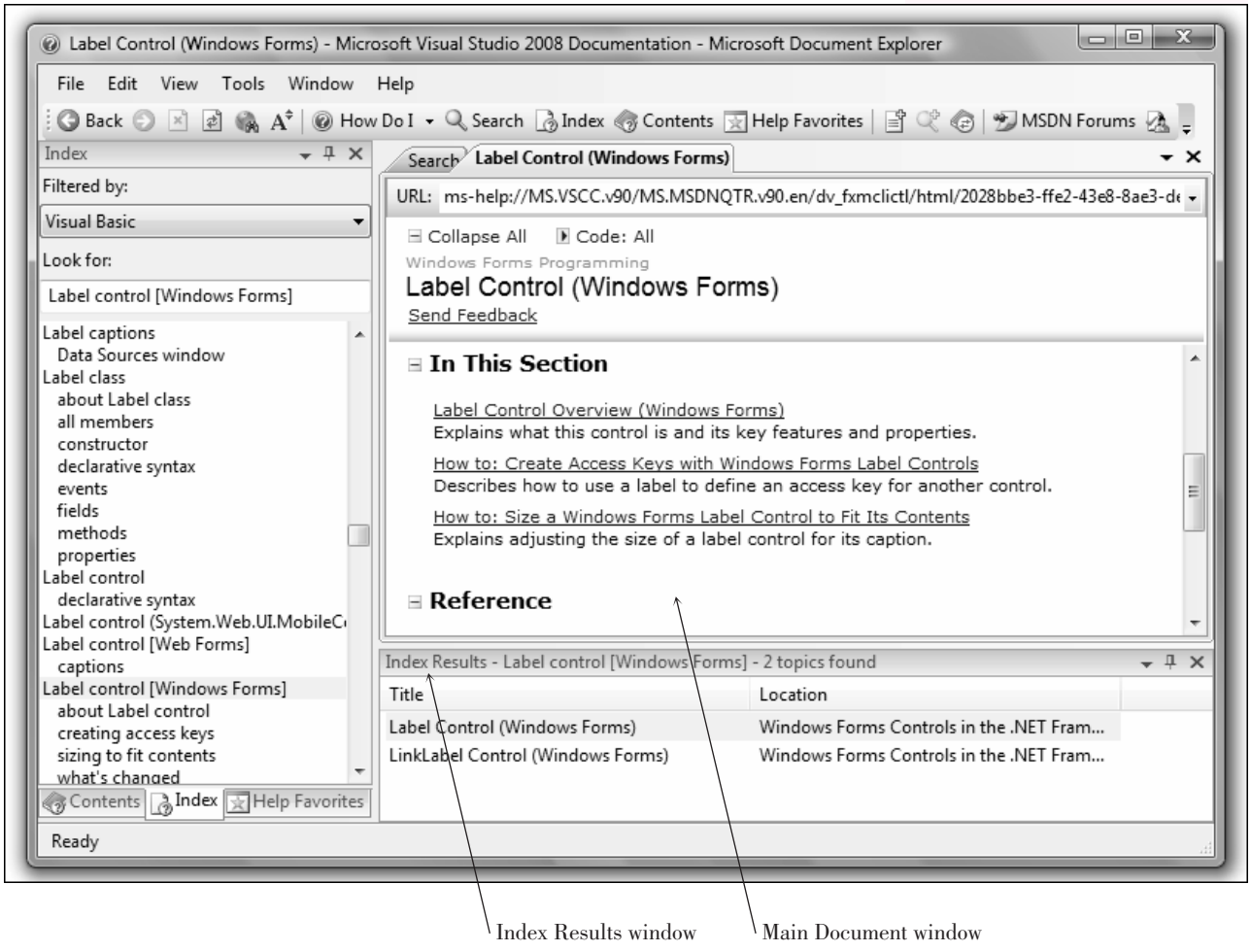
In the Help Index window, you see main topics and subtopics (indented beneath the main topics). All main topics and some subtopics have multiple entries available. When you choose a topic that has more than one possible entry, the choices appear in the Index Results window (Figure 1.59). Double-click on the entry of your choice to display its Help topic in the main Document window.

Many Help topics have entries for both Windows Forms and Web Forms (and some even Mobile Forms). For now, always choose Windows Forms. Chapters 1 to 8 deal with Windows Forms exclusively; Web Forms are introduced in Chapter 9.

A good way to start using Help is to view the topics that demonstrate how to look up topics in Help. On the *Help Contents* tab, select *Help on Help* (*Microsoft Document Explorer Help*). Then choose *Microsoft Document Explorer Overview* and *What's New in Document Explorer*. Make sure to visit *Managing Help Topics* and *Windows*, which has subtopics describing how to copy topics and print topics.

Figure 1.59

When an Index topic has a choice of subtopics, the choices appear in an Index Results pane at the bottom of the screen. Double-click the desired subtopic; the selected topic appears in the main Document window.



Context-Sensitive Help

A quick way to view Help on any topic is to use **context-sensitive Help**. Select a VB object, such as a form or control, or place the insertion point in a word in the editor and press F1. The Help window pops up with the corresponding Help topic displayed, if possible, saving you a search. You can display context-sensitive Help about the environment by clicking in an area of the screen and pressing Shift + F1.

Managing Windows

At times you may have more windows and tabs open than you want. You can hide or close any window, or switch to a different window.

To close a window that is a part of a tabbed window, click the window's Close button. Only the top window will close.

To switch to another window that is part of a tabbed window, click on its tab.

For additional help with the environment, see Appendix C, "Tips and Shortcuts for Mastering the Visual Studio Environment."

Feedback 1.1

Note: Answers for Feedback questions appear in Appendix A.

1. Display the Help Index, filter by *Visual Basic Express Edition* (or *Visual Basic*), and type "button control". In the Index list, notice multiple entries for button controls. Depending on the edition of Visual Basic, you may see entries for HTML, Web Forms, and Windows Forms. Locate the main topic *Button control [Windows Forms]* and click on the entry for *about Button control*. The topics included for the Professional Edition are more extensive than those for the Express Edition. In the Express Edition, only one page matches the selection and it appears in the main Document window. In the Professional Edition, several topics appear in the Index Results list. Click on a title in the Index Results to display the corresponding page in the Document window. Notice that additional links appear in the text in the Document window. You can click on a link to view another topic.
2. Display the Editor window of your Hello World project. Click on the `Close` method to place the insertion point. Press the F1 key to view context-sensitive help.
3. Select each of the options from the VS IDE's *Help* menu to see how they respond.

Your Hands-On Programming Example

Write a program for R 'n R--For Reading and Refreshment to display the current special promotions. Include labels to display the current special and the promotion code and buttons for each of the following departments: Books, Music, Periodicals, and Coffee Bar.

The user interface should also have buttons for *Print* and *Exit* and a label with the programmer's name. Change the name of the form to MainForm, and place "R 'n R--For Reading and Refreshment" in the title bar of the form.

The *Print* button should display the form in a Print Preview window.

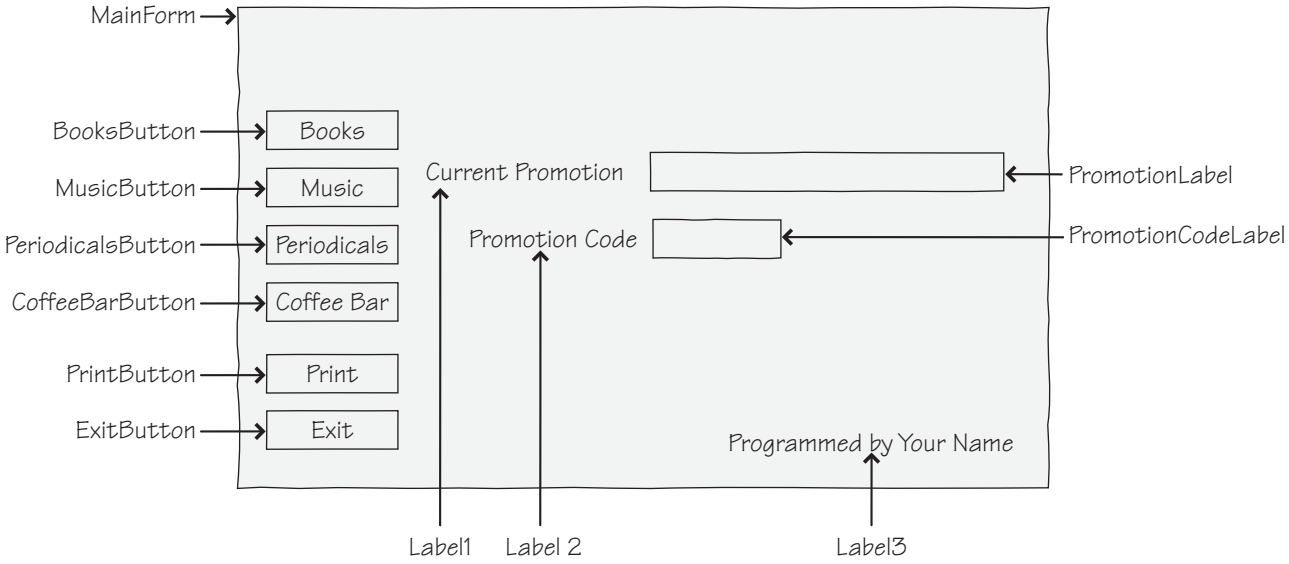
Planning the Project

Sketch a form (Figure 1.60), which your users sign off on as meeting their needs.

Note: Although this step may seem unnecessary, having your users sign off is standard programming practice and documents that your users have been involved and have approved the design.

Figure 1.60

A Planning sketch of the form for the hands-on programming example.



Plan the Objects and Properties Plan the property settings for the form and for each control.

Object	Property	Setting
MainForm	Name	MainForm
	Text	R 'n R--For Reading and Refreshment
	StartPosition	CenterScreen
BooksButton	Name	BooksButton
	Text	Books
MusicButton	Name	MusicButton
	Text	Music
PeriodicalsButton	Name	PeriodicalsButton
	Text	Periodicals
CoffeeBarButton	Name	CoffeeBarButton
	Text	Coffee Bar
PrintButton	Name	PrintButton
	Text	Print
ExitButton	Name	ExitButton
	Text	Exit
Label1	Text	Current Promotion
Label2	Text	Promotion Code
Label3	Text	Programmed by Your Name
PromotionLabel	Name	PromotionLabel
	AutoSize	False
	BorderStyle	FixedSingle
	Text	(blank)
	TextAlign	MiddleLeft

PromotionCodeLabel	Name	PromotionCodeLabel
	AutoSize	False
	BorderStyle	FixedSingle
	Text	(blank)
	TextAlign	MiddleLeft
PrintForm1	Name	PrintForm1

Plan the Event Procedures You will need event procedures for each button. Write the actions in pseudocode, which is English language that is "like code."

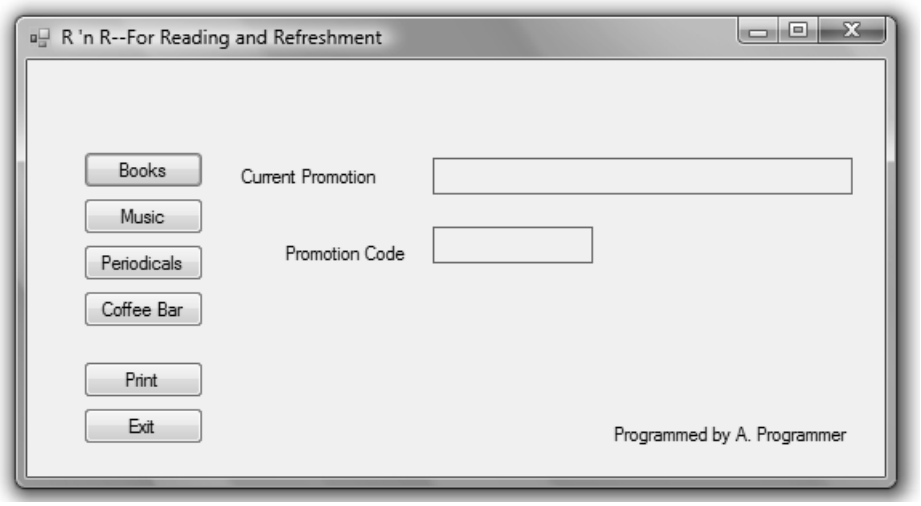
Procedure	**Actions—Pseudocode**
BooksButton_Click	Display "Buy two, get the second one for half price" and code B608.
MusicButton_Click	Display "Get a free MP3 download with purchase of a CD" and code M608.
PeriodicalsButton_Click	Display "Elite members receive 10% off every purchase" and code P608.
CoffeeBarButton_Click	Display "Celebrate the season with 20% off specialty drinks" and code C608.
PrintButton_Click	Set the print action to Print Preview. Call the Print method.
ExitButton_Click	End the project.

Write the Project Follow the sketch in Figure 1.60 to create the form. Figure 1.61 shows the completed form.

- Set the properties of each object, as you have planned.
- Working from the pseudocode, write each event procedure.
- When you complete the code, thoroughly test the project.

Figure 1.61

The form for the hands-on programming example



The Project Coding Solution

```
'Project:              Ch01HandsOn
'Programmer:           Bradley/Millspaugh
'Date:                 June 2008
'Description:          This project displays current promotions for each department.

Public Class MainForm

  Private Sub BooksButton_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles BooksButton.Click
      ' Display the current promotion.

      PromotionLabel.Text = "Buy two, get the second one for half price."
      PromotionCodeLabel.Text = "B608"
  End Sub

  Private Sub MusicButton_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles MusicButton.Click
      ' Display the current promotion.

      PromotionLabel.Text = "Get a free MP3 download with purchase of a CD."
      PromotionCodeLabel.Text = "M608"
  End Sub

  Private Sub PeriodicalsButton_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles PeriodicalsButton.Click
      ' Display the current promotion.

      PromotionLabel.Text = "Elite members receive 10% off every purchase."
      PromotionCodeLabel.Text = "P608"
  End Sub

  Private Sub CoffeeBarButton_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles CoffeeBarButton.Click
      ' Display the current promotion.

      PromotionLabel.Text = "Celebrate the season with 20% off specialty drinks."
      PromotionCodeLabel.Text = "C608"
  End Sub

  Private Sub PrintButton_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles PrintButton.Click
      ' Print the form.

      PrintForm1.PrintAction = Printing.PrintAction.PrintToPreview
      PrintForm1.Print()
  End Sub

  Private Sub ExitButton_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles ExitButton.Click
      ' End the program.

      Me.Close()
  End Sub

End Class
```

Summary

1. Visual Basic is an object-oriented language primarily used to write application programs that run in Windows or on the Internet using a graphical user interface (GUI).
2. In the OOP object model, classes are used to create objects that have properties, methods, and events.
3. The current release of Visual Basic is called 2008. Visual Basic is part of Visual Studio. VB 2008 has an Express Edition, a Standard Edition, a Professional Edition, and a Team System Edition.
4. The .NET Framework provides an environment for the objects from many languages to interoperate. Each language compiles to Microsoft Intermediate Language (MSIL) and runs in the Common Language Runtime (CLR).
5. To plan a project, first sketch the user interface and then list the objects and properties needed. Then plan the necessary event procedures.
6. The three steps to creating a Visual Basic project are (1) define the user interface, (2) set the properties, and (3) write the Basic code.
7. A Visual Basic application is called a *solution*. Each solution can contain multiple projects, and each project may contain multiple forms and additional files. The solution file has an extension of .sln, a project file has an extension of .vbproj, and form files and additional VB files have an extension of .vb. In addition, the Visual Studio environment and the VB compiler both create several more files.
8. The Visual Studio integrated development environment (IDE) consists of several tools, including a form designer, an editor, a compiler, a debugger, an object browser, and a Help facility.
9. VB has three modes: design time, run time, and debug time.
10. You can customize the Visual Studio IDE and reset all customizations back to their default state.
11. You create the user interface for an application by adding controls from the toolbox to a form. You can move, resize, and delete the controls.
12. The Name property of a control is used to refer to the control in code. The Text property holds the words that the user sees on the screen.
13. Visual Basic code is written in procedures. Sub procedures begin with the word `Sub` and end with `End Sub`.
14. Project remarks are used for documentation. Good programming practice requires remarks in every procedure and in the Declarations section of a file.
15. Assignment statements assign a value to a property or a variable. Assignment statements work from right to left, assigning the value on the right side of the equal sign to the property or variable named on the left side of the equal sign.
16. The `Me.Close()` method terminates program execution.
17. Each event to which you want to respond requires an event procedure.
18. You can print out the Visual Basic code for documentation. You also can use the PrintForm component in an application to print the current form, either to the printer or to the Print Preview window.
19. Three types of errors can occur in a Visual Basic project: syntax errors, which violate the syntax rules of the Basic language; run-time errors, which

contain a statement that cannot execute properly; and logic errors, which produce erroneous results.

20. Finding and fixing program errors is called *debugging*.
21. You should have a clean compile before you run the program.
22. Following good naming conventions can help make a project easier to debug.
23. Visual Basic Help has very complete descriptions of all project elements and their uses. You can use the *How Do I*, *Contents*, *Index*, *Search*, Help Favorites, or context-sensitive Help.

Key Terms

assignment statement *30*
AutoCorrect *48*
Button *19*
class *4*
clean compile *50*
code *6*
component tray *42*
context menu *23*
context-sensitive Help *55*
control *3*
debug time *14*
debugging *50*
Declarations section *43*
design time *14*
Document window *12*
event *4*
event procedure *30*
Express Edition *5*
form *3*
Form Designer *13*
graphical user interface (GUI) *3*
handle *13*
Help *13*
integrated development environment (IDE) *8*
Label *19*
logic error *46*
method *4*
namespace *23*
object *4*
object-oriented programming (OOP) *3*
Pascal casing *51*
PrintForm *41*
procedure *29*
Professional Edition *5*
Properties window *13*
property *4*
pseudocode *6*
remark *30*
resizing handle *21*
run time *14*
run-time error *46*
snap lines *21*
solution *7*
Solution Explorer window *13*
solution file *7*
Standard Edition *5*
sub procedure *29*
syntax error *46*
Team System Edition *5*
Text property *25*
toolbar *12*
toolbox *13*
user interface *6*
Visual Studio environment *8*

Review Questions

1. What are objects and properties? How are they related to each other?
2. What are the three steps for planning and creating Visual Basic projects? Describe what happens in each step.
3. What is the purpose of these Visual Basic file types: .sln, .suo, and .vb?
4. When is Visual Basic in design time? run time? debug time?
5. What is the purpose of the Name property of a control?
6. Which property determines what appears on the form for a Label control?
7. What is the purpose of the Text property of a button? the Text property of a form?
8. What does PushButton_Click mean? To what does PushButton refer? To what does Click refer?
9. What is a Visual Basic event? Give some examples of events.
10. What property must be set to center text in a label? What should be the value of the property?
11. What is the Declarations section of a file? What belongs there?
12. What is meant by the term *debugging*?
13. What is a syntax error, when does it occur, and what might cause it?
14. What is a run-time error, when does it occur, and what might cause it?
15. What is a logic error, when does it occur, and what might cause it?
16. Tell the class of control and the likely purpose of each of these object names:
    AddressLabel
    ExitButton
    NameTextBox
    TextBlueRadioButton
17. What does context-sensitive Help mean? How can you use it to see the Help page for a button?

Programming Exercises

1.1 For your first Visual Basic exercise, you must first complete the Hello World project. Then add buttons and event procedures to display the "Hello World" message in two more languages. You may substitute any other languages for those shown. Feel free to modify the user interface to suit yourself (or your instructor).

Make sure to use meaningful names for your new buttons, following the naming conventions in Table 1.2. Include remarks at the top of every procedure and at the top of the file.

"Hello World" in French:	Bonjour tout le monde
"Hello World" in Italian:	Ciao Mondo

1.2 Write a new Visual Basic project that displays a different greeting, or make it display the name of your school or your company. Include at least three buttons to display the greeting, print, and exit the project.

Include a label that holds your name at the bottom of the form and change the Text property of the form to something meaningful.

Follow good naming conventions for object names; include remarks at the top of every procedure and at the top of the file.

Select a different font name and font size for the greeting label. If you wish, you also can select a different color for the font. Select each font attribute from the *Font* dialog box from the Properties window.

1.3 Write a project that displays four sayings, such as "The early bird gets the worm" or "A penny saved is a penny earned." (You will want to keep the sayings short, as each must be entered on one line.) When the saying displays on your form, long lines will run off the form if the label's AutoSize property is set to True. To wrap text within the label, change the AutoSize property to False and use the sizing handles to make the label large enough.

Make a button for each saying with a descriptive Text property for each, a button to print, and a button to exit the project.

Include a label that holds your name at the bottom of the form. Also, make sure to change the form's title bar to something meaningful.

You may change the Font properties of the large label to the font and size of your choice.

Make sure the buttons are large enough to hold their entire Text properties.

Follow good naming conventions for object names; include remarks at the top of every procedure and at the top of the file.

1.4 Write a project to display company contact information. Include buttons and labels for the contact person, department, and phone. When the user clicks on one of the buttons, display the contact information in the corresponding label. Include a button to print and another to exit.

Include a label that holds your name at the bottom of the form and change the title bar of the form to something meaningful.

You may change the Font properties of the labels to the font and size of your choice.

Follow good naming conventions for object names; include remarks at the top of every procedure and at the top of the file.

1.5 Create a project to display the daily specials for "your" diner. Make up a name for your diner and display it in a label at the top of the form. Add a label to display the appropriate special depending on the button that is pressed. The buttons should be

- Soup of the Day
- Chef's Special
- Daily Fish

Also include a *Print* button and an *Exit* button.

Sample Data: Dorothy's Diner is offering Tortilla Soup, a California Cobb Salad, and Hazelnut-Coated Mahi Mahi.

Case Studies

Very Busy (VB) Mail Order

If you don't have the time to look for all those hard-to-find items, tell us what you're looking for. We'll send you a catalog from the appropriate company or order for you.

We can place an order and ship it to you. We also help with shopping for gifts; your order can be gift wrapped and sent anywhere you wish.

The company title will be shortened to VB Mail Order. Include this name on the title bar of the first form of each project that you create for this case study.

Your first job is to create a project that will display the name and telephone number for the contact person for the customer relations, marketing, order processing, and shipping departments.

Include a button for each department. When the user clicks on the button for a department, display the name and telephone number for the contact person in two labels. Also include identifying labels with Text "Department Contact" and "Telephone Number".

Be sure to include a button for *Print* and one for *Exit*.

Include a label at the bottom of the form that holds your name.

Test Data

Department	Department Contact	Telephone Number
Customer Relations	Tricia Mills	500-1111
Marketing	Michelle Rigner	500-2222
Order Processing	Kenna DeVoss	500-3333
Shipping	Eric Andrews	500-4444

Valley Boulevard (VB) Auto Center

Valley Boulevard Auto Center will meet all of your automobile needs. The center has facilities with everything for your vehicles including sales and leasing for new and used cars and RVs, auto service and repair, detail shop, car wash, and auto parts.

The company title will be shortened to VB Auto Center. This name should appear as the title bar on the first form of every project that you create throughout the text for this case study.

Your first job is to create a project that will display current notices.

Include four buttons labeled "Auto Sales", "Service Center", "Detail Shop", and "Employment Opportunities". One label will be used to display the information when the buttons are clicked. Be sure to include a *Print* button and an *Exit* button.

Include your name in a label at the bottom of the form.

Test Data

Button	Label Text
Auto Sales	Family wagon, immaculate condition $12,995
Service Center	Lube, oil, filter $25.99
Detail Shop	Complete detail $79.95 for most cars
Employment Opportunities	Sales position, contact Mr. Mann 551-2134 x475

Video Bonanza

This neighborhood store is an independently owned video rental business. The owners would like to allow their customers to use the computer to look up the aisle number for movies by category.

Create a form with a button for each category. When the user clicks on a button, display the corresponding aisle number in a label. Include a button to print and one to exit.

Include a label that holds your name at the bottom of the form and change the title bar of the form to Video Bonanza.

You may change the font properties of the labels to the font and size of your choice. Include additional categories, if you wish.

Follow good programming conventions for object names; include remarks at the top of every procedure and at the top of the file.

Test Data

Button	Location
Comedy	Aisle 1
Drama	Aisle 2
Action	Aisle 3
Sci-Fi	Aisle 4
Horror	Aisle 5
New Releases	Back Wall

Very Very Boards

This chain of stores features a full line of clothing and equipment for snowboard and skateboard enthusiasts. Management wants a computer application to allow their employees to display the address and hours for each of their branches.

Create a form with a button for each store branch. When the user clicks on a button, display the correct address and hours.

Include a label that holds your name at the bottom of the form and change the title bar of the form to Very Very Boards.

You may change the font properties of the labels to the font and size of your choice.

Include a *Print* button and an *Exit* button. Follow good programming conventions for object names; include remarks at the top of every procedure and at the top of the file.

Store Branches: The three branches are Downtown, Mall, and Suburbs. Make up hours and locations for each.

CHAPTER

2

User Interface Design

at the completion of this chapter, you will be able to . . .

1. Use text boxes, masked text boxes, rich text boxes, group boxes, check boxes, radio buttons, and picture boxes effectively.
2. Set the BorderStyle property to make controls appear flat or three-dimensional.
3. Select multiple controls and move them, align them, and set common properties.
4. Make your projects easy for the user to understand and operate by defining access keys, setting an Accept and a Cancel button, controlling the tab sequence, resetting the focus during program execution, and causing ToolTips to appear.
5. Clear the contents of text boxes and labels.
6. Make a control visible or invisible at run time by setting its Visible property.
7. Disable and enable controls at design time and run time.
8. Change text color during program execution.
9. Code multiple statements for one control using the `With` and `End With` statements.
10. Concatenate (join) strings of text.
11. Download the Line and Shape controls, add them to the toolbox, and use the controls on your forms.

Introducing More Controls

In Chapter 1 you learned to use labels and buttons. In this chapter you will learn to use several more control types: text boxes, group boxes, check boxes, radio buttons, and picture boxes. Figure 2.1 shows the toolbox, with the *Containers* and *Common Controls* tabs open, to show the tools for these new controls. Figure 2.2 shows some of these controls on a form. You will also download, install, and use the Line and Shape controls in the Visual Basic PowerPack 2.0.

Each class of controls has its own set of properties. To see a complete list of the properties for any class of control, you can (1) place a control on a form and examine the properties list in the Properties window or (2) click on a tool or a control and press F1 for context-sensitive Help. Visual Studio will display the Help page for that control, and you can view a list of the properties and an explanation of their use.

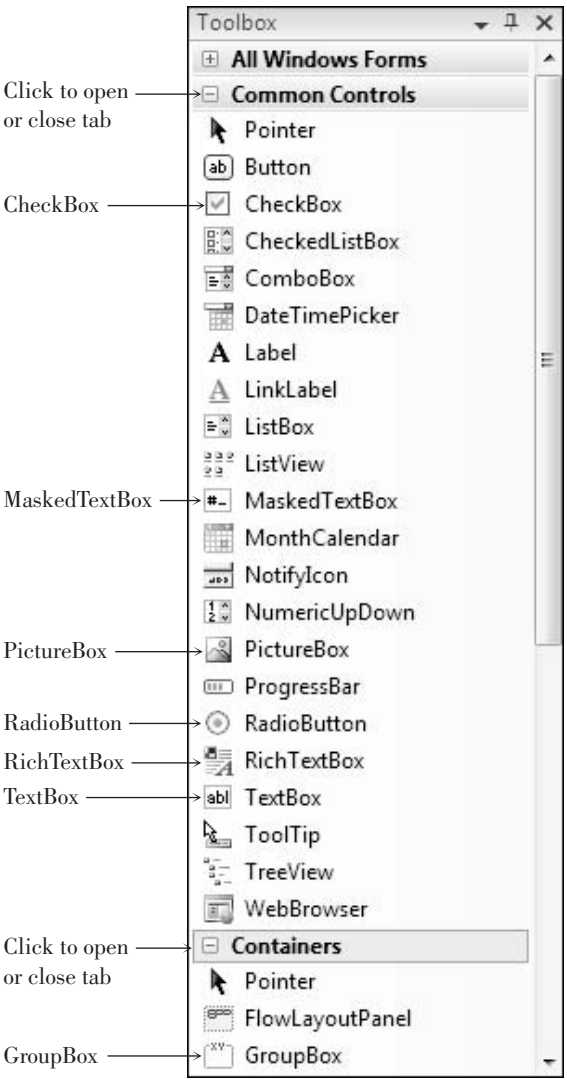


Figure 2.1

The toolbox with two tabs open, showing the new controls that are covered in this chapter. Click the plus and minus signs on the tabs to open and close each section.

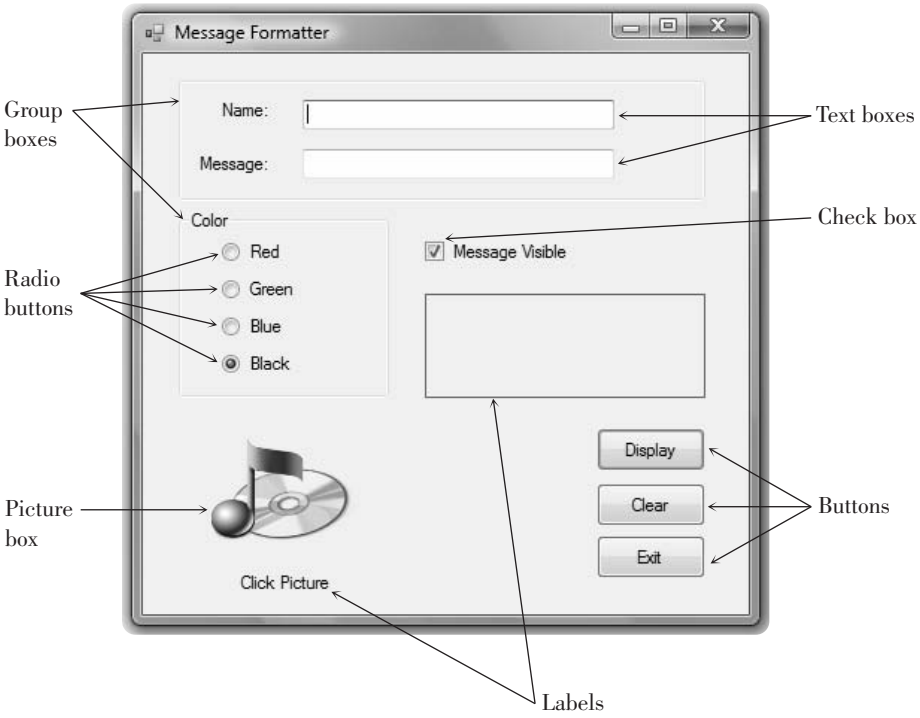


Figure 2.2

This form uses labels, text boxes, a check box, radio buttons, group boxes, and a picture box.

Text Boxes

Use a **text box** control when you want the user to type some input. The form in Figure 2.2 has two text boxes. The user can move from one box to the next, make corrections, cut and paste if desired, and click the *Display* button when finished. In your program code you can use the **Text property** of each text box.

Example

```
NameLabel.Text = NameTextBox.Text
```

In this example, whatever the user enters into the text box is assigned to the Text property of NameLabel. If you want to display some text in a text box during program execution, assign a literal to the Text property:

```
MessageTextBox.Text = "Watson, come here."
```

You can set the **TextAlign property** of text boxes to change the alignment of text within the box. In the Properties window, set the property to *Left*, *Right*, or *Center*. In code, you can set the property using these values:

HorizontalAlignment.Left
HorizontalAlignment.Right
HorizontalAlignment.Center

```
MessageTextBox.TextAlign = HorizontalAlignment.Left
```

Example Names for Text Boxes

```
TitleTextBox
CompanyTextBox
```

Masked Text Boxes

A specialized form of the TextBox control is the **MaskedTextBox**. You can specify the format (the Mask property) of the data required of the user. For example, you can select a mask for a ZIP code, a date, a phone number, or a social security number. Figure 2.3 shows the *Input Mask* dialog box where you can select the mask and even try it out. At run time the user cannot enter characters that do not conform to the mask. For example, the phone number and social security number masks do not allow input other than numeric digits.

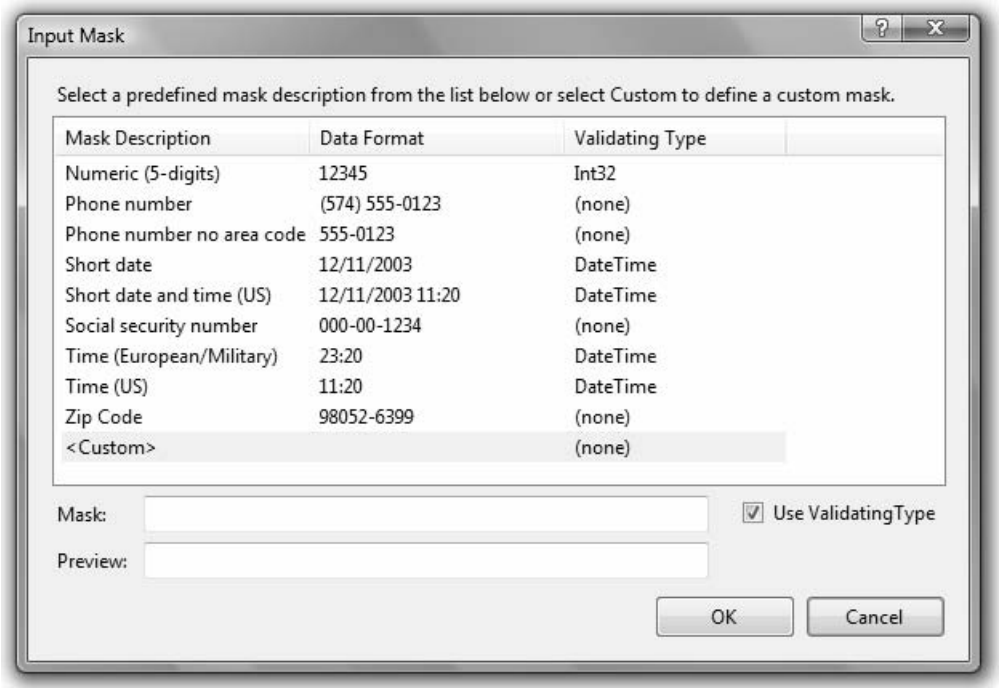
Example Names for Masked Text Boxes

```
DateMaskedTextBox
PhoneMaskedTextBox
```

Note: For a date or time mask, the user can enter only numeric digits but may possibly enter an invalid value; for example, a month or hour greater than 12. The mask will accept any numeric digits, which could possibly cause your program to generate a run-time error. You will learn to check the input values in Chapter 4.

Figure 2.3

Select a format for the input mask in the Input Mask dialog box, which supplies the Mask property of the MaskedTextBox control.



Rich Text Boxes

Another variety of text box is the **RichTextBox** control, which offers a variety of formatting features (Figure 2.4). In a regular text box, all of the text is formatted the same, but in a rich text box, the user can apply character and paragraph formatting to selected text, much like using a word processor.

One common use for a rich text box is for displaying URL addresses. In a regular text box, the address appears in the default font color, but the rich text box displays it as a link when the DetectUrl property is set to True. Note that it is not an active link, but it does have the formatting to show the URL as an address.

You also can load formatted text into a rich text box from a file stored in rich text format (rtf). Use the `LoadFile` method of the rich text box. In this example, the file "Rich Text Boxes.rtf" is stored in the bin/debug folder, but you could include the complete path to load a file from another location.

```
SampleRichTextBox.LoadFile("Rich Text Boxes.rtf")
```

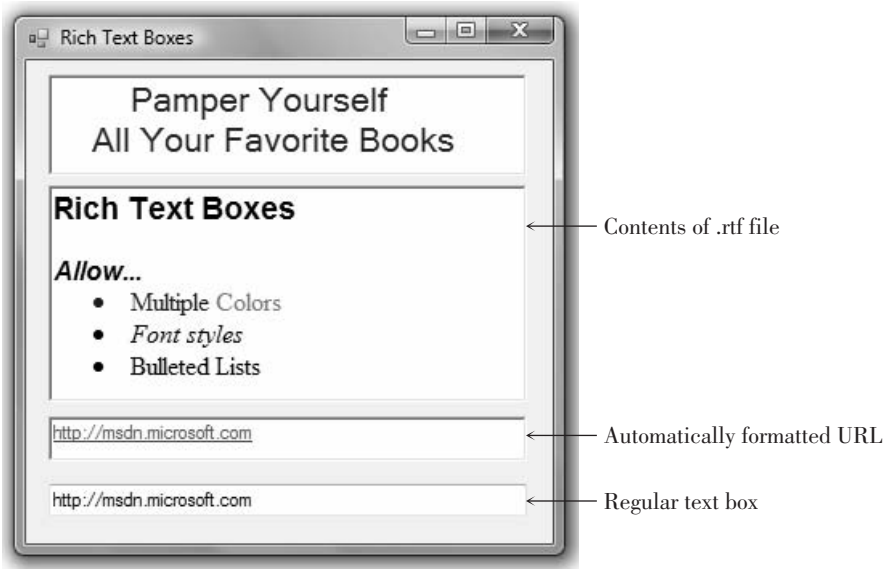


Figure 2.4

Using the RichTextBox control, you can apply font styles to selected text, show formatted URLs, and display text from a formatted .rtf file

Displaying Text on Multiple Lines

Both the regular text box and the rich text box have properties that allow you to display text on multiple lines. The **WordWrap property** determines whether the contents should wrap to a second line if they do not fit on a single line. The property is set to True by default. Both controls also have a **Multiline property**, which is set to False by default on a text box and True on a rich text box. Both WordWrap and Multiline must be set to True for text to wrap to a second line.

For a regular text box, you must set Multiline to True and then adjust the height to accommodate multiple lines. If Multiline is False (the default), a text box does not have resizing handles for vertical resizing. Be aware that a text box

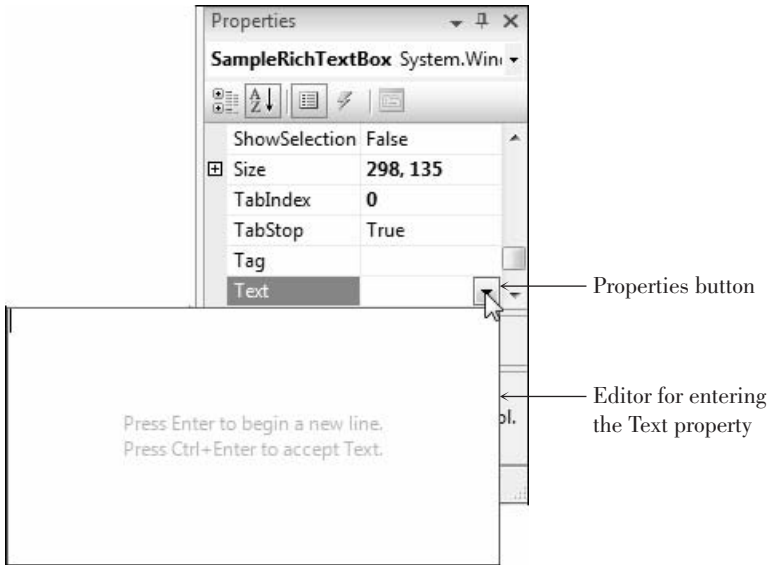
will not automatically resize to display multiple lines even though Multiline is True; you must make the height tall enough to display the lines.

You can set the Text property of a multiline text box (or rich text box) to a long value; the value will wrap to fit in the width of the box. You also can enter multiple lines and choose the location of the line breaks; the techniques differ depending on whether you set the Text property at design time or in code. At design time, click on the Text property in the Properties window and click on the Properties button (the down arrow); a small editing window pops up with instructions to press Enter at the end of each line and Ctrl + Enter to accept the text (Figure 2.5). In code, you can use a **NewLine character** (`Environment.NewLine`) in the text string where you want the line to break. Joining strings of text is called *concatenation* and is covered in "Concatenating Text" later in this chapter.

```
TitleRichTextBox.Text = " Pamper Yourself" & Environment.NewLine & _
  "All Your Favorite Books"
```

Figure 2.5

Click the Properties button for the Text property and a small editing box pops up. To enter multiple lines of text, press Enter at the end of each line and Ctrl + Enter to accept the text.



Group Boxes

GroupBox controls are used as **containers** for other controls. Usually, groups of radio buttons or check boxes are placed in group boxes. Using group boxes to group controls can make your forms easier to understand by separating the controls into logical groups.

Set a group box's Text property to the words you want to appear on the top edge of the box.

Example Names for Group Boxes

```
ColorGroupBox
StyleGroupBox
```

Check Boxes

Check boxes allow the user to select (or deselect) an option. In any group of check boxes, any number can be selected. The **Checked property** of a check box is set to False if unchecked or True if checked.

You can write an event procedure for the CheckedChanged event, which executes when the user clicks in the box. In Chapter 4, when you learn about `If` statements, you can take one action when the box is checked and another action when it is unchecked.

Use the Text property of a check box for the text you want to appear next to the box.

Example Names for Check Boxes

```
BoldCheckBox
ItalicCheckBox
```

Radio Buttons

Use **radio buttons** when only one button of a group may be selected. Any radio buttons that you place directly on the form (not in a group box) function as a group. A group of radio buttons inside a group box function together. The best method is to first create a group box and then create each radio button inside the group box.

When you need separate lists of radio buttons for different purposes, you must include each list in a separate group box. You can find an example program later in this chapter that demonstrates using two groups of radio buttons, one for setting the background color of the form and a second set for selecting the color of the text on the form. See "Using Radio Buttons for Selecting Colors."

The Checked property of a radio button is set to True if selected or to False if unselected. You can write an event procedure to execute when the user selects a radio button using the control's CheckedChanged event. In Chapter 4 you will learn to determine in your code whether or not a button is selected.

Set a radio button's Text property to the text you want to appear next to the button.

Example Names for Radio Buttons

```
RedRadioButton
BlueRadioButton
```

Picture Boxes

A **PictureBox control** can hold an image. You can set a picture box's **Image property** to a graphic file with an extension of .bmp, .gif, .jpg, .jpeg, .png, .ico, .emf, or .wmf. You first add your images to the project's resources; then you can assign the resource to the Image property of a PictureBox control.

Place a PictureBox control on a form and then select its Image property in the Properties window. Click on the Properties button (Figure 2.6) to display a ***Select Resource* dialog box** where you can select images that you have already added or add new images (Figure 2.7).

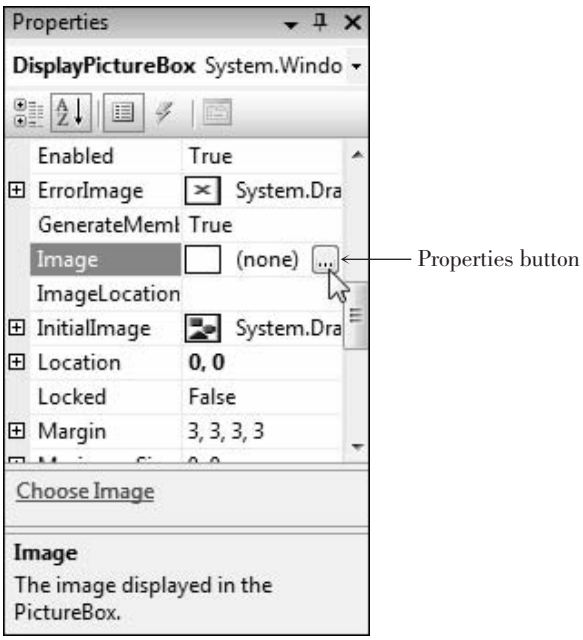


Figure 2.6

Click on the Image property for a PictureBox control, and a Properties button appears. Click on the Properties button to view the Select Resource dialog box.

Figure 2.7

The Select Resource dialog box. Make your selection here for the graphic file you want to appear in the PictureBox control; click Import to add an image to the list.

Click on the *Import* button of the *Select Resource* dialog box to add images. An *Open* dialog box appears (Figure 2.8), where you can navigate to your image files. A preview of the image appears in the preview box.

Note: To add files with an ico extension, select *All Files* for the *Files of type* in the *Open* dialog box.

Figure 2.8

Find the text graphic files and icon files supplied by Microsoft in the Student Data\Graphics folder.

You can use any graphic file (with the proper format) that you have available. You will find many icon files included with the Student Data files on the text Web site (www.mhhe.com/VisualBasic2008).

PictureBox controls have several useful properties that you can set at design time or run time. For example, set the **SizeMode property** to ***StretchImage*** to make the graphic resize to fill the control. You can set the **Visible property** to False to make the picture box disappear.

For example, to make a picture box invisible at run time, use this code statement:

```
LogoPictureBox.Visible = False
```

You can assign a graphic from the Resources folder at run time. You use the `My` keyword, which is a special VB keyword that gives you access to many system settings. In the following example, "Sunset" is the name of a graphic (without its extension) in the Resources folder of the project.

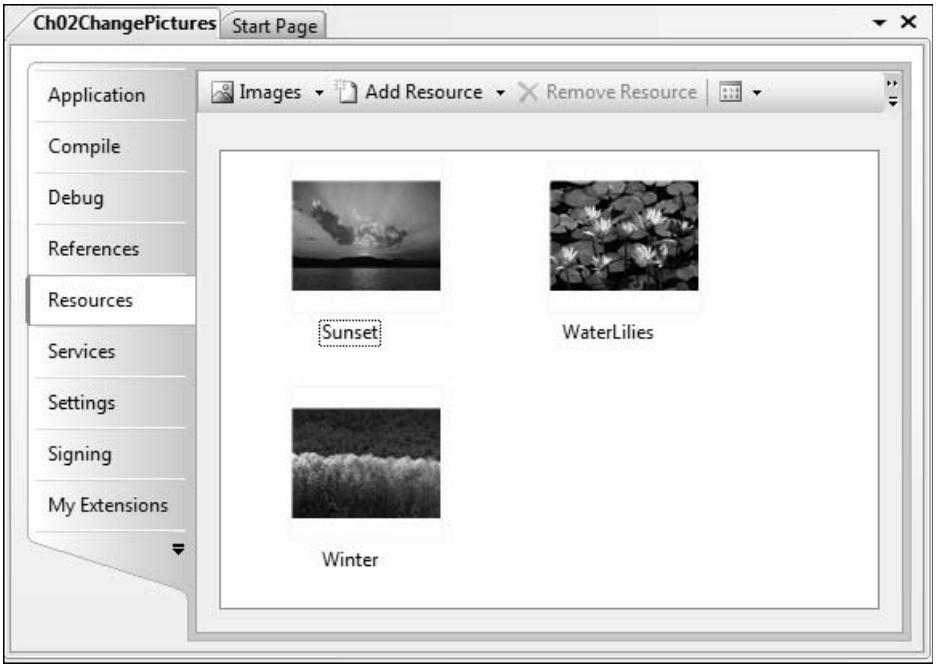
```
SamplePictureBox.Image = My.Resources.Sunset
```

Adding and Removing Resources

In Figure 2.6 you saw the easiest way to add a new graphic to the Resources folder, which you perform as you set the Image property of a PictureBox control. You also can add, remove, and rename resources using the Visual Studio **Project Designer**. From the *Project* menu, select *ProjectName Properties* (which always shows the name of the current project). The Project Designer opens in the main Document window; click on the *Resources* tab to display the project resources (Figure 2.9). You can use the buttons at the top of the window to add and remove images, or right-click an existing resource to rename or remove it.

Figure 2.9

Click on the Resources tab of the Project Designer to work with project resources. You can add, remove, and rename resources on this page.



Using Smart Tags

You can use smart tags to set the most common properties of many controls. When you add a PictureBox or a TextBox to a form, for example, you see a small arrow in the upper-right corner of the control. Click on the arrow to open the smart tag for that control (Figure 2.10). The smart tag shows a few properties that you can set from there, which is just a shortcut for making the changes from the Properties window.

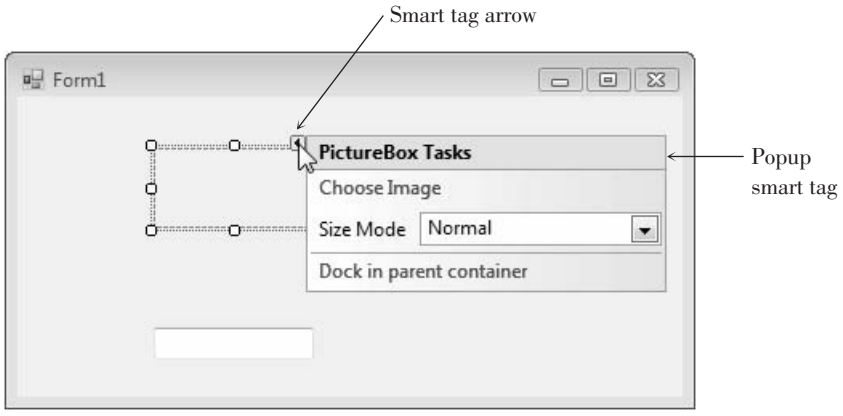


Figure 2.10

Point to the smart tag arrow to open the smart tag for a control. For this PictureBox control, you can set the Image, Size Mode, and Dock properties in the smart tag.

Using Images for Forms and Controls

You can use an image as the background of a form or a control. For a form, set the BackgroundImage property to a graphic resource; also set the form's BackgroundImageLayout property to Tile, Center, Stretch, or Zoom.

Controls such as buttons, check boxes, and radio buttons have an Image property that you can set to a graphic from the project's resources.

Setting a Border and Style

Most controls can appear to be three-dimensional or flat. Labels, text boxes, and picture boxes all have a **BorderStyle property** with choices of *None*, *FixedSingle*, or *Fixed3D*. Text boxes default to *Fixed3D*; labels and picture boxes default to *None*. Of course, you can change the property to the style of your choice.

Feedback 2.1

Create a picture box control that displays an enlarged icon and appears in a 3D box. Make up a name that conforms to this textbook's naming convention.

Property	Setting
Name	
BorderStyle	
SizeMode	
Visible	

Drawing a Line

You can draw a line on a form by using the Label control. You may want to include lines when creating a logo or you may simply want to divide the screen by drawing a line. To create the look of a line, set the AutoSize property of your label to False, set the Text property to blank, set the BorderStyle to *None*, and change the

Backcolor to the color you want for the line. You can control the size of the line with the Width and Height properties, located beneath the Size property.

Another way to draw a line on a form is to use the LineShape control, which you can download and install into Visual Studio. See "Downloading and Using the Line and Shape Controls" later in this chapter.

You also can draw a line on the form using the graphics methods. Drawing graphics is covered in Chapter 13.

Working with Multiple Controls

You can select more than one control at a time, which means that you can move the controls as a group, set similar properties for the group, and align the controls.

Selecting Multiple Controls

There are several methods of selecting multiple controls. If the controls are near each other, the easiest technique is to use the mouse to drag a selection box around the controls. Point to a spot that you want to be one corner of a box surrounding the controls, press the mouse button, and drag to the opposite corner (Figure 2.11). When you release the mouse button, the controls will all be selected (Figure 2.12). Note that selected labels and check boxes with AutoSize set to True do not have resizing handles; other selected controls do have resizing handles.

You also can select multiple controls, one at a time. Click on one control to select it, hold down the Ctrl key or the Shift key, and click on the next control. You can keep the Ctrl or Shift key down and continue clicking on controls you wish to select. Ctrl-click (or Shift-click) on a control a second time to deselect it without changing the rest of the group.

When you want to select most of the controls on the form, use a combination of the two methods. Drag a selection box around all of the controls to select them and then Ctrl-click on the ones you want to deselect. You also can select all of the controls using the *Select All* option on the *Edit* menu or its keyboard shortcut: Ctrl + A.

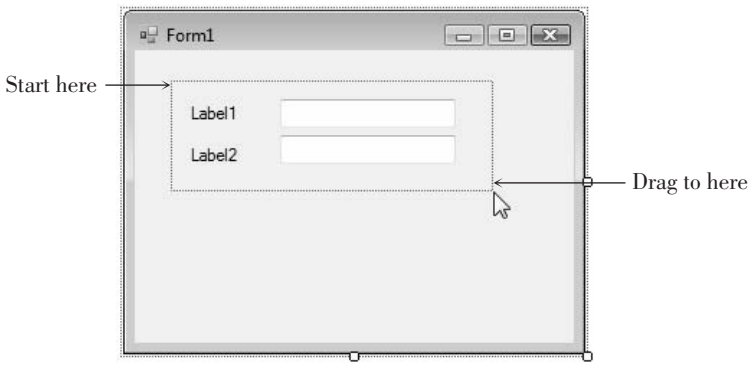


Figure 2.11

Use the pointer to drag a selection box around the controls you wish to select.

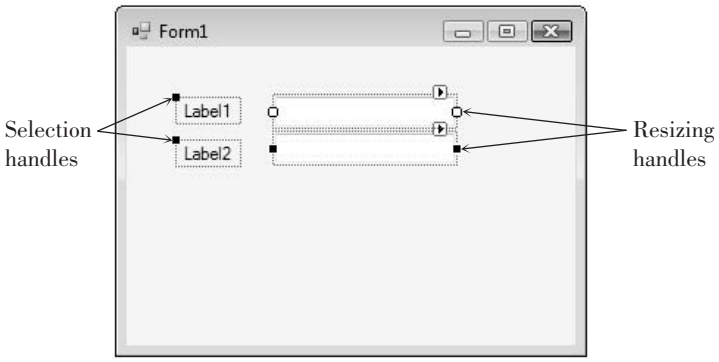


Figure 2.12

When multiple controls are selected, each has resizing handles (if resizable).

Deselecting a Group of Controls

When you are finished working with a group of controls, it's easy to deselect them. Just click anywhere on the form (not on a control) or select another previously unselected control.

Moving Controls as a Group

After selecting multiple controls, you can move them as a group. To do this, point inside one of the selected controls, press the mouse button, and drag the entire group to a new location (Figure 2.13).

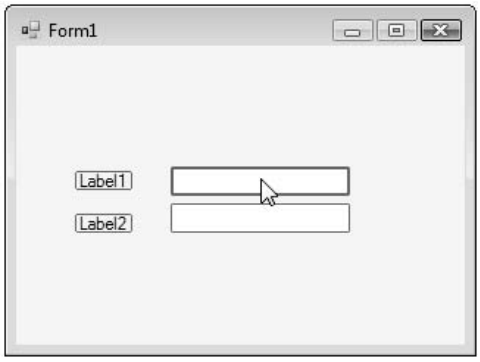


Figure 2.13

Drag a group of selected controls to move the entire group to a new location.

TIP

Make sure to read Appendix C for tips and shortcuts for working with controls. ■

Setting Properties for Multiple Controls

You can set some common properties for groups of controls. After selecting the group, look at the Properties window. Any properties that appear in the window are shared by all of the controls and can be changed all at once. For example, you may want to set the BorderStyle property for a group of controls to three-dimensional or change the font used for a group of labels. Some properties appear empty; those properties do not share a common value. You can enter a new value that will apply to all selected controls.

TIP

Setting the font for the form changes the default font for all controls on the form. ■

Aligning Controls

After you select a group of controls, it is easy to resize and align them using the buttons on the Layout toolbar (Figure 2.14) or the corresponding items on the *Format* menu. Select your group of controls and choose any of the resizing buttons. These can make the controls equal in width, height, or both. Then select another button to align the tops, bottoms, or centers of the controls. You also can move the entire group to a new location.

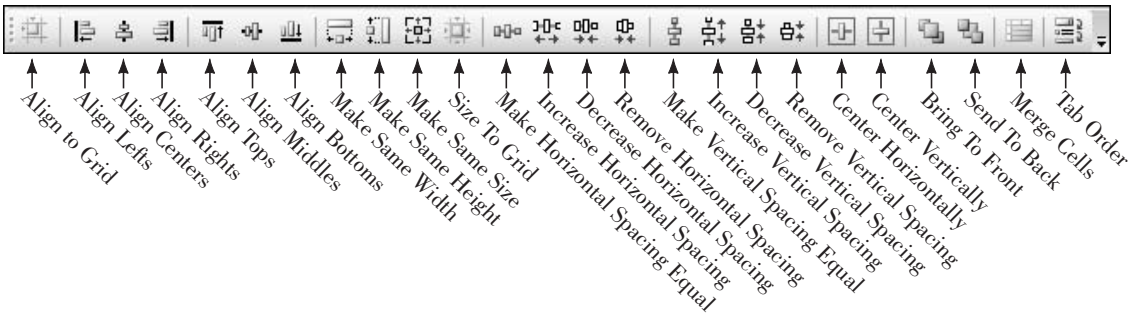
Note: The alignment options align the group of controls to the control that is active (the sizing handles are white). Referring to Figure 2.12, the upper text box is the active control. To make another selected control the active control, simply click on it.

To set the spacing between controls, use the buttons for horizontal and/or vertical spacing. These buttons enable you to create equal spacing between controls or to increase or decrease the space between controls.

Note: If the Layout toolbar is not displaying, select *View / Toolbars / Layout*.

Figure 2.14

Resize and align multiple controls using the Layout toolbar.



Designing Your Applications for User Convenience

One of the goals of good programming is to create programs that are easy to use. Your user interface should be clear and consistent. One school of thought says that if users misuse a program, it's the fault of the programmer, not the users. Because most of your users will already know how to operate Windows programs, you should strive to make your programs look and behave like other Windows programs. Some of the ways to accomplish this are to make the controls operate in the standard way, define keyboard access keys, set a default button, and make the Tab key work correctly. You also can define ToolTips, which are those small labels that pop up when the user pauses the mouse pointer over a control.

Designing the User Interface

The design of the screen should be easy to understand and "comfortable" for the user. The best way to accomplish these goals is to follow industry standards for the color, size, and placement of controls. Once users become accustomed to a screen design, they will expect (and feel more familiar with) applications that follow the same design criteria.

You should design your applications to match other Windows applications. Microsoft has done extensive program testing with users of different ages, genders, nationalities, and disabilities. We should take advantage of this research and follow their guidelines. Take some time to examine the screens and dialog boxes in Microsoft Office as well as those in Visual Studio.

One recommendation about interface design concerns color. You have probably noticed that Windows applications are predominantly gray. A reason for this choice is that many people are color blind. Also, research shows that gray is easiest for the majority of users. Although you may personally prefer brighter colors, you will stick with gray, or the system palette the user chooses, if you want your applications to look professional.

Note: By default the BackColor property of forms and controls is set to *Control*, which is a color included in the operating system's palette. If the user changes the system theme or color, your forms and controls will conform to their new settings.

Colors can indicate to the user what is expected. Use a white background for text boxes to indicate that the user should input information. Use a gray background for labels, which the user cannot change. Labels that will display a message should have a border around them; labels that provide text on the screen should have no border (the default).

Group your controls on the form to aid the user. A good practice is to create group boxes to hold related items, especially those controls that require user input. This visual aid helps the user understand the information that is being presented or requested.

Use a sans serif font on your forms, such as the default MS Sans Serif, and do not make them boldface. Limit large font sizes to a few items, such as the company name.

Defining Keyboard Access Keys

Many people prefer to use the keyboard, rather than a mouse, for most operations. Windows is set up so that most functions can be done with either the keyboard or a mouse. You can make your projects respond to the keyboard by defining **access keys,** also called *hot keys*. For example, in Figure 2.15 you can select the *OK* button with Alt + o and the *Exit* button with Alt + x.

Figure 2.15

The underlined character defines an access key. The user can select the OK button by pressing Alt + o and the Exit button with Alt + x.

You can set access keys for buttons, radio buttons, and check boxes when you define their Text properties. Type an ampersand (&) in front of the character you want for the access key; Visual Basic underlines the character. You also can set an access key for a label; see "Setting the Tab Order for Controls" later in this chapter.

For examples of access keys on buttons, type the following for the button's Text property:

`&OK` for O**K**
`E&xit` for E**x**it

When you define access keys, you need to watch for several pitfalls. First, try to use the Windows-standard keys whenever possible. For example, use the x of Exit and the S of Save. Second, make sure you don't give two controls the same access key. It confuses the user and doesn't work correctly. Only the next control (from the currently active control) in the tab sequence is activated when the user presses the access key.

Note: To view the access keys on controls or menus in Windows 2000, Windows XP, or Windows Vista, you may have to press the Alt key, depending on your system settings. You can set Windows Vista to always show underlined shortcuts in the Control Panel's *Ease of Use* section. Select *Change how your keyboard works*, and check the box for *Underline keyboard shortcuts and access keys.*

TIP

Use two ampersands when you want to make an ampersand appear in the Text property: `&Health && Welfare` for "H**e**alth & Welfare". ■

Setting the Accept and Cancel Buttons

Are you a keyboard user? If so, do you mind having to pick up the mouse and click a button after typing text into a text box? Once a person's fingers are on the keyboard, most people prefer to press the Enter key, rather than to click the mouse. If one of the buttons on the form is the Accept button, pressing Enter is the same as clicking the button.

You can make one of your buttons the Accept button by setting the **AcceptButton property** of the form to the button name. When the user presses the Enter key, that button is automatically selected.

You also can select a *Cancel button.* The Cancel button is the button that is selected when the user presses the Esc key. You can make a button the Cancel button by setting the form's **CancelButton property**. An example of a good time to set the CancelButton property is on a form with *OK* and *Cancel* buttons. You may want to set the form's AcceptButton to OKButton and the CancelButton property to CancelButton.

Setting the Tab Order for Controls

In Windows programs, one control on the form always has the **focus**. You can see the focus change as you tab from control to control. For many controls, such as buttons, the focus appears as a thick border. Other controls indicate the focus by a dotted line or a shaded background. For text boxes, the insertion point (also called the *cursor*) appears inside the box.

Some controls can receive the focus; others cannot. For example, text boxes and buttons can receive the focus, but labels and picture boxes cannot.

The Tab Order

Two properties determine whether the focus stops on a control and the order in which the focus moves. Controls that are capable of receiving focus have a **TabStop property**, which you can set to True or False. If you do not want the focus to stop on a control when the user presses the Tab key, set the TabStop property to False.

The **TabIndex property** determines the order the focus moves as the Tab key is pressed. As you create controls on your form, Visual Studio assigns the TabIndex property in sequence. Most of the time that order is correct, but if you want to tab in some other sequence or if you add controls later, you will need to modify the TabIndex properties of your controls.

When your program begins running, the focus is on the control with the lowest TabIndex (usually 0). Since you generally want the insertion point to appear in the first control on the form, its TabIndex should be set to 0. The next control should be set to 1; the next to 2; and so forth.

You may be puzzled by the properties of labels, which have a TabIndex property but not a TabStop. A label cannot receive focus, but it has a location in the tab sequence. This fact allows you to create keyboard access keys for text boxes. When the user types an access key that is in a label, such as Alt + N, the focus jumps to the first TabIndex following the label (the text box). See Figure 2.16.

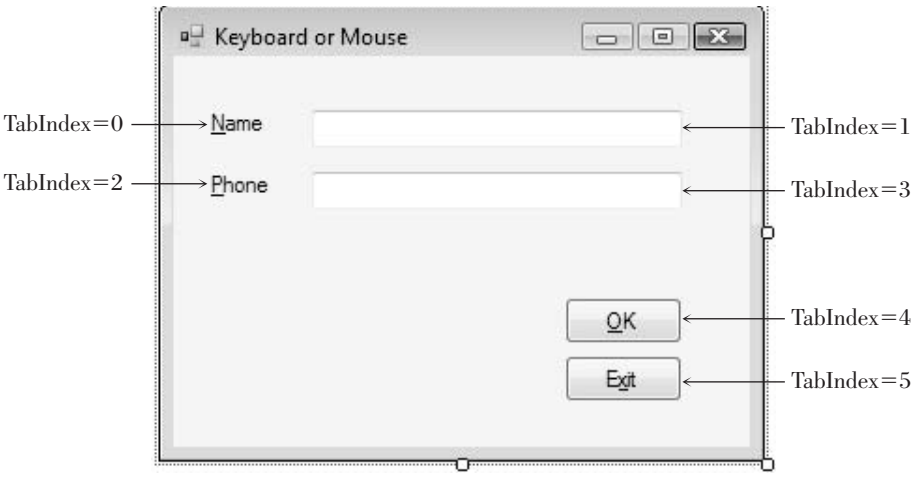


Figure 2.16

To use a keyboard access key for a text box, the TabIndex of the label must precede the TabIndex of the text box.

By default, buttons, text boxes, and radio buttons have their TabStop property set to True. Be aware that the behavior of radio buttons in the tab sequence is different from other controls: The Tab key takes you only to one radio button in a group (the selected button), even though all buttons in the group have their TabStop and TabIndex properties set. If you are using the keyboard to select radio buttons, you must tab to the group and then use your up and down arrow keys to select the correct button.

TIP

Make sure to not have duplicate numbers for the TabIndex properties or duplicate keyboard access keys. The result varies depending on the location of the focus and is very confusing. ■

Setting the Tab Order

To set the tab order for controls, you can set each control's TabIndex property in the Properties window. Or you can use Visual Studio's great feature that helps you set TabIndexes automatically. To use this feature, make sure that the Design window is active and select *View / Tab Order* or click the *Tab Order* button on the Layout toolbar. (The *Tab Order* item does not appear on the menu and is not available on the Layout toolbar unless the Design window is active.) Small numbers appear in the upper-left corner of each control; these are the current TabIndex properties of the controls. Click first in the control that you want to be TabIndex zero, then click on the control for TabIndex one, then click on the next control until you have set the TabIndex for all controls (Figure 2.17).

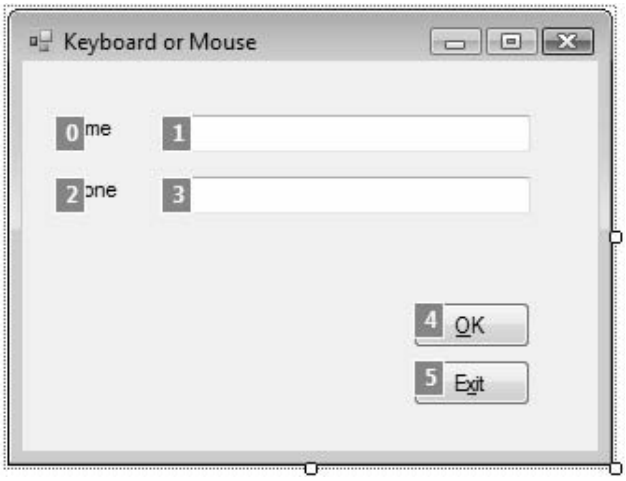


Figure 2.17

Click on each control, in sequence, to set the TabIndex property of the controls automatically.

When you have finished setting the TabIndex for all controls, the white numbered boxes change to blue. Select *View / Tab Order* again to hide the sequence numbers or press the Esc key. If you make a mistake and want to change the tab order, turn the option off and on again, and start over with TabIndex zero again, or you can keep clicking on the control until the number wraps around to the desired value.

TIP

To set the tab order for a group of controls, first set the TabIndex property for the group box and then set the TabIndex for controls inside the group. ■

Setting the Form's Location on the Screen

When your project runs, the form appears in the upper-left corner of the screen by default. You can set the form's screen position by setting the **StartPosition property** of the form. Figure 2.18 shows your choices for the property setting. To center your form on the user's screen, set the StartPosition property to *CenterScreen*.

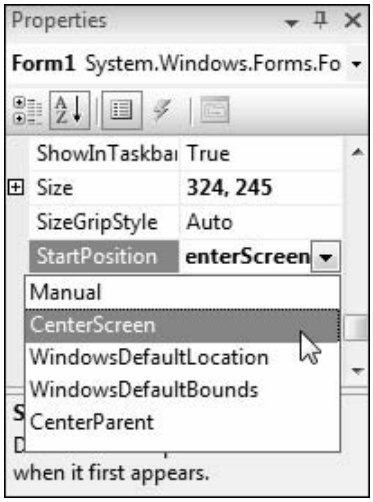


Figure 2.18

Set the StartPosition property of the form to CenterScreen to make the form appear in the center of the user's screen when the program runs.

Creating ToolTips

If you are a Windows user, you probably appreciate and rely on **ToolTips**, those small labels that pop up when you pause your mouse pointer over a toolbar button or control. You can easily add ToolTips to your projects by adding a **ToolTip component** to a form. After you add the component to your form, each of the form's controls has a new property: **ToolTip on ToolTip1**, assuming that you keep the default name, ToolTip1, for the control.

To define ToolTips, select the ToolTip tool from the toolbox (Figure 2.19) and click anywhere on the form or double-click the ToolTip tool in the toolbox. The new control appears in the component tray that opens at the bottom of the Form Designer (Figure 2.20). The component tray holds controls that do not have a visual representation at run time, such as the PrintForm control that you used in Chapter 1.

After you add the ToolTip component, examine the properties list for other controls on the form, such as buttons, text boxes, labels, radio buttons, check boxes, and even the form itself. Each has a new ToolTip on ToolTip1 property.

Try this example: Add a button to any form and add a ToolTip component. Change the button's Text property to Exit and set its ToolTip on ToolTip1 property to *Close and Exit the program*. Now run the project, point to the *Exit* button, and pause; the ToolTip will appear (Figure 2.21).

You also can add multiline ToolTips. In the ToolTip on ToolTip1 property, click the drop-down arrow. This drops down a white editing box in which you enter the text of the ToolTip. Type the first line and press Enter to create a second line; press Ctrl + Enter to accept the text (or click somewhere outside the Property window).

Figure 2.19

Add a ToolTip component to your form; each of the form's controls will have a new property to hold the text of the ToolTip.

Figure 2.20

The new ToolTip component goes in the component tray at the bottom of the Form Designer window.

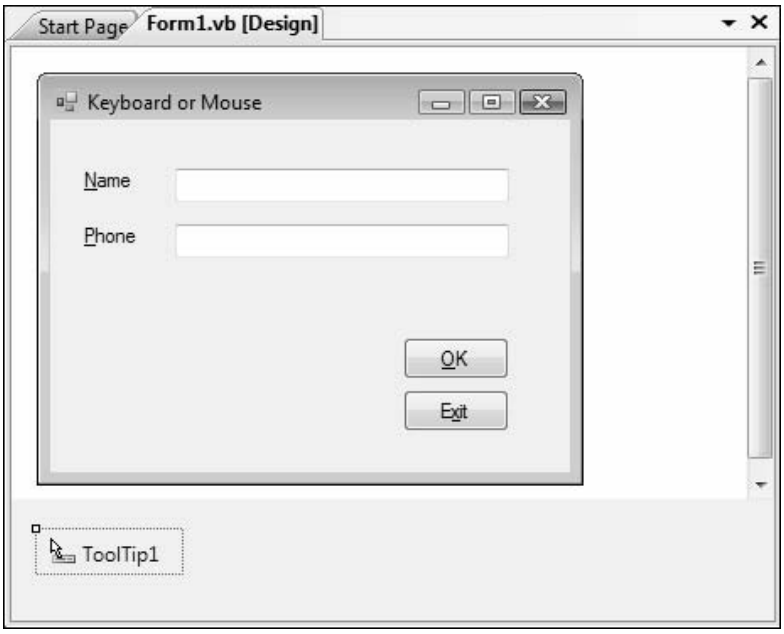
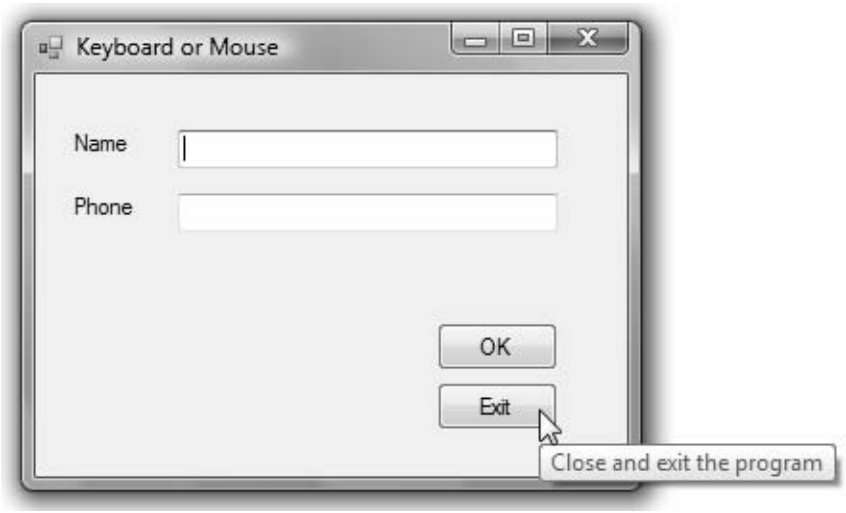


Figure 2.21

Use the ToolTip on ToolTip1 property to define a ToolTip.



You can modify the appearance of a ToolTip by setting properties of the ToolTip component. Select the ToolTip component in the component tray and try changing the BackColor and ForeColor properties. You also can set the IsBalloon property to True for a different appearance and include an icon in the ToolTips by selecting an icon for the ToolTipIcon property (Figure 2.22). Once you set properties for a ToolTip component, they apply to all ToolTips displayed with that component. If you want to create a variety of appearances, the best approach is to create multiple ToolTip components, giving each a unique name. For example, you might create three ToolTip components, in which case you would have properties for ToolTip on ToolTip1, ToolTip on ToolTip2, and ToolTip on ToolTip3 for the form and each control.

Figure 2.22

A ToolTip with properties modified for IsBalloon, ToolTipIcon, BackColor, and ForeColor.

Coding for the Controls

You already know how to set initial properties for controls at design time. You also may want to set some properties in code, as your project executes. You can clear out the contents of text boxes and labels, reset the focus (the active control), change the color of text, or change the text in a ToolTip.

Clearing Text Boxes and Labels

You can clear out the contents of a text box or label by setting the property to an **empty string**. Use "" (no space between the two quotation marks). This empty string is also called a *null string* or *zero-length string*. You also can clear out a text box using the `Clear` method or setting the Text property to `String.Empty`. Note that the `Clear` method works for text boxes but not for labels.

Examples

```
' Clear the contents of text boxes and labels.
NameTextBox.Text = ""
MessageLabel.Text = ""
DataTextBox.Clear()
MessageLabel.Text = String.Empty
```

Resetting the Focus

As your program runs, you want the insertion point to appear in the text box where the user is expected to type. The focus should therefore begin in the first text box. But what about later? If you clear the form's text boxes, you should reset the focus to the first text box. The **`Focus` method** handles this situation.

Remember, the convention is Object.Method, so the statement to set the insertion point in the text box called NameTextBox is as follows:

```
' Make the insertion point appear in this text box.
NameTextBox.Focus()
```

Note: You cannot set the focus to a control that has been disabled. See "Disabling Controls" later in this chapter.

Setting the Checked Property of Radio Buttons and Check Boxes

Of course, the purpose of radio buttons and check boxes is to allow the user to make selections. However, at times you need to select or deselect a control in code. You can select or deselect radio buttons and check boxes at design time (to set initial status) or at run time (to respond to an event).

To make a radio button or check box appear selected initially, set its Checked property to True in the Properties window. In code, assign True to its Checked property:

```
' Make button selected.
RedRadioButton.Checked = True

' Make check box checked.
DisplayCheckBox.Checked = True

' Make check box unchecked.
DisplayCheckBox.Checked = False
```

At times, you need to reset the selected radio button at run time, usually for a second request. You only need to set the Checked property to True for one button of the group; the rest of the buttons in the group will set to False automatically. Recall that only one radio button of a group can be selected at one time.

Setting Visibility at Run Time

You can set the visibility of a control at run time.

```
' Make label invisible.
MessageLabel.Visible = False
```

You may want the visibility of a control to depend on the selection a user makes in a check box or radio button. This statement makes the visibility match the check box: When the check box is checked (Checked = True), the label is visible (Visible = True).

```
' Make the visibility of the label match the setting in the check box.
MessageLabel.Visible = DisplayCheckBox.Checked
```

Disabling Controls

The **Enabled property** of a control determines whether the control is available or "grayed-out." The Enabled property for controls is set to True by default, but you can change the value either at design time or run time. You might want to disable a button or other control initially and enable it in code, depending on an action of the user. If you disable a button control (Enabled = False) at design time, you can use the following code to enable the button at run time.

```
DisplayButton.Enabled = True
```

When you have a choice to disable or hide a control, it's usually best to disable it. Having a control disabled is more understandable to a user than having it disappear.

To disable radio buttons, consider disabling the group box holding the buttons, rather than the buttons themselves. Disabling the group box grays the entire group.

```
DepartmentGroupBox.Enabled = False
```

Note: Even though a control has its TabStop property set to True and its TabIndex is in the proper order, you cannot tab to a control that has been disabled.

Feedback 2.2

1. Write the Basic statements to clear the text box called CompanyTextBox and reset the insertion point into the box.
2. Write the Basic statements to clear the label called CustomerLabel and place the insertion point into a text box called OrderTextBox.
3. What will be the effect of each of these Basic statements?
   (a) `PrintCheckBox.Checked = True`
   (b) `ColorRadioButton.Checked = True`
   (c) `DrawingPictureBox.Visible = False`
   (d) `LocationLabel.BorderStyle = BorderStyle.Fixed3D`
   (e) `CityLabel.Text = CityTextBox.Text`
   (f) `RedRadioButton.Enabled = True`

Setting Properties Based on User Actions

Often you need to change the Enabled or Visible property of a control based on an action of the user. For example, you may have controls that are disabled or invisible until the user signs in. In the following example, when the user logs in and clicks the *Sign In* button, several controls become visible, others become invisible, and a group box of radio buttons is enabled:

```
Private Sub SignInButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles SignInButton.Click
    ' Set up the screen to display the department promotions and the
    ' welcome message. Hide the sign-in controls.

    ' Hide and disable the sign-in controls.
    CheckInGroupBox.Visible = False
    SignInButton.Enabled = False

    ' Enable the group of radio buttons.
    DepartmentGroupBox.Enabled = True

    ' Show the promotions controls.
    PromotionTextBox.Visible = True
    ImageVisibleCheckBox.Visible = True
    WelcomeRichTextBox.Visible = True

    'Display the welcome message.
    WelcomeRichTextBox.Text = "Welcome Member #" & MemberIDMaskedTextBox.Text _
      & Environment.NewLine & NameTextBox.Text
End Sub
```

Changing the Color of Text

You can change the color of text by changing the **ForeColor property** of a control. Actually, most controls have a ForeColor and a BackColor property. The ForeColor property changes the color of the text; the BackColor property determines the color around the text.

The Color Constants

Visual Basic provides an easy way to specify a large number of colors. These **color constants** are in the Color class. If you type the keyword `Color` and a period in the editor, you can see a full list of colors. Some of the colors are listed below.

```
Color.AliceBlue
Color.AntiqueWhite
Color.Bisque
Color.BlanchedAlmond
Color.Blue
```

Examples

```
NameTextBox.ForeColor = Color.Red
MessageLabel.ForeColor = Color.White
```

Using Radio Buttons for Selecting Colors

Here is a small example (Figure 2.23) that demonstrates using two groups of radio buttons to change the color of the form (the form's BackColor property) and the color of the text (the form's ForeColor property). The radio buttons in each group box operate together, independently of those in the other group box.

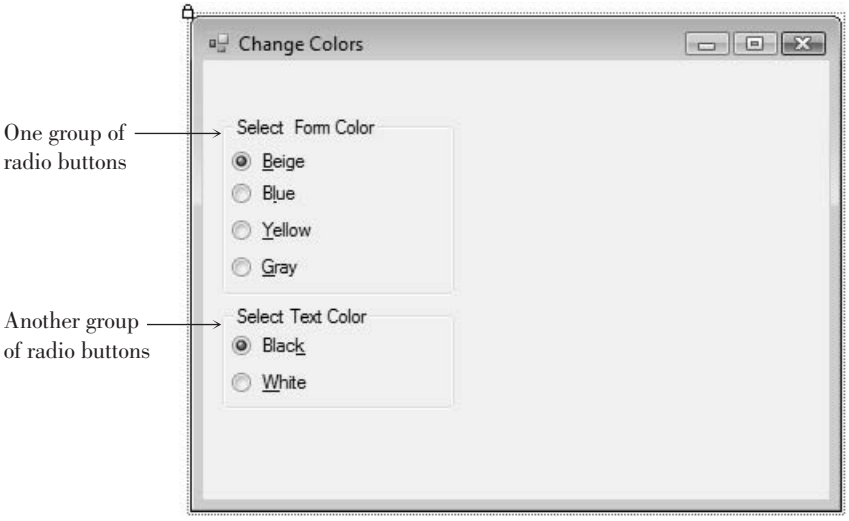


Figure 2.23

The radio buttons in each group box function independently of the other group. Each button changes a property of the form: BackColor changes the background of the form itself and ForeColor changes the color of the text on the form.

```
'Project:              Ch02Colors
'Programmer:           Bradley/Millspaugh
'Date:                 June 2008
'Description:          Demonstrate changing a form's background and foreground
'                      colors using two groups of radio buttons.

Public Class ColorsForm

  Private Sub BeigeRadioButton_CheckedChanged(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles BeigeRadioButton.CheckedChanged
      ' Set the form color to beige.

      Me.BackColor = Color.Beige
  End Sub

  Private Sub BlueRadioButton_CheckedChanged(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles BlueRadioButton.CheckedChanged
      ' Set the form color to blue.

      Me.BackColor = Color.Blue
  End Sub

  Private Sub YellowRadioButton_CheckedChanged(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles YellowRadioButton.CheckedChanged
      ' Set the form color to yellow.

      Me.BackColor = Color.Yellow
  End Sub

  Private Sub GrayRadioButton_CheckedChanged(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles GrayRadioButton.CheckedChanged
      ' Set the form color to gray.

      Me.BackColor = Color.Gray
  End Sub
```

```
  Private Sub BlackRadioButton_CheckedChanged(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles BlackRadioButton.CheckedChanged
      ' Set the text color to black.

      Me.ForeColor = Color.Black
  End Sub

  Private Sub WhiteRadioButton_CheckedChanged(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles WhiteRadioButton.CheckedChanged
      ' Set the text color to white.

      Me.ForeColor = Color.White
  End Sub

End Class
```

Changing Multiple Properties of a Control

By now you can see that there are times when you will want to change several properties of a single control. In early versions of Visual Basic, you had to write out the entire name (Object.Property) for each statement.

Examples

```
TitleTextBox.Visible = True
TitleTextBox.ForeColor = Color.White
TitleTextBox.Focus()
```

Of course, you can still specify the statements this way, but Visual Basic provides a better way: the **`With` and `End With` statements**.

The With and End With Statements—General Form

General Form

```
With ObjectName
    ' Statement(s)
End With
```

You specify an object name in the `With` statement. All subsequent statements until the `End With` relate to that object.

The With and End With Statements—Example

Example

```
With TitleTextBox
  .Visible = True
  .ForeColor = Color.White
  .Focus()
End With
```

The statements beginning with `With` and ending with `End With` are called a ***`With` block***. The statements inside the block are indented for readability. Although indentation is not required by VB, it is required by good programming practices and aids in readability.

The real advantage of using the `With` statement, rather than spelling out the object for each statement, is that `With` is more efficient. Your Visual Basic projects will run a little faster if you use `With`. On a large, complicated project, the savings can be significant.

Concatenating Text

At times you need to join strings of text. For example, you may want to join a literal and a property. You can "tack" one string of characters to the end of another in the process called ***concatenation***. Use an ampersand (&), preceded and followed by a space, between the two strings.

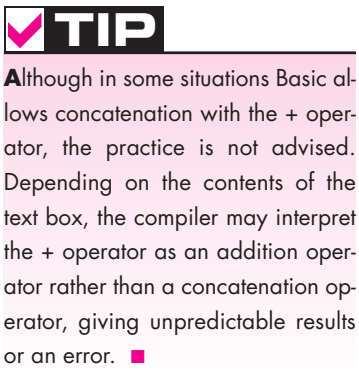
Examples

```
MessageLabel.Text = "Your name is: " & NameTextBox.Text
NameAndAddressLabel.Text = NameTextBox.Text & " " & AddressTextBox.Text
```

Continuing Long Program Lines

Basic interprets the code on one line as one statement. You can type very long lines in the Editor window; the window scrolls sideways to allow you to keep typing. However, this method is inconvenient; it isn't easy to see the ends of the long lines.

When a Basic statement becomes too long for one line, use a **line-continuation character**. You can type a space and an underscore, press Enter, and continue the statement on the next line. It is OK to indent the continued lines. The only restriction is that the line-continuation character must appear between elements; you cannot place a continuation in the middle of a literal or split the name of an object or property.



Example

```
GreetingsLabel.Text = "Greetings " & NameTextBox.Text & ": " & _
  "You have been selected to win a free prize. " & _
  "Just send us $100 for postage and handling."
```

Downloading and Using the Line and Shape Controls

You can add graphic shapes to your forms using a set of controls that Microsoft makes available in a PowerPack, which is a separate and free download. After you download the PowerPack, you run the installation file, which installs the controls into Visual Studio. Once installed, you can add the controls to the Visual Studio toolbox.

Download and Install the Controls

The first step is to download from Microsoft's site: http://msdn2.microsoft.com/en-us/vbasic/bb735936.aspx and follow the links to download the installation file.

It's best to download the file VisualBasicPowerPacks3Setup.exe to your hard drive (save it somewhere easy to find, such as the desktop). After the download is complete, make sure that Visual Studio is not running and double-click the setup file name to run the setup.

If you are running the Professional Edition or above and Visual Studio is closed, the new tools are automatically added to a new section of the toolbox. You can find the new section, called Visual Basic Power Packs 3.0, at the bottom of the toolbox (Figure 2.24).

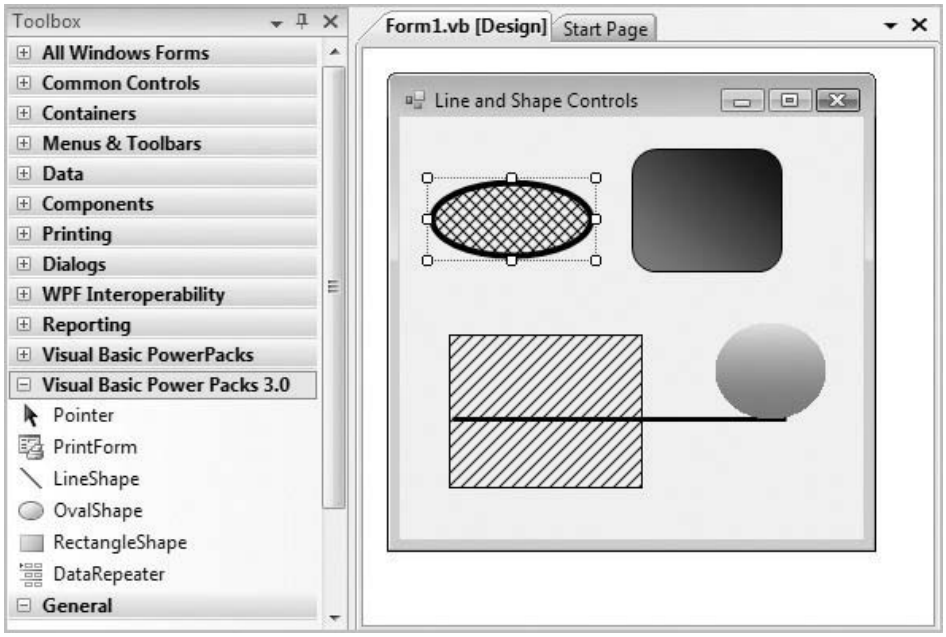
For the Express Edition, or the Professional Edition if the IDE was open when you ran setup, you must manually add the controls to the toolbox. Open Visual Studio or Visual Basic Express and start a new project so that you can see the Form Designer and the toolbox. Right-click in the toolbox and select *Add Tab*. Type "Visual Basic Power Packs 3.0" as the Tab name, then right-click on the new tab and select *Choose Items* from the context menu. The *Choose Toolbox Items* dialog box appears with the list of all available tools. You can save some time by typing "Power" in the *Filter* box, which will limit the list to the PowerPack controls. Then select *LineShape*, *OvalShape*, and *RectangleShape* (*PrintForm* should already be selected). If you have multiple versions of the controls listed, choose the highest version number (9.0.0.0 as of this writing). Then click OK to return to the toolbox.

The new tools should appear in the Visual Basic PowerPacks 3.0 tab of the toolbox.

Note: The controls appear in the section of the toolbox that is active when you select *Choose Toolbox Items*.

Figure 2.24

The line and shape controls in the toolbox, with some sample controls on the form.



Place the Controls on a Form

To place a control on the form, click on the tool in the toolbox and use the mouse pointer to draw the shape that you want on the form. Alternately, you can double-click one of the tools to create a default size control that you can move and resize as desired.

The line and shape controls have many properties that you can set, as well as events, such as Click and DoubleClick, for which you can write event procedures.

Properties of a line include BorderStyle (Solid, Dot, Dash, and a few more); BorderWidth (the width of the line, in pixels); BorderColor; and the locations for the two endpoints of the line (X1, X2, X3, X4). Of course, you can move and resize the line visually, but it sometimes is more precise to set the pixel location exactly.

The properties of the shape controls are more interesting. You can set transparency with the BackStyle property and the border with BorderColor, BorderStyle, and BorderWidth. Set the interior of the shape using FillColor, FillGradientColor, FillGradientStyle, and FillStyle. You can give a rectangle rounded corners by setting the CornerRadius, which defaults to zero for square corners.

Your Hands-On Programming Example

Create a form that allows members to log in and view special promotions for R 'n R. The member name is entered in a text box, and the member ID is entered in a masked text box that allows five numeric digits. Include three buttons: one for *Sign In*, one for *Print*, and one for *Exit*. Set the AcceptButton to the *Sign In* button, and use the *Exit* button for the CancelButton. Include keyboard shortcuts as needed.

Use a group box of radio buttons for the departments and another group box to visually separate the data entry boxes (the text box and masked text box).

A check box allows the user to choose whether an image should display for the selected department. You will need an image to display for each department. You can use any images that you have available, find them on the Web, or use images from the text Web site.

When the program begins, the Department group box should be disabled and visible, and the controls for the image, promotion, and check box should be invisible. When the user clicks on the *Sign In* button, the data entry boxes and labels should disappear, and the promotions text box, the department image, and the check box should appear. Display the user name and member ID concatenated in a rich text box. (*Hint*: If you place the data entry controls in a group box, you can simply set the group box visibility to False.)

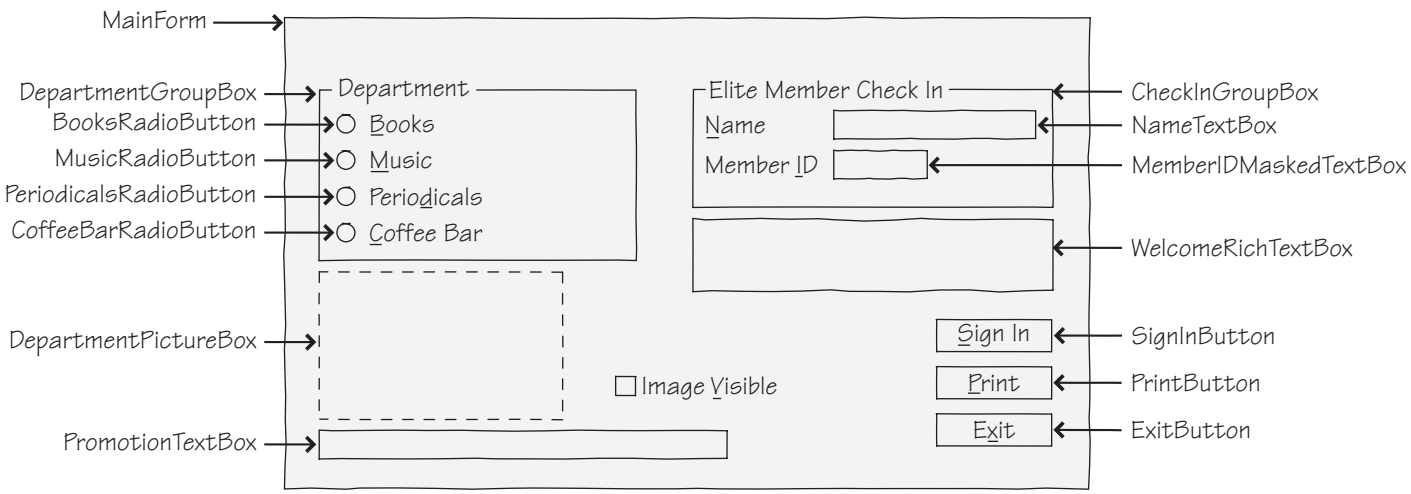
Add ToolTips as appropriate. The ToolTip for the Member ID text box should say: "Your 5 digit member number."

Planning the Project

Sketch a form (Figure 2.25), which your users sign off as meeting their needs.

Figure 2.25

A planning sketch of the form for the hands-on programming example.



Note: Although this step may seem unnecessary, having your users sign off is standard programming practice and documents that your users have been involved and have approved the design.

Plan the Objects and Properties Plan the property settings for the form and for each control.

Object	Property	Setting
MainForm	Name	MainForm
	Text	R 'n R--For Reading and Refreshment"
	AcceptButton	SignInButton
	CancelButton	ExitButton
	StartPosition	CenterScreen
DepartmentGroupBox	Name	DepartmentGroupBox
	Text	Department
BooksRadioButton	Name	BooksRadioButton
	Text	&Books
MusicRadioButton	Name	MusicRadioButton
	Text	&Music
PeriodicalsRadioButton	Name	PeriodicalsRadioButton
	Text	Perio&dicals
CoffeeBarRadioButton	Name	CoffeeBarRadioButton
	Text	&Coffee Bar
SignInButton	Name	SignInButton
	Text	&Sign In
PrintButton	Name	PrintButton
	Text	&Print
ExitButton	Name	ExitButton
	Text	E&xit
DepartmentPictureBox	Name	DepartmentPictureBox
	Visible	False
	SizeMode	StretchImage
ImageVisibleCheckBox	Name	ImageVisibleCheckBox
	Text	Image &Visible
	Visible	False
PromotionTextBox	Name	PromotionTextBox
	Text	(blank)

Object	Property	Setting
CheckInGroupBox	Name	CheckInGroupBox
	Text	Elite Member Check In
Label1	Text	&Name
Label2	Text	Member &ID
NameTextBox	Name	NameTextBox
	Text	(blank)
MemberIDMaskedTextBox	Name	MemberIDMaskedTextBox
	Text	(blank)
	Mask	00000
WelcomeRichTextBox	Name	WelcomeRichTextBox
	Text	(blank)
PrintForm1	Name	PrintForm1
ToolTip1	Name	ToolTip1

Plan the Event Procedures You will need event procedures for each button, radio button, and check box.

Procedure	Actions-Pseudocode
BooksRadioButton_CheckedChanged	Display "Buy two, get the second one for half price" and the books image.
MusicRadioButton_CheckedChanged	Display "Get a free MP3 download with purchase of a CD" and the music image.
PeriodicalsRadioButton_CheckedChanged	Display "Elite members receive 10% off every purchase" and the periodicals image.
CoffeeBarRadioButton_CheckedChanged	Display "Celebrate the season with 20% off specialty drinks" and the coffee image.
ImageVisibleCheckBox_CheckedChanged	Set the visibility of the department image.
SignInButton_Click	Hide the check-in group box.
	Disable the sign-in button
	Enable the Department group box.
	Make the check box, promotion text box, and the welcome text box visible.
	Concatenate the name and member ID and display them in the welcome rich text box.
PrintButton_Click	Set the print action to Print Preview.
	Call the Print method.
ExitButton_Click	End the project.

Write the Project Follow the sketch in Figure 2.25 to create the form. Figure 2.26 shows the completed form.

- Set the properties of each object, as you have planned. Make sure to set the tab order of the controls.
- Working from the pseudocode, write each event procedure.
- When you complete the code, thoroughly test the project.

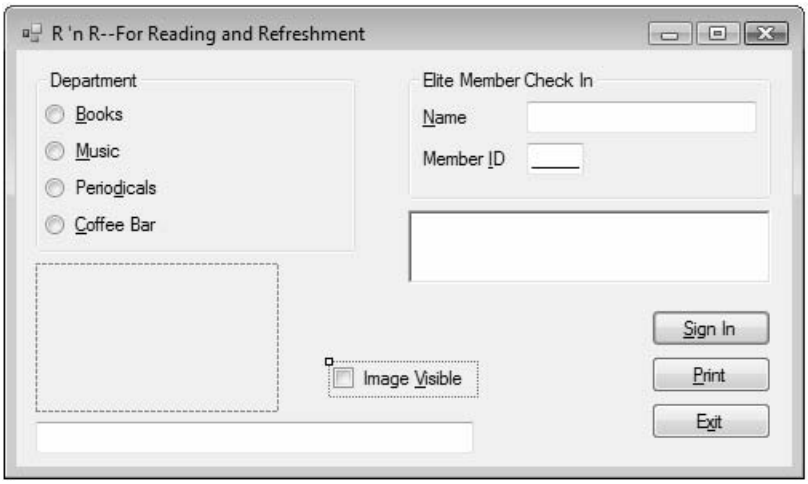


Figure 2.26

The form for the hands-on programming example.

The Project Coding Solution

```
'Project:      Ch02HandsOn
'Programmer:   Bradley/Millspaugh
'Date:         June 2008
'Description:  Allow the user to sign in and display current sales promotion.

Public Class MainForm

  Private Sub BooksRadioButton_CheckedChanged(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles BooksRadioButton.CheckedChanged
      ' Display the image and promotion for the Books department.

      DepartmentPictureBox.Image = My.Resources.Books
      PromotionTextBox.Text = "Buy two, get the second one for half price."
  End Sub

  Private Sub CoffeeBarRadioButton_CheckedChanged(ByVal sender As Object, _
    ByVal e As System.EventArgs) Handles CoffeeBarRadioButton.CheckedChanged
      ' Display the image and promotion for the Coffee Bar.

      DepartmentPictureBox.Image = My.Resources.Coffee
      PromotionTextBox.Text = _
        "Celebrate the season with 20% off specialty drinks."
  End Sub
```

```
  Private Sub MusicRadioButton_CheckedChanged(ByVal sender As Object, _
    ByVal e As System.EventArgs) Handles MusicRadioButton.CheckedChanged
      ' Display the image and promotion for the Music department.

      DepartmentPictureBox.Image = My.Resources.Music
      PromotionTextBox.Text = "Get a free MP3 download with purchase of a CD."
  End Sub

  Private Sub PeriodicalsRadioButton_CheckedChanged(ByVal sender As Object, _
    ByVal e As System.EventArgs) Handles PeriodicalsRadioButton.CheckedChanged
      ' Display the image and promotion for the Periodicals department.

      DepartmentPictureBox.Image = My.Resources.Periodicals
      PromotionTextBox.Text = "Elite members receive 10% off every purchase."
  End Sub

  Private Sub ImageVisibleCheckBox_CheckedChanged(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles ImageVisibleCheckBox.CheckedChanged
      ' Set the visibility of the department image.

      DepartmentPictureBox.Visible = ImageVisibleCheckBox.Checked
  End Sub

  Private Sub SignInButton_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles SignInButton.Click
      ' Set up the screen to display the department promotions and the
      ' welcome message. Hide the sign-in controls.

      ' Hide and disable the sign-in controls.
      CheckInGroupBox.Visible = False
      SignInButton.Enabled = False

      ' Enable the group of radio buttons.
      DepartmentGroupBox.Enabled = True

      ' Show the promotions controls.
      PromotionTextBox.Visible = True
      ImageVisibleCheckBox.Visible = True
      WelcomeRichTextBox.Visible = True

      ' Display the welcome message.
      WelcomeRichTextBox.Text = "Welcome Member #" & MemberIDMaskedTextBox.Text _
        & Environment.NewLine & NameTextBox.Text
  End Sub

  Private Sub PrintButton_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles PrintButton.Click
      ' Print the form in the Print Preview window.

      PrintForm1.PrintAction = Printing.PrintAction.PrintToPreview
      PrintForm1.Print()
  End Sub

  Private Sub ExitButton_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles ExitButton.Click
      ' End the program.

      Me.Close()
  End Sub
End Class
```

Good Programming Habits

1. Always test the tab order on your forms. Fix it if necessary by changing the TabIndex properties of the controls.
2. Provide visual separation for input fields and output fields and always make it clear to the user which are which.
3. Make sure that your forms can be navigated and entered from the keyboard. Always set an Accept button (AcceptButton property) for every form.
4. To make a label maintain its size regardless of the value of the Text property, set AutoSize to False.
5. To make the text in a text box right justified or centered, set the TextAlign property.
6. You can use the Checked property of a check box to set other properties that must be True or False.

Summary

1. Text boxes are used primarily for user input. The Text property holds the value input by the user. You also can assign a literal to the Text property during design time or run time.
2. A MaskedTextBox has a Mask property that allows you to specify the data type and format of the input data.
3. A RichTextBox is a specialized text box that allows additional formatting of the text.
4. Both text boxes and rich text boxes have Multiline and WordWrap properties that can allow a long Text property to wrap to multiple lines. The text will wrap to the width of the control, which must be tall enough to display multiple lines.
5. Group boxes are used as containers for other controls and to group like items on a form.
6. Check boxes and radio buttons allow the user to make choices. In a group of radio buttons, only one can be selected; but in a group of check boxes, any number of the boxes may be selected.
7. The current state of check boxes and radio buttons is stored in the Checked property; the CheckedChanged event occurs when the user clicks on one of the controls.
8. Picture box controls hold a graphic, which is assigned to the Image property. Set the SizeMode property to *StretchImage* to make the image resize to fit the control.
9. The *Resources* tab of the Project Designer can be used to add, remove, and rename images in the project Resources folder.
10. Forms and controls can display images from the project's resources. Use the form's BackgroundImage property and a control's Image property.
11. The BorderStyle property of many controls can be set to *None*, *FixedSingle*, or *Fixed3D* to determine whether the control appears flat or three-dimensional.
12. To create a line on a form, you can use a Label control, or use the new LineShape control included in the Visual Basic Power Packs.

13. You can select multiple controls and treat them as a group, including setting common properties at once, moving them, or aligning them.
14. Make your programs easier to use by following Windows standard guidelines for colors, control size and placement, access keys, default and Cancel buttons, and tab order.
15. Define keyboard access keys by including an ampersand in the Text property of buttons, radio buttons, check boxes, and labels.
16. Set the AcceptButton property of the form to the desired button so that the user can press Enter to select the button. If you set the form's CancelButton property to a button, that button will be selected when the user presses the Esc key.
17. The focus moves from control to control as the user presses the Tab key. The sequence for tabbing is determined by the TabIndex properties of the controls. The Tab key stops only on controls that have their TabStop property set to True and are enabled.
18. Set the form's location on the screen by setting the StartPosition property.
19. Add a ToolTip control to a form and then set the ToolTip on ToolTip1 property of a control to make a ToolTip appear when the user pauses the mouse pointer over the control. You can set properties of the ToolTip component to modify the background, foreground, shape, and an icon for the ToolTips.
20. Clear the Text property of a text box or a label by setting it to an empty string. Text boxes also can be cleared using the `Clear` method.
21. To make a control have the focus, which makes it the active control, use the `Focus` method. Using the `Focus` method of a text box makes the insertion point appear in the text box. You cannot set the focus to a disabled control.
22. You can set the Checked property of a radio button or check box at run time and also set the Visible property of controls in code.
23. Controls can be disabled by setting the Enabled property to False.
24. Change the color of text in a control by changing its ForeColor property.
25. You can use the color constants to change colors during run time.
26. The `With` and `End With` statements provide an easy way to refer to an object multiple times without repeating the object's name.
27. Joining two strings of text is called *concatenation* and is accomplished by placing an ampersand between the two elements. (A space must precede and follow the ampersand.)
28. Use a space and an underscore to continue a long statement on another line.

Key Terms

AcceptButton property *82*
access key *81*
BorderStyle property *77*
CancelButton property *82*
check box *73*
Checked property *73*
color constant *90*
concatenation *93*
container *72*
empty string *87*
Enabled property *89*
focus *82*
`Focus` method *87*
ForeColor property *90*
GroupBox control *72*
Image property *73*
line-continuation character *93*
MaskedTextBox *70*

Multiline property *71*
NewLine character *72*
PictureBox control *73*
Project Designer *76*
radio button *73*
RichTextBox *71*
Select Resource dialog box *73*
SizeMode property *75*
StartPosition property *84*
StretchImage *75*
TabIndex property *83*
TabStop property *83*
text box *69*
Text property *69*
TextAlign property *69*
ToolTip *85*
ToolTip component *85*
ToolTip on ToolTip1 property *85*
Visible property *75*
`With` and `End With` statements *92*
`With` block *92*
WordWrap property *71*

Review Questions

1. You can display program output in a text box or a label. When should you use a text box? When is a label appropriate?
2. What would be the advantage of using a masked text box rather than a text box?
3. When would it be appropriate to use a rich text box instead of a text box?
4. What properties of a TextBox and RichTextBox must be set to allow a long Text property to wrap to multiple lines?
5. How does the behavior of radio buttons differ from the behavior of check boxes?
6. If you want two groups of radio buttons on a form, how can you make the groups operate independently?
7. Explain how to make a graphic appear in a picture box control.
8. Describe how to select several labels and set them all to 12-point font size at once.
9. What is the purpose of keyboard access keys? How can you define them in your project? How do they operate at run time?
10. Explain the purpose of the AcceptButton and CancelButton properties of the form. Give an example of a good use for each.
11. What is a ToolTip? How can you make a ToolTip appear?
12. What is the focus? How can you control which object has the focus?
13. Assume you are testing your project and don't like the initial position of the insertion point. Explain how to make the insertion point appear in a different text box when the program begins.
14. During program execution, you want to return the insertion point to a text box called AddressTextBox. What Basic statement will you use to make that happen?
15. What Basic statements will clear the current contents of a text box and a label?
16. How are the `With` and `End With` statements used? Give an example.
17. What is concatenation and when would it be useful?
18. Explain how to continue a very long Basic statement onto another line.

Programming Exercises

Graphics Files: You can find the icon files in the StudentData\Graphics folder on the text Web site (www.mhhe.com/VB2008).

2.1 Create a project that will switch a light bulb on and off, using the user interface shown below as a guide.

Form: Include a text box for the user to enter his or her name. Create two picture boxes, one on top of the other. Only one will be visible at a time. Use radio buttons to select the color of the text in the label beneath the light bulb picture box.

Include keyboard access keys for the radio buttons and the buttons. Make the *Exit* button the Cancel button. Create ToolTips for both light bulb picture boxes; make the ToolTips say "Click here to turn the light on or off."

Project Operation: The user will enter a name and click a radio button for the color (not necessarily in that order). When the light bulb is clicked, display the other picture box and change the message below it. Concatenate the user name to the end of the message.

The two icon files are Lightoff.ico and Lighton.ico and are found in the following folder:

```
Graphics\MicrosoftIcons
```

(See the note at the top of the exercises for graphic file locations.)

Coding: In the click event procedure for each Color radio button, change the color of the message below the light bulb.

2.2 Write a project to display the flags of four different countries, depending on the setting of the radio buttons. In addition, display the name of the country in the large label under the flag picture box. The user also can choose to display or hide the form's title, the country name, and the name of the programmer. Use check boxes for the display/hide choices.

Include keyboard access keys for all radio buttons, check boxes, and buttons. Make the *Exit* button the Cancel button. Include ToolTips.

You can choose the countries and flags.

Hints: When a project begins running, the focus goes to the control with the lowest TabIndex. Because that control likely is a radio button, one button will appear selected. You must either display the first flag to match the radio button or make the focus begin in a different control. You might consider beginning the focus on the button.

Set the Visible property of a control to the Checked property of the corresponding check box. That way when the check box is selected, the control becomes visible.

Because all three selectable controls will be visible when the project begins, set the Checked property of the three check boxes to True at design time. Set the flag picture box to `Visible = False` so it won't appear at startup. (If you plan to display the picture box at startup, its Visible property must be set to True.)

Make sure to set the SizeMode property of the picture box control to *StretchImage*.

2.3 Write a project to display a weather report. The user can choose one of the radio buttons and display an icon and a message. The message should give the weather report in words and include the person's name (taken from the text box at the top of the form). For example, if the user chooses the Sunny button, you might display "It looks like sunny weather today, John" (assuming that the user entered *John* in the text box).

Include keyboard access keys for the button and radio buttons. Make the *Exit* button the Cancel button and include ToolTips.

The four icons displayed are called Cloud.ico, Rain.ico, Snow.ico, and Sun.ico. (See the note at the top of the exercises for graphic file locations.)

2.4 Write a project that will input the user name and display a message of the day in a label, along with the user's name. Include buttons (with keyboard access keys) for *Display*, *Clear*, and *Exit*. Make the *Display* button the Accept button and the *Clear* button the Cancel button. Include ToolTips where appropriate.

Include a group of radio buttons for users to select the color of the message. Give them a choice of four different colors.

Make your form display a changeable picture box. You can use the happy face icon files or any other images you have available (Face01.ico, Face02.ico, and Face03.ico). (See the note at the top of the exercises for graphic file locations.)

You may choose to have only one message of the day, or you can have several that the user can select with radio buttons. You might want to choose messages that go with the different face icons.

2.5 Create a project that allows the user to input information and then display the lines of output for a mailing label.

Remember that fields to be input by the user require text boxes, but display the output in labels. Use text boxes for the first name, last name, street address, city, state, and ZIP code; give meaningful names to the text boxes and set the initial Text properties to blank. Add appropriate labels to each text box to tell the user which data will be entered into each box and also provide ToolTips.

Use buttons for *Display Label Info*, Clear, and *Exit*. Make the *Display* button the Accept button and the *Clear* button the Cancel button.

Use three labels for displaying the information for Line 1, Line 2, and Line 3.

Use a masked text box for the ZIP code.

A click event on the *Display Label Info* button will display the following:

Line 1—The first name and last name concatenated together with a space between.
Line 2—The street address.
Line 3—The city, state, and ZIP code concatenated together. (Make sure to concatenate a comma and a space between the city and state, using ", " and two spaces between the state and ZIP code.)

Case Studies

VB Mail Order

Design and code a project that displays shipping information.

Use an appropriate image in a picture box in the upper-left corner of the form.

Use text boxes with identifying labels for Catalog Code, Page Number, and Part Number.

Use two groups of radio buttons on the form; enclose each group in a group box. The first group box should have a Text property of *Shipping* and contain radio buttons for Express and Ground. Make the second group box have a Text property of *Payment Type* and include radio buttons for Charge, COD, and Money Order.

Use a check box for New Customer.

Add buttons for *Print*, *Clear*, and *Exit*. Make the *Clear* button the Cancel button.

Add ToolTips as appropriate.

VB Auto Center

Modify the project from the Chapter 1 VB Auto Center case study, replacing the buttons with images in picture boxes. (See "Copy and Move Projects" in Appendix C for help in making a copy of the Chapter 1 project to use for this project.) Above each picture box, place a label that indicates which department or command the graphic represents. A click on a picture box will produce the appropriate information in the special notices label.

Add an image in a picture box that clears the special notices label. Include a ToolTip for each picture box to help the user understand the purpose of the graphic.

Add radio buttons that will allow the user to view the special notices label in different colors.

Include a check box labeled Hours. When the check box is selected, a new label will display the message "Open 24 Hours—7 days a week".

By default, the images are all stored in the Icons folder. (See the note at the top of the exercises for graphic file locations.)

Department/Command	Image for Picture box
Auto Sales	Cars.ico
Service Center	Wrench.ico
Detail Shop	Water.ico
Employment Opportunities	MAIL12.ico
Exit	MSGBOX01.ico

Video Bonanza

Design and code a project that displays the location of videos using radio buttons. Use a radio button for each of the movie categories and a label to display the aisle number. A check box will allow the user to display or hide a message for members. When the check box is selected, a message stating "All Members Receive a 10% Discount" will appear.

Include buttons (with keyboard access keys) for *Clear* and *Exit*. The *Clear* button should be set as the Accept button and the *Exit* as the Cancel button.

Place a label on the form in a 24-point font that reads "Video Bonanza". Use a line to separate the label from the rest of the interface. Include an image in a picture box.

Radio Button	Location
Comedy	Aisle 1
Drama	Aisle 2
Action	Aisle 3
Sci-Fi	Aisle 4
Horror	Aisle 5

Very Very Boards

Create a project to display an advertising screen for Very Very Boards. Include the company name, a slogan (use "The very best in boards" or make up your own slogan), and a graphic image for a logo. You may use the graphic included with the text materials (Skateboard.gif) or one of your own.

Allow the user to select the color for the slogan text using radio buttons. Additionally, the user may choose to display or hide the company name, the slogan, and the logo. Use check boxes for the display options so that the user can select each option independently.

Include keyboard access keys for the radio buttons and the buttons. Make the *Exit* button the Cancel button. Create ToolTips for the company name ("Our company name"), the slogan ("Our slogan"), and the logo ("Our logo").

When the project begins execution, the slogan text should be red and the Red radio button selected. When the user selects a new color, change the color of the slogan text to match.

Each of the check boxes must appear selected initially, since the company name, slogan, logo, and programmer name display when the form appears. Each time the user selects or deselects a check box, make the corresponding item display or hide.

Make the form appear in the center of the screen.

CHAPTER

3

Variables, Constants, and Calculations

at the completion of this chapter, you will be able to . . .

1. Distinguish between variables, constants, and controls.
2. Differentiate among the various data types.
3. Apply naming conventions incorporating standards and indicating the data type.
4. Declare variables and constants.
5. Select the appropriate scope for a variable.
6. Convert text input to numeric values.
7. Perform calculations using variables and constants.
8. Convert between numeric data types using implicit and explicit conversions.
9. Round decimal values using the `Decimal.Round` method.
10. Format values for output using the `ToString` method.
11. Use `Try/Catch` blocks for error handling.
12. Display message boxes with error messages.
13. Accumulate sums and generate counts.

In this chapter you will learn to do calculations in Visual Basic. You will start with text values input by the user, convert them to numeric values, and perform calculations on them. You will also learn to format the results of your calculations and display them for the user.

Although the calculations themselves are quite simple (addition, subtraction, multiplication, and division), there are some important issues to discuss first. You must learn about variables and constants, the various types of data used by Visual Basic, and how and where to declare variables and constants. Variables are declared differently, depending on where you want to use them and how long you need to retain their values.

The code below is a small preview to show the calculation of the product of two text boxes. The first group of statements (the `Dim`s) declares the variables and their data types. The second group of statements converts the text box contents to numeric and places the values into the variables. The last line performs the multiplication and places the result into a variable. The following sections of this chapter describe how to set up your code for calculations.

```
' Declare the variables.
Dim QuantityInteger As Integer
Dim PriceDecimal, ExtendedPriceDecimal As Decimal

' Convert input text to numeric and assign values to variables.
QuantityInteger = Integer.Parse(QuantityTextBox.Text)
PriceDecimal = Decimal.Parse(PriceTextBox.Text)

' Calculate the product.
ExtendedPriceDecimal = QuantityInteger * PriceDecimal
```

Data—Variables and Constants

So far, all data you have used in your projects have been properties of objects. You have worked with the Text property of text boxes and labels. Now you will work with values that are not properties. Basic allows you to set up locations in memory and give each location a name. You can visualize each memory location as a scratch pad; the contents of the scratch pad can change as the need arises. In this example, the memory location is called *MaximumInteger*.

```
MaximumInteger = 100
```

MaximumInteger
100

After executing this statement, the value of MaximumInteger is 100. You can change the value of MaximumInteger, use it in calculations, or display it in a control.

In the preceding example, the memory location called MaximumInteger is a **variable**. Memory locations that hold data that can be changed during project execution are called *variables*; locations that hold data that cannot change during execution are called ***constants***. For example, the customer's name will vary as the information for each individual is processed. However, the name of the company and the sales tax rate will remain the same (at least for that day).

When you declare a variable or a **named constant**, Visual Basic reserves an area of memory and assigns it a name, called an ***identifier***. You specify identifier names according to the rules of Basic as well as some recommended naming conventions.

The **declaration** statements establish your project's variables and constants, give them names, and specify the type of data they will hold. The statements are not considered executable; that is, they are not executed in the flow of instructions during program execution. An exception to this rule occurs when you initialize a variable on the same line as the declaration.

Here are some sample declaration statements:

```
' Declare a string variable.
Dim NameString As String

' Declare integer variables.
Dim CounterInteger As Integer
Dim MaxInteger As Integer = 100

' Declare a named constant.
Const DISCOUNT_RATE_Decimal As Decimal = .15D
```

The next few sections describe the data types, the rules for naming variables and constants, and the format of the declarations.

Data Types

The **data type** of a variable or constant indicates what type of information will be stored in the allocated memory space: perhaps a name, a dollar amount, a date, or a total. The data types in VB are actually classes, and the variables are objects of the class. Table 3.1 shows the VB data types.

The most common types of variables and constants we will use are String, Integer, and Decimal. When deciding which data type to use, follow this guideline: If the data will be used in a calculation, then it must be numeric (usually Integer or Decimal); if it is not used in a calculation, it will be String. Use Decimal as the data type for any decimal fractions in business applications; Single and Double data types are generally used in scientific applications.

Consider the following examples:

Contents	Data Type	Reason
Social security number	String	Not used in a calculation.
Pay rate	Decimal	Used in a calculation; contains a decimal point.
Hours worked	Decimal	Used in a calculation; may contain a decimal point. (Decimal can be used for any decimal fraction, not just dollars.)
Phone number	String	Not used in a calculation.
Quantity	Integer	Used in calculations; contains a whole number.

The Visual Basic Data Types, Common Language Runtime (CLR) Data Types, the Kind of Data Each Type Holds, and the Amount of Memory Allocated for Each **Table 3.1**

VB Data Type	Common Language Runtime (CLR) Data Type	Use For	Storage Size in bytes
Boolean	Boolean	True or False values	2
Byte	Byte	0 to 255, binary data	1
Char	Char	Single Unicode character	2
Date	DateTime	1/1/0001 through 12/31/9999	8
Decimal	Decimal	Decimal fractions, such as dollars and cents	16
Single	Single	Single-precision floating-point numbers with six digits of accuracy	4
Double	Double	Double-precision floating-point numbers with 14 digits of accuracy	8
Short	Int16	Small integer in the range −32,768 to 32,767	2
Integer	Int32	Whole numbers in the range −2,147,483,648 to +2,147,483,647	4
Long	Int64	Larger whole numbers	8
String	String	Alphanumeric data: letters, digits, and other characters	Varies
Object	Object	Any type of data	4

Note: Generally you will use the Visual Basic data types, but for some conversion methods, you must use the corresponding CLR data type.

Naming Rules

A programmer has to name (identify) the variables and named constants that will be used in a project. Basic requires identifiers for variables and named constants to follow these rules: names may consist of letters, digits, and underscores; they must begin with a letter; they cannot contain any spaces or periods; and they may not be reserved words. (Reserved words, also called *keywords*, are words to which Basic has assigned some meaning, such as *print*, *name*, and *value*.)

Identifiers in VB are not case sensitive. Therefore, the names sumInteger, SumInteger, suminteger, and SUMINTEGER all refer to the same variable.

Note: You can make variable names as long as you wish; the maximum length of an identifier is 16,383 characters.

Naming Conventions

When naming variables and constants, you *must* follow the rules of Basic. In addition, you *should* follow some naming conventions. Conventions are the guidelines that separate good names from bad (or not so good) names. The meaning and use of all identifiers should always be clear.

Just as we established conventions for naming objects in Chapter 1, in this chapter we adopt conventions for naming variables and constants. The following conventions are widely used in the programming industry:

1. *Identifiers must be meaningful*. Choose a name that clearly indicates its purpose. Do not abbreviate unless the meaning is obvious and do not use very short identifiers, such as *X* or *Y*.
2. *Include the class (data type) of the variable*.
3. Begin with an uppercase letter and then capitalize each successive word of the name. Always use mixed case for variables; uppercase for constants.

Sample Identifiers

Field of Data	Possible Identifier
Social security number	SocialSecurityNumberString
Pay rate	PayRateDecimal
Hours worked	HoursWorkedDecimal
Phone number	PhoneNumberString
Quantity	QuantityInteger
Tax rate (constant)	TAX_RATE_Decimal
Quota (constant)	QUOTA_Integer
Population	PopulationLong

Feedback 3.1

Indicate whether each of the following identifiers conforms to the rules of Basic and to the naming conventions. If the identifier is invalid, give the reason. Remember, the answers to Feedback questions are found in Appendix A.

1. `Omitted`
2. `#SoldInteger`
3. `Number Sold Integer`
4. `Number.Sold.Integer`
5. `Amount$Decimal`
6. `Sub`
7. `SubString`
8. `text`
9. `Maximum`
10. `MinimumRateDecimal`
11. `MaximumCheckDecimal`
12. `CompanyNameString`

Constants: Named and Intrinsic

Constants provide a way to use words to describe a value that doesn't change. In Chapter 2 you used the Visual Studio constants Color.Blue, Color.Red, Color.Yellow, and so on. Those constants are built into the environment and called *intrinsic constants*; you don't need to define them anywhere. The constants that you define for yourself are called *named constants*.

Named Constants

You declare named constants using the keyword `Const`. You give the constant a name, a data type, and a value. Once a value is declared as a constant, its value cannot be changed during the execution of the project. The data type that you declare and the data type of the value must match. For example, if you declare an integer constant, you must give it an integer value.

You will find two important advantages to using named constants rather than the actual values in code. The code is easier to read; for example, seeing the identifier MAXIMUM_PAY_Decimal is more meaningful than seeing a number, such as 1,000. In addition, if you need to change the value at a later time, you need to change the constant declaration only once; you do not have to change every reference to it throughout the code.

Const Statement—General Form

General Form

```
Const Identifier [As Datatype] = Value
```

Naming conventions for constants require that you include the data type in the name as well as the `As` clause that actually declares the data type. Use all uppercase for the name with individual words separated by underscores.

This example sets the company name, address, and the sales tax rate as constants:

Const Statement—Examples

Examples

```
Const COMPANY_NAME_String As String = "R 'n R for Reading 'n Refreshment"
Const COMPANY_ADDRESS_String As String = "101 S. Main Street"
Const SALES_TAX_RATE_Decimal As Decimal = .08D
```

Assigning Values to Constants

The values you assign to constants must follow certain rules. You have already seen that a text (string) value must be enclosed in quotation marks; numeric values are not enclosed. However, you must be aware of some additional rules.

Numeric constants may contain only the digits (0–9), a decimal point, and a sign (+ or –) at the left side. You cannot include a comma, dollar sign, any other special characters, or a sign at the right side. You can declare the data type of numeric constants by appending a type-declaration character. If you do not append a type-declaration character to a numeric constant, any whole number is assumed to be Integer and any fractional value is assumed to be Double. The type-declaration characters are

Decimal	D
Double	R
Integer	I
Long	L
Short	S
Single	F

String literals (also called string constants) may contain letters, digits, and special characters, such as $#@%&*. You will have a problem when you want to include quotation marks inside a string literal since quotation marks enclose the literal. The solution is to use two quotation marks together inside the literal. Visual Basic will interpret the pair as one symbol. For example, `"He said, ""I like it."""` produces this string: `He said, "I like it."`

Although you can use numeric digits inside a string literal, remember that these numbers are text and cannot be used for calculations.

The string values are referred to as ***string literals*** because they contain exactly (literally) whatever is inside the quotation marks.

The following table lists example constants.

Data Type	Constant Value Example
Integer	5 125 2170 2000 –100 12345678I
Single	101.25F –5.0F
Decimal	850.50D –100D
Double	52875.8 52875.8R –52875.8R
Long	134257987L –8250758L
String literals	"Visual Basic" "ABC Incorporated" "1415 J Street" "102” "She said ""Hello.""""

Intrinsic Constants

Intrinsic constants are system-defined constants. Many sets of intrinsic constants are declared in system class libraries and are available for use in your VB programs. For example, the color constants that you used in Chapter 2 are intrinsic constants.

You must specify the class name or group name as well as the constant name when you use intrinsic constants. For example, Color.Red is the constant “Red” in the class “Color”. Later in this chapter you will learn to use constants from the MessageBox class for displaying message boxes to the user.

Declaring Variables

Although there are several ways to declare a variable, inside a procedure you must use the `Dim` statement. Later in this chapter you will learn to declare variables outside of a procedure, using the `Public`, `Private`, or `Dim` statement.

Declaration Statements—General Form

General Form

```
Public|Private|Dim Identifier [As Datatype]
```

If you omit the optional data type, the variable’s type defaults to Object. It is recommended practice to *always* declare the data type.

Note: If Option Strict is On, you receive a syntax error if you omit the data type.

Declaration Statement—Examples

Examples

```
Dim CustomerNameString As String
Private TotalSoldInteger As Integer
Dim TemperatureSingle As Single
Dim PriceDecimal As Decimal
Private CostDecimal As Decimal
```

The reserved word `Dim` is really short for dimension, which means "size." When you declare a variable, the amount of memory reserved depends on its data type. Refer to Table 3.1 (page 112) for the size of each data type.

You also can declare several variables in one statement; the data type you declare in the `As` clause applies to all of the variables on the line. Separate the variable names with commas. Here are some sample declarations:

```
Dim NameString, AddressString, PhoneString As String
Dim PriceDecimal, TotalDecimal As Decimal
```

TIP

Rename a variable or control using the handy *Rename* feature: Right-click on the name and choose *Rename* from the context menu. The identifier will be changed everywhere it occurs. ■

Entering Declaration Statements

Visual Basic's IntelliSense feature helps you enter `Private`, `Public`, and `Dim` statements. After you type the space that follows `VariableName As`, a list pops up (Figure 3.1). This list shows the possible entries to complete the statement. The easiest way to complete the statement is to begin typing the correct entry; the list automatically scrolls to the correct section (Figure 3.2). When the correct entry is highlighted or is the only item showing, press Enter, Tab, or the spacebar to select the entry, or double-click if you prefer using the mouse.

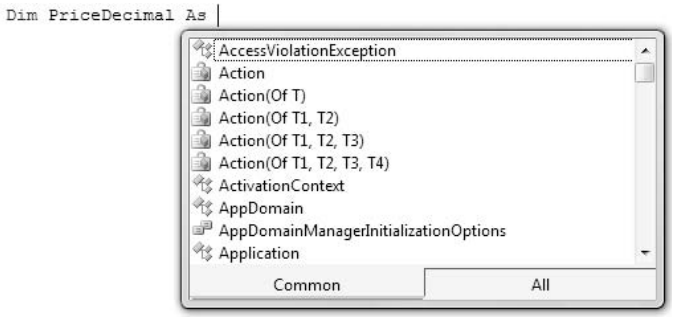


Figure 3.1

As soon as you type the space after As, *the IntelliSense menu pops up. You can make a selection from the list with your mouse or the keyboard.*

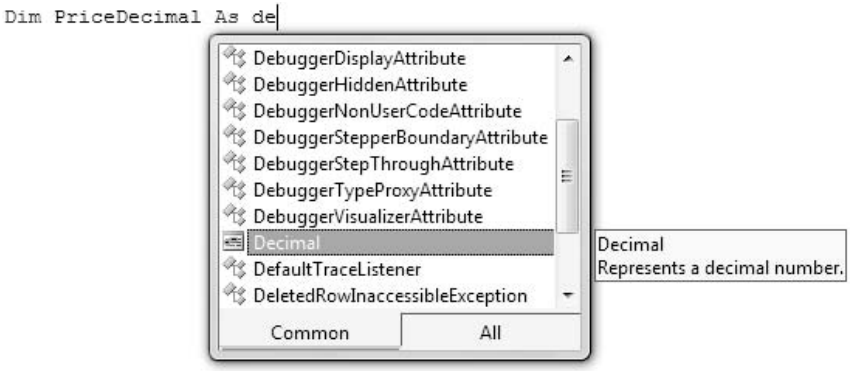


Figure 3.2

Type the first few characters of the data type and the IntelliSense list quickly scrolls to the correct section. When the correct word is highlighted, press Enter, Tab, or the spacebar to select the entry.

Note: Some people find the IntelliSense feature annoying rather than helpful. You can turn off the feature by selecting *Tools / Options*. In the *Options* dialog box, make sure that *Show all settings* is selected and choose *Text Editor / Basic / General*; deselect *Auto list members* and *Parameter information*.

Feedback 3.2

Write a declaration using the `Dim` statement for the following situations; make up an appropriate variable identifier.

1. You need variables for payroll processing to store the following:
   (a) Number of hours, which can hold a decimal value.
   (b) Employee's name.
   (c) Department number (not used in calculations).
2. You need variables for inventory control to store the following:
   (a) Integer quantity.
   (b) Description of the item.
   (c) Part number.
   (d) Cost.
   (e) Selling price.

Scope and Lifetime of Variables

A variable may exist and be visible for an entire project, for only one form, or for only one procedure. The visibility of a variable is referred to as its **scope**. Visibility really means "this variable can be used or 'seen' in this location." The scope is said to be namespace, module level, local, or block. A **namespace-level variable** may be used in all procedures of the namespace, which is generally the entire project. **Module-level variables**, also called **class-level variables**, are accessible from all procedures of a form. A **local variable** may be used only within the procedure in which it is declared, and a **block-level variable** is used only within a block of code inside a procedure.

You declare the scope of a variable by choosing where to place the declaration statement.

Note: Previous versions of VB and some other programming languages refer to namespace variables as *global variables*.

Variable Lifetime

When you create a variable, you must be aware of its **lifetime**. The *lifetime* of a variable is the period of time that the variable exists. The lifetime of a local or block variable is normally one execution of a procedure. For example, each time you execute a sub procedure, the local `Dim` statements are executed. Each variable is created as a "fresh" new one, with an initial value of 0 for numeric variables and an empty string for string variables. When the procedure finishes, its variables disappear; that is, their memory locations are released.

The lifetime of a module-level variable is the entire time the form is loaded, generally the lifetime of the entire project. If you want to maintain the value of a variable for multiple executions of a procedure—for example, to calculate a running total—you must use a module-level variable (or a variable declared as `Static`, which is discussed in Chapters 6 and 7).

Local Declarations

Any variable that you declare inside a procedure is local in scope, which means that it is known only to that procedure. Use the keyword `Dim` for local declarations. A `Dim` statement may appear anywhere inside the procedure as long as it appears prior to the first use of the variable in a statement. However, good programming practices dictate that `Dim`s should appear at the top of the procedure, prior to all other code statements (after the remarks).

```
' Module-level declarations.
Const DISCOUNT_RATE_Decimal As Decimal = 0.15D

Private Sub CalculateButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) _
  Handles CalculateButton.Click)
    ' Calculate the price and discount.
    Dim QuantityInteger As Integer
    Dim PriceDecimal, ExtendedPriceDecimal, DiscountDecimal, DiscountedPriceDecimal _
      As Decimal

    ' Convert input values to numeric variables.
    QuantityInteger = Integer.Parse(QuantityTextBox.Text)
    PriceDecimal = Decimal.Parse(PriceTextBox.Text)

    ' Calculate values.
    ExtendedPriceDecimal = QuantityInteger * PriceDecimal
    DiscountDecimal = Decimal.Round( _
      (ExtendedPriceDecimal * DISCOUNT_RATE_Decimal), 2)
    DiscountedPriceDecimal = ExtendedPriceDecimal – DiscountDecimal
```

Notice the `Const` statement in the preceding example. Although you can declare named constants to be local, block, module level, or namespace in scope, just as you can variables, good programming practices dictate that constants should be declared at the module level. This technique places all constant declarations at the top of the code and makes them easy to find in case you need to make changes.

Note: Any variables that you declare but do not use are marked with a gray squiggle underline. You can ignore the marks if you have just declared the variable and not yet written the code.

Module-Level Declarations

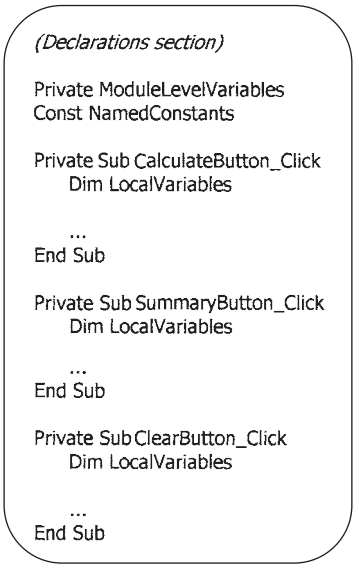
At times you need to be able to use a variable or constant in more than one procedure of a form. When you declare a variable or constant as module level, you can use it anywhere in that form. When you write module-level declarations, you can use the `Dim`, `Public`, or `Private` keyword. The preferred practice is to use either the `Public` or `Private` keyword for module-level variables rather than `Dim`. In Chapter 6 you will learn how and why to choose `Public` or `Private`. Until then we will declare all module-level variables using the `Private` keyword.

Place the declarations (`Private` or `Const`) for module-level variables and constants in the Declarations section of the form. (Recall that you have been using the Declarations section for remarks since Chapter 1.) **If you wish to accumulate a sum or count items for multiple executions of a procedure, you should declare the variable at the module level.**

Figure 3.3 illustrates the locations for coding local variables and module-level variables.

Figure 3.3

The variables you declare inside a procedure are local. Variables that you declare in the Declarations section are module level.



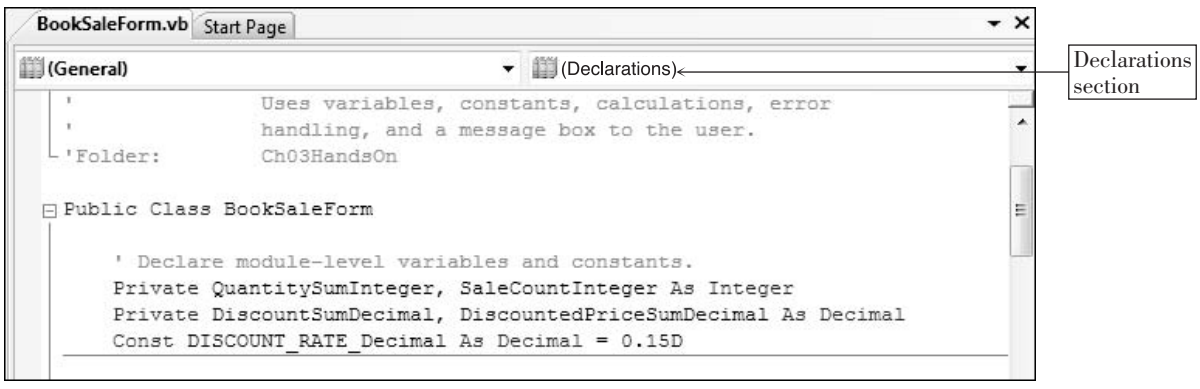

```
' Declarations section of a form.

' Declare module-level variables and constants.
Private QuantitySumInteger, SaleCountInteger As Integer
Private DiscountSumDecimal As Decimal
Const MAXIMUM_DISCOUNT_Decimal As Decimal = 100.0D
```

Coding Module-Level Declarations

To enter module-level declarations, you must be in the Editor window at the top of your code (Figure 3.4). Place the `Private` and `Const` statements after the Class declaration but before your first procedure.

Figure 3.4

Code module-level declarations in the Declarations section at the top of your code.



Block-Level and Namespace-Level Declarations

You won't use block-level or namespace-level declarations in this chapter. Block-level variables and constants have a scope of a block of code, such as `If / End If` or `Do / Loop`. These statements are covered later in this text.

Namespace-level variables and constants can sometimes be useful when a project has multiple forms and/or modules, but good programming practices exclude the use of namespace-level variables.

Feedback 3.3

Write the declarations (`Dim`, `Private`, or `Const` statements) for each of the following situations and indicate where each statement will appear.

1. The total of the payroll that will be needed in a Calculate event procedure and in a Summary event procedure.
2. The sales tax rate that cannot be changed during execution of the program but will be used by multiple procedures.
3. The number of participants that are being counted in the Calculate event procedure but not displayed until the Summary event procedure.

Calculations

In programming you can perform calculations with variables, with constants, and with the properties of certain objects. The properties you will use, such as the Text property of a text box or a label, are usually strings of text characters. These character strings, such as "Howdy" or "12345", cannot be used directly in calculations unless you first convert them to the correct data type.

Converting Strings to a Numeric Data Type

You can use a `Parse` method to convert the Text property of a control to its numeric form before you use the value in a calculation. The class that you use depends on the data type of the variable to which you are assigning the value. For example, to convert text to an integer, use the `Integer.Parse` method; to convert to a decimal value, use `Decimal.Parse`. Pass the text string that you want to convert as an **argument** of the `Parse` method.

```
' Convert input values to numeric variables.
QuantityInteger = Integer.Parse(QuantityTextBox.Text)
PriceDecimal = Decimal.Parse(PriceTextBox.Text)

' Calculate the extended price.
ExtendedPriceDecimal = QuantityInteger * PriceDecimal
```

Converting from one data type to another is sometimes called *casting*. In the preceding example, the String value from the QuantityTextBox.Text property is cast into an Integer data type and the String from PriceTextBox.Text is cast into a Decimal data type.

Using the Parse Methods

As you know, objects have methods that perform actions, such as the `Focus` method for a text box. The data types that you use to declare variables are

classes, which have properties and methods. Each of the numeric data type classes has a `Parse` method, which you will use to convert text strings into the correct numeric value for that type. The Decimal class has a `Parse` method that converts the value inside the parentheses to a decimal value while the Integer class has a `Parse` method to convert the value to an integer.

The Parse Methods—General Forms

General Forms

```
' Convert to Integer.
Integer.Parse(StringToConvert)

' Convert to Decimal
Decimal.Parse(StringToConvert)
```

The expression you wish to convert can be the property of a control, a string variable, or a string constant. The `Parse` method returns (produces) a value that can be used in a statement, such as the assignment statements in the following examples.

The Parse Methods—Examples

Examples

```
QuantityInteger = Integer.Parse(QuantityTextBox.Text)
PriceDecimal = Decimal.Parse(PriceTextBox.Text)
WholeNumberInteger = Integer.Parse(DigitString)
```

The `Parse` methods examine the value stored in the argument and attempt to convert it to a number in a process called *parsing*, which means to pick apart, character by character, and convert to another format.

When a `Parse` method encounters a value that it cannot parse to a number, such as a blank or nonnumeric character, an error occurs. You will learn how to avoid those errors later in this chapter in the section titled "Handling Exceptions."

You will use the `Integer.Parse` and `Decimal.Parse` methods for most of your programs. But in case you need to convert to Long, Single, or Double, VB also has a `Parse` method for each of those data type classes.

Converting to String

When you assign a value to a variable, you must take care to assign like types. For example, you assign an integer value to an Integer variable and a decimal value to a Decimal variable. Any value that you assign to a String variable or the Text property of a control must be string. You can convert any of the numeric data types to a string value using the `ToString` method. Later in this chapter you will learn to format numbers for output using parameters of the `ToString` method.

Note: The rule about assigning only like types has some exceptions. See "Implicit Conversions" later in this chapter.

Examples

```
ResultTextBox.Text = ResultDecimal.ToString()
CountTextBox.Text = CountInteger.ToString()
IDString = IDInteger.ToString()
```

Arithmetic Operations

The arithmetic operations you can perform in Visual Basic include addition, subtraction, multiplication, division, integer division, modulus, and exponentiation.

Operator	Operation
+	Addition
–	Subtraction
*	Multiplication
/	Division
\	Integer division
Mod	Modulus—Remainder of division
^	Exponentiation

The first four operations are self-explanatory, but you may not be familiar with \, Mod, or ^.

Integer Division (\)

Use integer division (\) to divide one integer by another, giving an integer result and truncating (dropping) any remainder. For example, if TotalMinutesInteger = 150, then

```
HoursInteger = TotalMinutesInteger \ 60
```

returns 2 for HoursInteger.

Mod

The Mod operator returns the remainder of a division operation. For example, if TotalMinutesInteger = 150, then

```
MinutesInteger = TotalMinutesInteger Mod 60
```

returns 30 for MinutesInteger.

Exponentiation (^)

The exponentiation operator (^) raises a number to the power specified and returns (produces) a result of the Double data type. The following are examples of exponentiation.

```
SquaredDouble = NumberDecimal ^ 2       ' Square the number--Raise to the 2nd power.
CubedDouble = NumberDecimal ^ 3         ' Cube the number--Raise to the 3rd power.
```

Order of Operations

The order in which operations are performed determines the result. Consider the expression 3 + 4 * 2. What is the result? If the addition is done first, the result is 14. However, if the multiplication is done first, the result is 11.

The hierarchy of operations, or **order of precedence**, in arithmetic expressions from highest to lowest is

1. Any operation inside parentheses
2. Exponentiation
3. Multiplication and division
4. Integer division
5. Modulus
6. Addition and subtraction

In the previous example, the multiplication is performed before the addition, yielding a result of 11. To change the order of evaluation, use parentheses. The expression

(3 + 4) * 2

will yield 14 as the result. One set of parentheses may be used inside another set. In that case, the parentheses are said to be *nested*. The following is an example of nested parentheses:

```
((Score1Integer + Score2Integer + Score3Integer) / 3) * 1.2
```

Extra parentheses can always be used for clarity. The expressions

```
2 * CostDecimal * RateDecimal
```

and

```
(2 * CostDecimal) * RateDecimal
```

are equivalent, but the second is easier to understand.

Multiple operations at the same level (such as multiplication and division) are performed from left to right. The example 8 / 4 * 2 yields 4 as its result, not 1. The first operation is 8 / 4, and 2 * 2 is the second.

Evaluation of an expression occurs in this order:

1. All operations within parentheses. Multiple operations within the parentheses are performed according to the rules of precedence.
2. All exponentiation. Multiple exponentiation operations are performed from left to right.
3. All multiplication and division. Multiple operations are performed from left to right.
4. All integer division. Multiple operations are performed from left to right.
5. Mod operations. Multiple operations are performed from left to right.
6. All addition and subtraction are performed from left to right.

TIP

Use extra parentheses to make the precedence clearer. The operation will be easier to understand and the parentheses have no negative effect on execution. ■

Although the precedence of operations in Basic is the same as in algebra, take note of one important difference: There are no implied operations in Basic. The following expressions would be valid in mathematics, but they are not valid in Basic:

Mathematical Notation	Equivalent Basic Function
2A	2 * A
3(X + Y)	3 * (X + Y)
(X + Y)(X – Y)	(X + Y) * (X – Y)

Feedback 3.4

What will be the result of the following calculations using the order of precedence?

Assume that: FirstInteger = 2, SecondInteger = 4, ThirdInteger = 3

1. FirstInteger + SecondInteger ^ 2
2. 8 / SecondInteger / FirstInteger
3. FirstInteger * (FirstInteger + 1)
4. FirstInteger * FirstInteger + 1
5. SecondInteger ^ FirstInteger + ThirdInteger * 2
6. SecondInteger ^ (FirstInteger + ThirdInteger) * 2
7. (SecondInteger ^ FirstInteger) + ThirdInteger * 2
8. ((SecondInteger ^ FirstInteger) + ThirdInteger) * 2

Using Calculations in Code

You perform calculations in assignment statements. Recall that whatever appears on the right side of an = (assignment operator) is assigned to the item on the left. The left side may be the property of a control or a variable.

Examples

```
AverageDecimal = SumDecimal / CountInteger
AmountDueLabel.Text = (PriceDecimal – (PriceDecimal * DiscountRateDecimal)).ToString()
CommissionTextBox.Text = (SalesTotalDecimal * CommissionRateDecimal).ToString()
```

In the preceding examples, the results of the calculations were assigned to a variable, the Text property of a label, and the Text property of a text box. In most cases you will assign calculation results to variables or to the Text properties of text boxes. When you assign the result of a calculation to a Text property, you must place parentheses around the entire calculation and convert the result of the calculation to a string.

Assignment Operators

In addition to the equal sign (=) as an **assignment operator**, VB has several operators that can perform a calculation and assign the result as one operation. The combined assignment operators are +=, – =, *=, /=, \=, and &=. Each of these assignment operators is a shortcut for the standard method; you can use the standard (longer) form or the shortcut. The shortcuts allow you to

type a variable name only once instead of having to type it on both sides of the equal sign.

For example, to add SalesDecimal to TotalSalesDecimal, the long version is

```
' Accumulate a total.
TotalSalesDecimal = TotalSalesDecimal + SalesDecimal
```

Instead you can use the shortcut assignment operator:

```
' Accumulate a total.
TotalSalesDecimal += SalesDecimal
```

The two statements have the same effect.

To subtract 1 from a variable, the long version is

```
' Subtract 1 from a variable.
CountDownInteger = CountDownInteger – 1
```

And the shortcut, using the – = operator:

```
' Subtract 1 from a variable.
CountDownInteger –= 1
```

The assignment operators that you will use most often are += and – =. The following are examples of other assignment operators:

```
' Multiply ResultInteger by 2 and assign the result to ResultInteger.
ResultInteger *= 2

' Divide SumDecimal by CountInteger and assign the result to SumDecimal.
SumDecimal /= CountInteger

' Concatenate SmallString to the end of BigString.
BigString &= SmallString
```

Feedback 3.5

1. Write two statements to add 5 to CountInteger, using (*a*) the standard, long version and (*b*) the assignment operator.
2. Write two statements to subtract WithdrawalDecimal from BalanceDecimal, using (*a*) the standard, long version and (*b*) the assignment operator.
3. Write two statements to multiply PriceDecimal by CountInteger and place the result into PriceDecimal. Use (*a*) the standard, long version and (*b*) the assignment operator.

Option Explicit and Option Strict

Visual Basic provides two options that can significantly change the behavior of the editor and compiler. Not using these two options, **Option Explicit** and **Option Strict**, can make coding somewhat easier but provide opportunities for hard-to-find errors and very sloppy programming.

Option Explicit

When Option Explicit is turned off, you can use any variable name without first declaring it. The first time you use a variable name, VB allocates a new variable. For example, you could write the line

```
Z = MyTotal + 1
```

without first declaring either Z or MyTotal. This is a throwback to very old versions of Basic that did not require variable declaration. In those days, programmers spent many hours debugging programs that had just a small misspelling or typo in a variable name.

You should always program with Option Explicit turned on. In VB, the option is turned on by default for all new projects. If you need to turn it off (not a recommended practice), place the line

```
Option Explicit Off
```

before the first line of code in a file.

Option Strict

Option Strict is an option that makes VB more like other **strongly typed** languages, such as C++, Java, and C#. When Option Strict is turned on, the editor and compiler try to help you keep from making hard-to-find mistakes. Specifically, Option Strict does not allow any implicit (automatic) conversions from a wider data type to a narrower one, or between String and numeric data types.

All of the code you have seen so far in this text has been written with Option Strict turned on. With this option, you must convert to the desired data type from String or from a wider data type to a narrower type, such as from Decimal to Integer.

With Option Strict turned off, code such as this is legal:

```
QuantityInteger = QuantityTextBox.Text
```

and

```
AmountInteger = AmountLong
```

and

```
TotalInteger += SaleAmountDecimal
```

With each of these legal (but dangerous) statements, the VB compiler makes assumptions about your data. And the majority of the time, the assumptions are correct. But bad input data or very large numbers can cause erroneous results or run-time errors.

The best practice is to always turn on Option Strict. This technique will save you from developing poor programming habits and will also likely save

you hours of debugging time. You can turn on Option Strict either in code or in the Project Designer for the current project. Place the line

```
Option Strict On
```

before the first line of code, after the general remarks at the top of a file.

Example

```
'Project:       MyProject
'Date:          Today
'Programmer:    Your Name
'Description:   This project calculates correctly.

Option Strict On

Public Class MyForm
```

To turn on Option Strict or Option Explicit for all files of a project, open the Project Designer by selecting *Project / Properties* or double-clicking My Project in the Solution Explorer. On the *Compile* tab you will find settings for both Option Explicit and Option Strict. By default, Option Explicit is turned on and Option Strict is turned off. Select *On* for Option Strict.

A better approach is to set Option Strict on by default. Select *Tools / Options / Projects and Solutions / VB Defaults* and set the defaults. Changing the default will affect all new projects begun after the change but will not change the open project or any previously written projects that you open. Use the Project Designer to change the option in existing projects.

Note: Option Strict includes all of the requirements of Option Explicit. If Option Strict is turned on, variables must be declared, regardless of the setting of Option Explicit.

Converting between Numeric Data Types

In VB you can convert data from one numeric data type to another. Some conversions can be performed implicitly (automatically) and some you must specify explicitly. And some cannot be converted if the value would be lost in the conversion.

Implicit Conversions

If you are converting a value from a narrower data type to a wider type, where there is no danger of losing any precision, the conversion can be performed by an **implicit conversion**. For example, the statement

```
BigNumberDouble = SmallNumberInteger
```

does not generate any error message, assuming that both variables are properly declared. The value of SmallNumberInteger is successfully converted and stored in BigNumberDouble. However, to convert in the opposite direction could cause problems and cannot be done implicitly.

The following list shows selected data type conversions that can be performed implicitly in VB:

From	To
Byte	Short, Integer, Long, Single, Double, or Decimal
Short	Integer, Long, Single, Double, or Decimal
Integer	Long, Single, Double, or Decimal
Long	Single, Double, or Decimal
Decimal	Single, Double
Single	Double

Notice that Double does not convert to any other type and you cannot convert implicitly from floating point (Single or Double) to Decimal.

Explicit Conversions

If you want to convert between data types that do not have implicit conversions, you must use an **explicit conversion**, also called ***casting***. But beware: If you perform a conversion that causes significant digits to be lost, an exception is generated. (Exceptions are covered later in this chapter in the section titled "Handling Exceptions.")

Use methods of the Convert class to convert between data types. The Convert class has methods that begin with "To" for each of the data types: `ToDecimal`, `ToSingle`, and `ToDouble`. However, you must specify the integer data types using their .NET class names rather than the VB data types.

For the VB data type:	Use the method for the .NET data type:
Short	`ToInt16`
Integer	`ToInt32`
Long	`ToInt64`

The following are examples of explicit conversion. For each, assume that the variables are already declared following the textbook naming standards.

```
NumberDecimal = Convert.ToDecimal(NumberSingle)
ValueInteger = Convert.ToInt32(ValueDouble)
AmountSingle = Convert.ToSingle(AmountDecimal)
```

You should perform a conversion from a wider data type to a narrower one only when you know that the value will fit, without losing significant digits. Fractional values are rounded to fit into integer data types, and a single or double value converted to decimal is rounded to fit in 28 digits.

Performing Calculations with Unlike Data Types

When you perform calculations with unlike data types, VB performs the calculation using the wider data type. For example, `CountInteger / NumberDecimal` produces a decimal result. If you want to convert the result to a different data type, you must perform a cast: `Convert.ToInt32(CountInteger / NumberDecimal)` or `Convert.ToSingle(CountInteger / NumberDecimal)`.

Note, however, that VB does not convert to a different data type until it is necessary. The expression `CountInteger / 2 * AmountDecimal` is evaluated as integer division for `CountInteger / 2`, producing an integer intermediate result; then the multiplication is performed on the integer and decimal value (AmountDecimal), producing a decimal result.

Note: The methods of the Convert class use the .NET data types rather than the VB data types. Use Int32 for Integer, Int16 for Short, and Int64 for Long.

Rounding Numbers

At times you may want to round decimal fractions. You can use the `Decimal.Round` method to round decimal values to the desired number of decimal positions.

The Round Method—General Form

General Form

```
Decimal.Round(DecimalValue, IntegerNumberOfDecimalPositions)
```

The `Decimal.Round` method returns a decimal result, rounded to the specified number of decimal positions, which can be an integer in the range 0–28.

The Round Method—Examples

Examples

```
' Round to two decimal positions.
ResultDecimal = Decimal.Round(AmountDecimal, 2)

' Round to zero decimal positions.
WholeDollarsDecimal = Decimal.Round(DollarsAndCentsDecimal, 0)

' Round the result of a calculation.
DiscountDecimal = Decimal.Round(ExtendedPriceDecimal * DISCOUNT_RATE_Decimal, 2)
```

The `Decimal.Round` method and the `Convert` methods round using a technique called "rounding toward even." If the digit to the right of the final digit is exactly 5, the number is rounded so that the final digit is even.

Examples

Decimal Value to Round	Number of Decimal Positions	Result
1.455	2	1.46
1.445	2	1.44
1.5	0	2
2.5	0	2

In addition to the `Decimal.Round` method, you can use the `Round` method of the Math class to round either decimal or double values. See Appendix B for the methods of the Math class.

Note: Visual Basic provides many functions for mathematical operations, financial calculations, and string manipulation. These functions can simplify many programming tasks. When Microsoft moved Visual Basic to object-oriented programming, they made the decision to keep many functions from previous versions of VB, although the functions do not follow the OOP pattern of Object.Method. You can find many of these helpful functions in Appendix B. The authors of this text elected to consistently use OOP methods rather than mix methods and functions.

Formatting Data for Display

When you want to display numeric data in the Text property of a label or text box, you must first convert the value to string. You also can **format** the data for display, which controls the way the output looks. For example, 12 is just a number, but $12.00 conveys more meaning for dollar amounts. Using the `ToString` method and formatting codes, you can choose to display a dollar sign, a percent sign, and commas. You also can specify the number of digits to appear to the right of the decimal point. VB rounds the value to return the requested number of decimal positions.

If you use the `ToString` method with an empty argument, the method returns an unformatted string. This is perfectly acceptable when displaying integer values. For example, the following statement converts NumberInteger to a string and displays it in DisplayTextBox.Text.

```
DisplayTextBox.Text = NumberInteger.ToString()
```

Using Format Specifier Codes

You can use the **format specifier** codes to format the display of output. These predefined codes can format a numeric value to have commas and dollar signs, if you wish.

Note: The default format of each of the formatting codes is based on the computer's regional setting. The formats presented here are for the default English (United States) values.

```
' Display as currency.
ExtendedPriceTextBox.Text = (QuantityInteger * PriceDecimal).ToString("C")
```

The "C" code specifies *currency*. By default, the string will be formatted with a dollar sign, commas separating each group of 3 digits, and 2 digits to the right of the decimal point.

```
' Display as numeric.
DiscountTextBox.Text = DiscountDecimal.ToString("N")
```

The "N" code stands for *number*. By default, the string will be formatted with commas separating each group of 3 digits, with 2 digits to the right of the decimal point.

You can specify the number of decimal positions by placing a numeric digit following the code. For example, "C0" displays as currency with zero digits to the right of the decimal point. The value is rounded to the specified number of decimal positions.

Format Specifier Codes	Name	Description
C or c	Currency	Formats with a dollar sign, commas, and 2 decimal places. Negative values are enclosed in parentheses.
F or f	Fixed-point	Formats as a string of numeric digits, no commas, 2 decimal places, and a minus sign at the left for negative values.
N or n	Number	Formats with commas, 2 decimal places, and a minus sign at the left for negative values.
D or d	Digits	Use only for *integer* data types. Formats with a left minus sign for negative values. Usually used to force a specified number of digits to display.
P or p	Percent	Multiplies the value by 100, adds a space and a percent sign, and rounds to 2 decimal places; negative values have a minus sign at the left.

Examples

Variable	Value	Format Specifier Code	Output
TotalDecimal	1125.6744	`"C"`	$1,125.67
TotalDecimal	1125.6744	`"N"`	1,125.67
TotalDecimal	1125.6744	`"N0"`	1,126
BalanceDecimal	1125.6744	`"N3"`	1,125.674
BalanceDecimal	1125.6744	`"F0"`	1126
PinInteger	123	`"D6"`	000123
RateDecimal	0.075	`"P"`	7.50 %
RateDecimal	0.075	`"P3"`	7.500 %
RateDecimal	0.075	`"P0"`	8 %
ValueInteger	–10	`"C"`	($10.00)
ValueInteger	–10	`"N"`	–10.00
ValueInteger	–10	`"D3"`	–010

Note that the formatted value returned by the `ToString` method is no longer purely numeric and cannot be used in further calculations. For example, consider the following lines of code:

```
AmountDecimal += ChargesDecimal
AmountTextBox.Text = AmountDecimal.ToString("C")
```

Assume that AmountDecimal holds 1050 after the calculation, and AmountTextBox.Text displays $1,050.00. If you want to do any further calculations with this amount, such as adding it to a total, you must use AmountDecimal, not AmountTextBox.Text. The variable AmountDecimal holds a numeric value; AmountTextBox.Text holds a string of (nonnumeric) characters.

You also can format DateTime values using format codes and the `ToString` method. Unlike the numeric format codes, the date codes are case sensitive. The strings returned are based on the computer's regional settings and can be changed. The following are default values for US-English in Windows Vista.

Date Specifier Code	Name	Description	Example of Default Setting
d	short date	Mm/dd/yyyy	6/16/2008
D	long date	Day, Month dd, yyyy	Monday, June 16, 2008
t	short time	hh:mm AM|PM	4:55 PM
T	long time	hh:mm:ss AM|PM	4:55:45 PM
f	full date/time (short time)	Day, Month dd, yyyy hh:mm AM|PM	Monday, June 16, 2008 4:55 PM
F	full date/time (long time)	Day, Month dd, yyyy hh:mm:ss AM|PM	Monday, June 16, 2008 4:55:45 PM
g	general (short time)	Mm/dd/yyyy hh:mm AM|PM	6/16/2008 11:00 AM
G	general (long time)	Mm/dd/yyyy hh:mm:ss AM|PM	6/16/2008 11:00:15 AM
M or m	month	Month dd	June 16
R or r	GMT pattern	Day, dd mmm yyyy hh:mm:ss GMT	Mon, 16 Jun 2008 11:00:15 GMT

Note that you can also use methods of the DateTime structure for formatting dates: `ToLongDateString`, `ToShortDateString`, `ToLongTimeString`, `ToShortTimeString`. See Appendix B or MSDN for additional information.

Choosing the Controls for Program Output

Some programmers prefer to display program output in labels; others prefer text boxes. Both approaches have advantages, but whichever approach you use, you should clearly differentiate between (editable) input areas and (uneditable) output areas.

Users generally get clues about input and output fields from their color. By Windows convention, input text boxes have a white background; output text has

a gray background. The default background color of text boxes (BackColor property) is set to white; the default BackColor of labels is gray. However, you can change the BackColor property and the BorderStyle property of both text boxes and labels so that the two controls look very similar. You might wonder why a person would want to do that, but there are some very good reasons.

Using text boxes for output can provide some advantages: The controls do not disappear when the Text property is cleared, and the borders and sizes of the output boxes can match those of the input boxes, making the form more visually uniform. Also, the user can select the text and copy it to another program using the Windows clipboard.

If you choose to display output in labels (the traditional approach), set the AutoSize property to False so that the label does not disappear when the Text property is blank. You also generally set the BorderStyle property of the labels to *Fixed3D* or *FixedSingle*, so that the outline of the label appears.

To use a text box for output, set its ReadOnly property to True (to prevent the user from attempting to edit the text) and set its TabStop property to False, so that the focus will not stop on that control when the user tabs from one control to the next. Notice that when you set ReadOnly to true, the BackColor property automatically changes to *Control*, which is the system default for labels.

The example programs in this chapter use text boxes, rather than labels, for output.

Feedback 3.6

Give the line of code that assigns the formatted output and tell how the output will display for the specified value.

1. A calculated variable called AveragePayDecimal has a value of 123.456 and should display in a text box called AveragePayTextBox.
2. The variable QuantityInteger, which contains 176123, must be displayed in the text box called QuantityTextBox.
3. The total amount collected in a fund drive is being accumulated in a variable called TotalCollectedDecimal. What statement will display the variable in a text box called TotalTextBox with commas and two decimal positions but no dollar signs?

A Calculation Programming Example

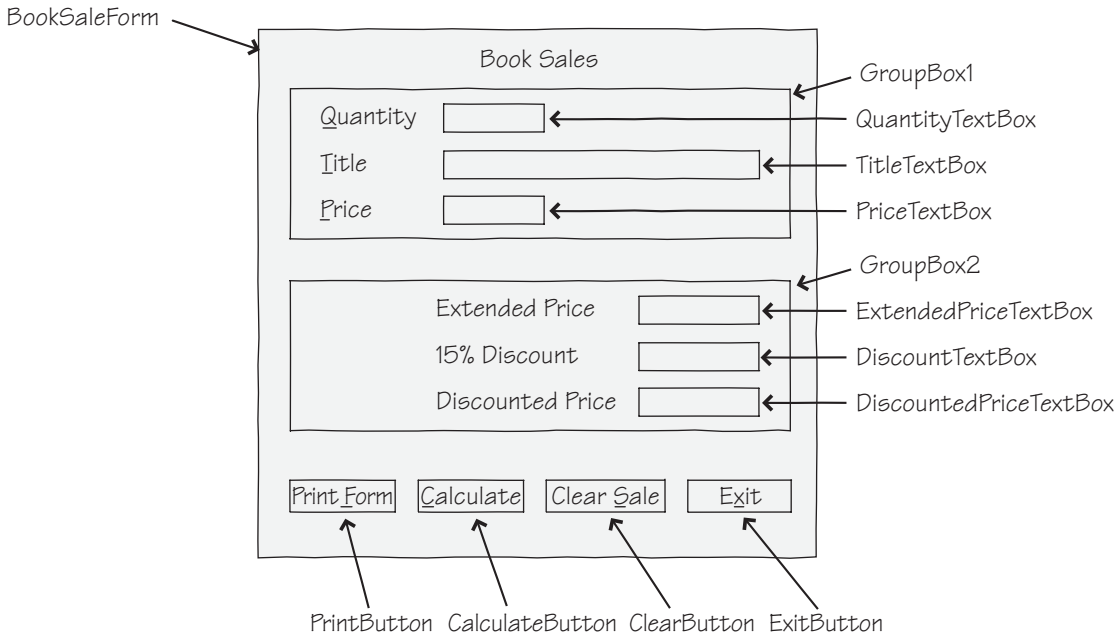
R 'n R—for Reading 'n Refreshment needs to calculate prices and discounts for books sold. The company is currently having a big sale, offering a 15 percent discount on all books. In this project you will calculate the amount due for a quantity of books, determine the 15 percent discount, and deduct the discount, giving the new amount due—the discounted amount. Use text boxes with the ReadOnly property set to True for the output fields.

Planning the Project

Sketch a form (Figure 3.5) that meets the needs of your users.

Figure 3.5

A planning sketch of the form for the calculation programming example.



Plan the Objects and Properties

Plan the property settings for the form and each of the controls.

Object	Property	Setting
BookSaleForm	Name Text AcceptButton CancelButton	BookSaleForm R 'n R for Reading 'n Refreshment CalculateButton ClearButton
Label1	Text Font	Book Sales Bold, 12 point
GroupBox1	Name Text	GroupBox1 (blank)
Label2	Text	&Quantity
QuantityTextBox	Name Text	QuantityTextBox (blank)
Label3	Text	&Title
TitleTextBox	Name Text	TitleTextBox (blank)
Label4	Text	&Price
PriceTextBox	Name Text	PriceTextBox (blank)

Object	Property	Setting
GroupBox2	Name Text	GroupBox2 (blank)
Label5	Text	Extended Price
ExtendedPriceTextBox	Name TextAlign ReadOnly TabStop	ExtendedPriceTextBox Right True False
Label6	Text	15% Discount
DiscountTextBox	Name TextAlign ReadOnly TabStop	DiscountTextBox Right True False
Label7	Text	Discounted Price
DiscountedPriceTextBox	Name TextAlign ReadOnly TabStop	DiscountedPriceTextBox Right True False
PrintButton	Name Text	PrintButton Print &Form
CalculateButton	Name Text	CalculateButton &Calculate
ClearButton	Name Text	ClearButton Clear &Sale
ExitButton	Name Text	ExitButton E&xit

Plan the Event Procedures

Since you have four buttons, you need to plan the actions for four event procedures.

Event Procedure	Actions-Pseudocode
PrintButton_Click	Set the print action to preview. Print the form.
CalculateButton_Click	Declare the variables. Convert the input Quantity and Price to numeric. Calculate Extended Price = Quantity * Price. Calculate and round: Discount = Extended Price * Discount Rate. Calculate Discounted Price = Extended Price – Discount. Format and display the output in text boxes.
ClearButton_Click	Clear each text box. Set the focus in the first text box.
ExitButton_Click	Exit the project.

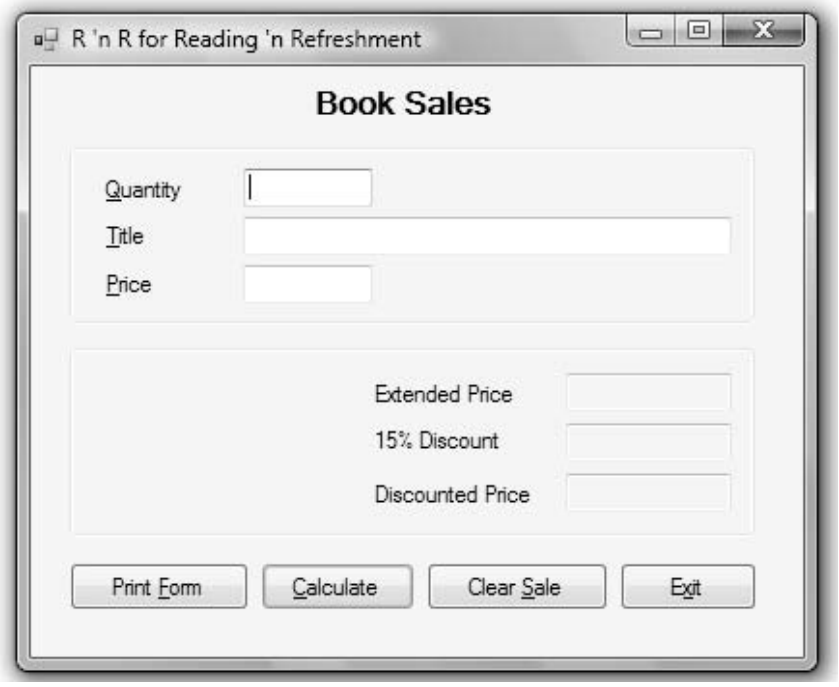
Write the Project

Follow the sketch in Figure 3.5 to create the form. Figure 3.6 shows the completed form.

1. Set the properties of each object, as you have planned.
2. Write the code. Working from the pseudocode, write each event procedure.
3. When you complete the code, use a variety of test data to thoroughly test the project.

Figure 3.6

The form for the calculation programming example



Note: If the user enters nonnumeric data or leaves a numeric field blank, the program will cancel with a run-time error. In the "Handling Exceptions" section that follows this program, you will learn to handle the errors.

The Project Coding Solution

```
'Project:       Chapter Example BookSale
'Date:          June 2008
'Programmer:    Bradley/Millspaugh
'Description:   This project inputs sales information for books.
'               It calculates the extended price and discount for
'               a sale.
'               Uses variables, constants, and calculations.
'               Note that no error trapping is included in this version
'               of the program.
'Folder:        Ch03BookSale

Public Class BookSaleForm

    ' Declare the constant.
    Const DISCOUNT_RATE_Decimal As Decimal = 0.15D
```

```
  Private Sub PrintButton_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles PrintButton.Click
      ' Print the form.

      PrintForm1.PrintAction = Printing.PrintAction.PrintToPreview
      PrintForm1.Print()
  End Sub

  Private Sub CalculateButton_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles CalculateButton.Click

      ' Calculate the price and discount.
      Dim QuantityInteger As Integer
      Dim PriceDecimal, ExtendedPriceDecimal, DiscountDecimal, _
        DiscountedPriceDecimal As Decimal

      ' Convert input values to numeric variables.
      QuantityInteger = Integer.Parse(QuantityTextBox.Text)
      PriceDecimal = Decimal.Parse(PriceTextBox.Text)

      ' Calculate values.
      ExtendedPriceDecimal = QuantityInteger * PriceDecimal
      DiscountDecimal = Decimal.Round( _
       (ExtendedPriceDecimal * DISCOUNT_RATE_Decimal), 2)
      DiscountedPriceDecimal = ExtendedPriceDecimal - DiscountDecimal

      ' Format and display answers.
      ExtendedPriceTextBox.Text = ExtendedPriceDecimal.ToString("C")
      DiscountTextBox.Text = DiscountDecimal.ToString("N")
      DiscountedPriceTextBox.Text = DiscountedPriceDecimal.ToString("C")
  End Sub

  Private Sub ClearButton_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles clearButton.Click
      ' Clear previous amounts from the form.

      TitleTextBox.Clear()
      PriceTextBox.Clear()
      ExtendedPriceTextBox.Clear()
      DiscountTextBox.Clear()
      DiscountedPriceTextBox.Clear()
      With QuantityTextBox
          .Clear()
          .Focus()
      End With
  End Sub

  Private Sub ExitButton_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles ExitButton.Click
      ' Exit the project.

      Me.Close()
  End Sub
End Class
```

Handling Exceptions

When you allow users to input numbers and use those numbers in calculations, lots of things can go wrong. The `Parse` methods, `Integer.Parse` and `Decimal.Parse`, fail if the user enters nonnumeric data or leaves the text box

blank. Or your user may enter a number that results in an attempt to divide by zero. Each of those situations causes an **exception** to occur, or, as programmers like to say, *throws an exception*.

You can easily "catch" program exceptions by using structured exception handling. You catch the exceptions before they can cause a run-time error, and handle the situation, if possible, within the program. Catching exceptions as they happen and writing code to take care of the problems is called *exception handling*. The exception handling in Visual Studio is standardized for all of the languages using the Common Language Runtime, which greatly improves on the old error trapping in early versions of VB.

Try/Catch Blocks

To trap or catch exceptions, enclose any statement(s) that might cause an error in a **`Try/Catch` block**. If an exception occurs while the statements in the `Try` block are executing, program control transfers to the `Catch` block; if a `Finally` statement is included, the code in that section executes last, whether or not an exception occurred.

The Try Block—General Form

General Form

```
Try
    ' Statements that may cause an error.
Catch [VariableName As ExceptionType]
    ' Statements for action when an exception occurs.
[Finally
    ' Statements that always execute before exit of the Try block]
End Try
```

The Try Block—Example

Example

```
Try
    QuantityInteger = Integer.Parse(QuantityTextBox.Text)
    QuantityTextBox.Text = QuantityInteger.ToString()
Catch
    MessageLabel.Text = "Error in input data."
End Try
```

The `Catch` as it appears in the preceding example will catch any exception. You also can specify the type of exception that you want to catch, and even write several `Catch` statements, each to catch a different type of exception. For example, you might want to display one message for bad input data and a different message for a calculation problem.

To specify a particular type of exception to catch, use one of the predefined exception classes, which are all based on, or derived from, the SystemException class. Table 3.2 shows some of the common exception classes.

To catch bad input data that cannot be converted to numeric, write this `Catch` statement:

```
Catch TheException As FormatException
    MessageLabel.Text = "Error in input data."
```

TIP

In the Editor window, type "Try" and press Enter. The editor will insert a skeleton `Try/Catch` block. ■

The Exception Class

Each exception is an instance of the Exception class. The properties of this class allow you to determine the code location of the error, the type of error, and the cause. The Message property contains a text message about the error, and the Source property contains the name of the object causing the error. The StackTrace property can identify the location in the code where the error occurred.

Common Exception Classes **Table 3.2**

Exception	Caused By
FormatException	Failure of a numeric conversion, such as `Integer.Parse` or `Decimal.Parse`. Usually blank or nonnumeric data.
InvalidCastException	Failure of a conversion operation. May be caused by loss of significant digits or an illegal conversion.
ArithmeticException	A calculation error, such as division by zero or overflow of a variable.
System.IO.EndOfStreamException	Failure of an input or output operation such as reading from a file.
OutOfMemoryException	Not enough memory to create an object.
Exception	Generic.

You can include the text message associated with the type of exception by specifying the Message property of the Exception object, as declared by the variable you named on the `Catch` statement. Be aware that the messages for exceptions are usually somewhat terse and not oriented to users, but they can sometimes be helpful.

```
Catch TheException As FormatException
    MessageLabel.Text = "Error in input data: " & TheException.Message
```

Handling Multiple Exceptions

If you want to trap for more than one type of exception, you can include multiple `Catch` blocks (handlers). When an exception occurs, the `Catch` statements are checked in sequence. The first one with a matching exception type is used.

```
Catch TheException As FormatException
    ' Statements for nonnumeric data.
Catch TheException As ArithmeticException
    ' Statements for calculation problem.
Catch TheException As Exception
    ' Statements for any other exception.
```

The last `Catch` will handle any exceptions that do not match either of the first two exception types. Note that it is acceptable to use the same variable name for multiple `Catch` statements; each `Catch` represents a separate code block, so the variable's scope is only that block.

Later in this chapter in the "Testing Multiple Fields" section, you will see how to nest one `Try/Catch` block inside another one.

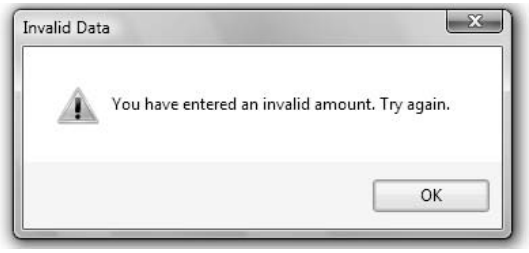
Displaying Messages in Message Boxes

You may want to display a message when the user has entered invalid data or neglected to enter a required data value. You can display a message to the user in a message box, which is a special type of window. You can specify the message, an optional icon, title bar text, and button(s) for the message box (Figure 3.7).

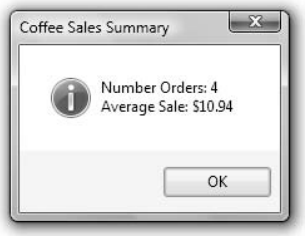
Figure 3.7

Two sample message boxes created with the MessageBox class.

a.



b.



You use the **`Show` method** of the **MessageBox** object to display a message box. The MessageBox object is a predefined instance of the MessageBox class that you can use any time you need to display a message.

The MessageBox Object—General Forms

There is more than one way to call the `Show` method. Each of the following statements is a valid call; you can choose the format you want to use. It's very important that the arguments you supply exactly match one of the formats. For example, you cannot reverse, transpose, or leave out any of the arguments. When there are multiple ways to call a method, the method is said to be *overloaded*. See the section "Using Overloaded Methods" later in this chapter.

General Forms

```
MessageBox.Show(TextMessage)
MessageBox.Show(TextMessage, TitlebarText)
MessageBox.Show(TextMessage, TitlebarText, MessageBoxButtons)
MessageBox.Show(TextMessage, TitlebarText, MessageBoxButtons, MessageBoxIcon)
```

The TextMessage is the message you want to appear in the message box. The TitlebarText appears on the title bar of the MessageBox window. The MessageBoxButtons argument specifies the buttons to display. And the MessageBoxIcon determines the icon to display.

The MessageBox Statement—Examples

Examples

```
MessageBox.Show("Enter numeric data.")

MessageBox.Show("Try again.", "Data Entry Error")

MessageBox.Show("This is a message.", "This is a title bar", MessageBoxButtons.OK)

Try
    QuantityInteger = Integer.Parse(QuantityTextBox.Text)
    QuantityTextBox.Text = QuantityInteger.ToString()
Catch ex As FormatException
    MessageBox.Show("Nonnumeric Data.", "Error", _
      MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
End Try
```

The TextMessage String

The message string you display may be a string literal enclosed in quotes or it may be a string variable. You also may want to concatenate several items, for example, combining a literal with a value from a variable. If the message you specify is too long for one line, Visual Basic will wrap it to the next line.

The Titlebar Text

The string that you specify for TitlebarText will appear in the title bar of the message box. If you choose the first form of the `Show` method, without the TitlebarText, the title bar will appear empty.

MessageBoxButtons

When you show a message box, you can specify the button(s) to display. In Chapter 4, after you learn to make selections using the `If` statement, you will display more than one button and take alternate actions based on which button the user clicks. You specify the buttons using the MessageBoxButtons constants from the MessageBox class. The choices are OK, OKCancel, RetryCancel, YesNo, YesNoCancel, and AbortRetryIgnore. The default for the `Show` method is OK, so unless you specify otherwise, you will get only the OK button in your message box.

MessageBoxIcon

The easy way to select the icon to display is to type MessageBoxIcon and a period into the editor; the IntelliSense list pops up with the complete list. The actual appearance of the icons varies from one operating system to another. You can see a description of the icons in Help under "MessageBoxIcon Enumeration."

Constants for MessageBoxIcon

Asterisk
Error
Exclamation
Hand
Information
None
Question
Stop
Warning

Using Overloaded Methods

As you saw earlier, you can call the `Show` method with several different argument lists. This feature, called ***overloading***, allows the `Show` method to act differently for different arguments. Each argument list is called a ***signature***, so you can say that the `Show` method has several signatures.

When you call the `Show` method, the arguments that you supply must exactly match one of the signatures provided by the method. You must supply the correct number of arguments of the correct data type and in the correct sequence.

Fortunately, the Visual Studio smart editor helps you enter the arguments; you don't have to memorize or look up the argument lists. Type "MessageBox.Show(" and IntelliSense pops up with the first of the signatures for the `Show` method (Figure 3.8). Notice in the figure that there are 21 possible forms of the argument list, or 21 signatures for the `Show` method. (We only showed 4 of the 21 signatures in the previous example, to simplify the concept.)

To select the signature that you want to use, use the up or down arrows at the left end of the IntelliSense popup. For example, to select the signature that needs only the text of the message and the title bar caption, select the 14th format (Figure 3.9). The argument that you are expected to enter is shown in bold, and a description of that argument appears in the last line of the popup. After you type the text of the message and a comma, the second argument appears in bold and the description changes to tell you about that argument (Figure 3.10).

TIP

You can use the keyboard up and down arrow keys rather than the mouse to view and select the signature. ■

Figure 3.8

IntelliSense pops up the first of 21 signatures for the `Show` *method. Use the up and down arrows to see the other possible argument lists.*

```
MessageBox.Show(
▲1 of 21▼ Show (text As String, caption As String, buttons As System.Windows.Forms.MessageBoxButtons,
                icon As System.Windows.Forms.MessageBoxIcon,
                defaultButton As System.Windows.Forms.MessageBoxDefaultButton,
                options As System.Windows.Forms.MessageBoxOptions, displayHelpButton As Boolean)
  As System.Windows.Forms.DialogResult
text: The text to display in the message box.
```

Figure 3.9

Select the 14th signature to see the argument list. The currently selected argument is shown in bold, and the description of the argument appears in the last line of the popup.

```
MessageBox.Show(
▲14 of 21▼ Show (text As String, caption As String) As System.Windows.Forms.DialogResult
text: The text to display in the message box.
```

Figure 3.10

Type the first argument and a comma, and IntelliSense bolds the second argument and displays a description of the needed data.

```
MessageBox.Show("Data Entry Error",
▲1 of 20▼ Show (text As String, caption As String, buttons As System.Windows.Forms.MessageBoxButtons,
                icon As System.Windows.Forms.MessageBoxIcon,
                defaultButton As System.Windows.Forms.MessageBoxDefaultButton,
                options As System.Windows.Forms.MessageBoxOptions, displayHelpButton As Boolean)
  As System.Windows.Forms.DialogResult
caption: The text to display in the title bar of the message box.
```

Testing Multiple Fields

When you have more than one input field, each field presents an opportunity for an exception. If you would like your exception messages to indicate the field that caused the error, you can nest one `Try/Catch` block inside another one.

Nested Try/Catch Blocks

One `Try/Catch` block that is completely contained inside another one is called a **nested `Try/Catch` block**. You can nest another `Try/Catch` block within the `Try` block or the `Catch` block.

```
Try     ' Outer try block for first field.
        ' Convert first field to numeric .
    Try     ' Inner Try block for second field.
            ' Convert second field to numeric.
            ' Perform the calculations for the fields that passed conversion.
    Catch SecondException As FormatException
        ' Handle any exceptions for the second field.
        ' Display a message and reset the focus for the second field.
    End Try ' End of inner Try block for second field.
Catch FirstException As FormatException
    ' Handle exceptions for first field.
    ' Display a message and reset the focus for the first field.
Catch AnyOtherException as Exception
    ' Handle any generic exceptions.
    ' Display a message.
End Try
```

You can nest the `Try/Catch` blocks as deeply as you need. Make sure to place the calculations within the most deeply nested `Try`; you do not want to perform the calculations unless all of the input values are converted without an exception.

By testing each `Parse` method individually, you can be specific about which field caused the error and set the focus back to the field in error. Also, by using the `SelectAll` method of the text box, you can make the text appear selected to aid the user. Here are the calculations from the earlier program, rewritten with nested `Try/Catch` blocks.

```
Private Sub CalculateButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles CalculateButton.Click
    ' Calculate the price and discount.
    Dim QuantityInteger As Integer
    Dim PriceDecimal, ExtendedPriceDecimal, DiscountDecimal, _
      DiscountedPriceDecimal, AverageDiscountDecimal As Decimal
    Try
      ' Convert quantity to numeric variables.
      QuantityInteger = Integer.Parse(QuantityTextBox.Text)
      Try
          ' Convert price if quantity was successful.
          PriceDecimal = Decimal.Parse(PriceTextBox.Text)
```

```
            ' Calculate values for sale.
            ExtendedPriceDecimal = QuantityInteger * PriceDecimal
            DiscountDecimal = Decimal.Round( _
              (ExtendedPriceDecimal * DISCOUNT_RATE_Decimal), 2)
            DiscountedPriceDecimal = ExtendedPriceDecimal – DiscountDecimal

            ' Calculate summary values.
            QuantitySumInteger += QuantityInteger
            DiscountSumDecimal += DiscountDecimal
            DiscountedPriceSumDecimal += DiscountedPriceDecimal
            SaleCountInteger += 1
            AverageDiscountDecimal = DiscountSumDecimal / SaleCountInteger

            ' Format and display answers for the sale.
            ExtendedPriceTextBox.Text = ExtendedPriceDecimal.ToString("C")
            DiscountTextBox.Text = DiscountDecimal.ToString("N")
            DiscountedPriceTextBox.Text = DiscountedPriceDecimal.ToString("C")

            ' Format and display summary values.
            QuantitySumTextBox.Text = QuantitySumInteger.ToString()
            DiscountSumTextBox.Text = DiscountSumDecimal.ToString("C")
            DiscountAmountSumTextBox.Text = DiscountedPriceSumDecimal.ToString("C")
            AverageDiscountTextBox.Text = AverageDiscountDecimal.ToString("C")
        Catch PriceException As FormatException
            ' Handle a price exception.
            MessageBox.Show("Price must be numeric.", "Data Entry Error", _
              MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
            With PriceTextBox
                .Focus()
                .SelectAll()
            End With
        End Try
    Catch QuantityException As FormatException
        ' Handle a quantity exception.
        MessageBox.Show("Quantity must be numeric.", "Data Entry Error", _
          MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
        With QuantityTextBox
            .Focus()
            .SelectAll()
        End With
    Catch AnException As Exception
        ' Handle any other exception.
        MessageBox.Show("Error: " & AnException.Message)
    End Try
End Sub
```

Counting and Accumulating Sums

Programs often need to calculate the sum of numbers. For example, in the previous programming exercise, each sale is displayed individually. If you want to accumulate totals of the sales amounts, of the discounts, or of the number of books sold, you need some new variables and new techniques.

As you know, the variables you declare inside a procedure are local to that procedure. They are re-created each time the procedure is called; that is, their lifetime is one time through the procedure. Each time the procedure is entered, you have a new fresh variable with an initial value of 0. If you want a variable to retain its value for multiple calls, in order to accumulate totals, you must

declare the variable as module level. (Another approach, using Static variables, is discussed in Chapter 7.)

Summing Numbers

The technique for summing the sales amounts for multiple sales is to declare a module-level variable for the total. Then, in the CalculateButton_Click event procedure for each sale, add the current amount to the total:

```
DiscountedPriceSumDecimal += DiscountedPriceDecimal
```

This assignment statement adds the current value for DiscountedPriceDecimal into the sum held in DiscountedPriceSumDecimal.

Counting

If you want to count something, such as the number of sales in the previous example, you need another module-level variable. Declare a counter variable as integer:

```
Private SaleCountInteger as Integer
```

Then, in the calculateButton_Click event procedure, add 1 to the counter variable:

```
SaleCountInteger += 1
```

This statement adds 1 to the current contents of SaleCountInteger. The statement will execute one time for each time the CalculateButton_Click event procedure executes. Therefore, SaleCountInteger will always hold a running count of the number of sales.

Calculating an Average

To calculate an average, divide the sum of the items by the count of the items. In the R 'n R book example, we can calculate the average sale by dividing the sum of the discounted prices by the count of the sales:

```
AverageDiscountedSaleDecimal = DiscountedPriceSumDecimal / SaleCountInteger
```

Your Hands-On Programming Example

In this project, R 'n R—for Reading 'n Refreshment needs to expand the book sale project done previously in this chapter. In addition to calculating individual sales and discounts, management wants to know the total number of books sold, the total number of discounts given, the total discounted amount, and the average discount per sale.

Help the user by adding ToolTips wherever you think they will be useful.

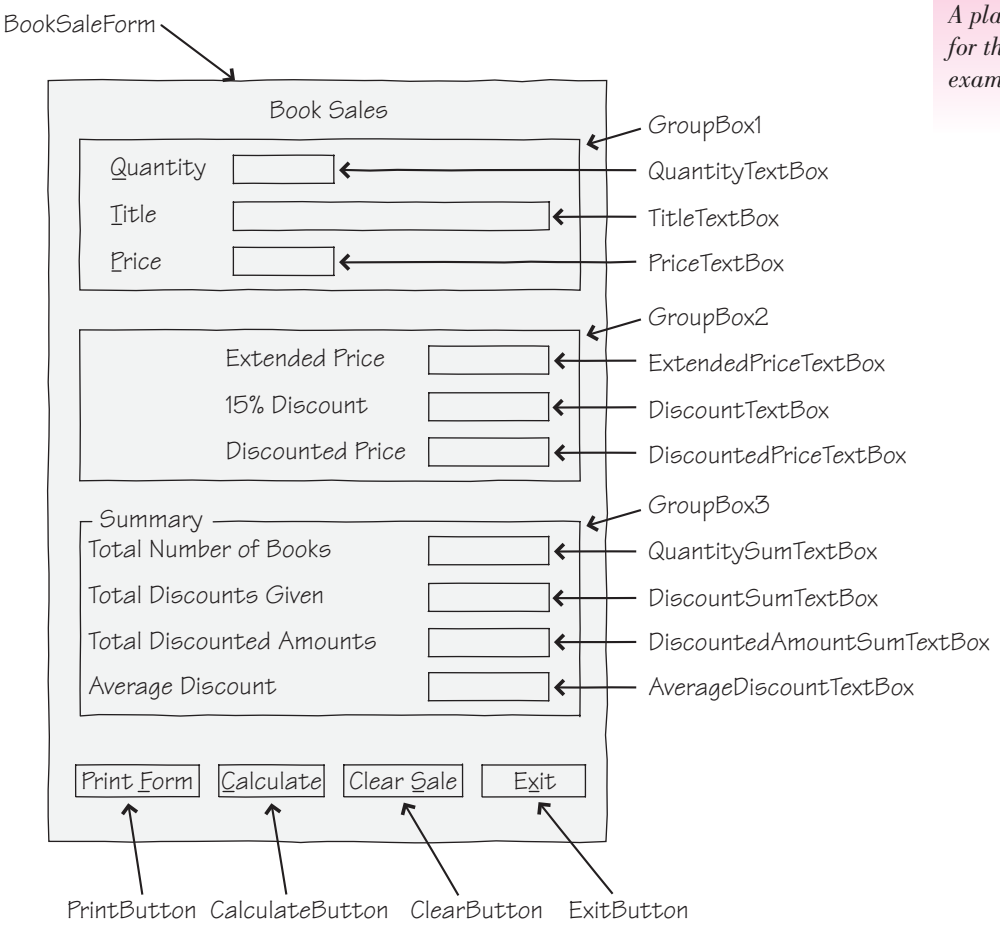
Add error handling to the program, so that missing or nonnumeric data will not cause a run-time error.

Planning the Project

Sketch a form (Figure 3.11) that your users sign off as meeting their needs.

Figure 3.11

A planning sketch of the form for the hands-on programming example.



Plan the Objects and Properties Plan the property settings for the form and each control. These objects and properties are the same as the previous example, with the addition of the summary information beginning with GroupBox3.

Note: The ToolTips have not been added to the planning forms. Make up and add your own.

Object	Property	Setting
BookSaleForm	Name	BookSaleForm
	Text	R 'n R for Reading 'n Refreshment
	AcceptButton	CalculateButton
	CancelButton	ClearButton
Label1	Text	Book Sales
	Font	Bold, 12 point
GroupBox1	Name	GroupBox1
	Text	(blank)
Label2	Text	&Quantity

Object	Property	Setting
QuantityTextBox	Name	QuantityTextBox
	Text	(blank)
Label3	Text	&Title
TitleTextBox	Name	TitleTextBox
	Text	(blank)
Label4	Text	&Price
PriceTextBox	Name	PriceTextBox
	Text	(blank)
GroupBox2	Name	GroupBox2
	Text	(blank)
Label5	Text	Extended Price
ExtendedPriceTextBox	Name	ExtendedPriceTextBox
	Text	(blank)
	ReadOnly	True
	TextAlign	Right
Label6	Text	15% Discount
DiscountTextBox	Name	DiscountTextBox
	Text	(blank)
	ReadOnly	True
	TextAlign	Right
Label7	Text	Discounted Price
DiscountedPriceTextBox	Name	DiscountedPriceTextBox
	Text	(blank)
	TextAlign	Right
	ReadOnly	True
PrintButton	Name	PrintButton
	Text	Print &Form
CalculateButton	Name	CalculateButton
	Text	&Calculate
ClearButton	Name	ClearButton
	Text	Clear &Sale
ExitButton	Name	ExitButton
	Text	E&xit
GroupBox3	Name	GroupBox3
	Text	Summary
Label8	Text	Total Number of Books
QuantitySumTextBox	Name	QuantitySumTextBox
	Text	(Blank)
	ReadOnly	True
	TextAlign	Right
Label9	Text	Total Discounts Given

Object	Property	Setting
DiscountSumTextBox	Name	DiscountSumTextBox
	Text	(blank)
	ReadOnly	True
	TextAlign	Right
Label10	Text	Total Discounted Amounts
DiscountedAmountSumTextBox	Name	DiscountedAmountSumTextBox
	Text	(blank)
	ReadOnly	True
	TextAlign	Right
Label11	Text	Average Discount
AverageDiscountTextBox	Name	AverageDiscountTextBox
	Text	(blank)
	ReadOnly	True
	TextAlign	Right

Plan the Event Procedures The planning that you did for the previous example will save you time now. The only procedure that requires more steps is the CalculateButton_Click event.

Event Procedure	Actions-Pseudocode
PrintButton_Click	Set the print action to preview. Print the form.

CalculateButton_Click	Declare the variables.
	Try
	  Convert the input Quantity to numeric.
	  Try
	  Convert the input Price to numeric
	  Calculate Extended Price = Quantity * Price.
	  Calculate Discount = Extended Price * Discount Rate.
	  Calculate Discounted Price = Extended Price – Discount.
	  Calculate the summary values:
	  Add Quantity to Quantity Sum.
	  Add Discount to Discount Sum.
	  Add Discounted Price to Discounted Price Sum.
	  Add 1 to Sale Count.
	  Calculate Average Discount = Discount Sum / Sale Count.
	  Format and display sale output.
	  Format and display summary values.
	  Catch any Price exception
	  Display error message and reset the focus to Price.
	Catch any Quantity exception
	  Display error message and reset the focus to Quantity.
	Catch any generic exception
	  Display error message.

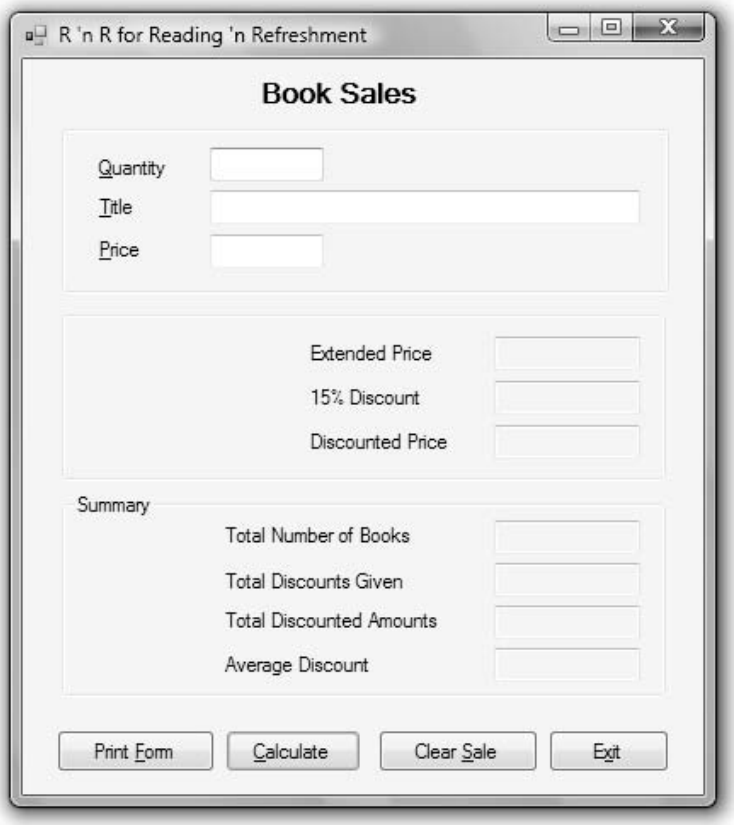
ClearButton_Click	Clear each text box except Summary fields. Set the focus in the first text box.
ExitButton_Click	Exit the project.

Write the Project Follow the sketch in Figure 3.11 to create the form. Figure 3.12 shows the completed form.

- Set the properties of each of the objects, as you have planned.
- Write the code. Working from the pseudocode, write each event procedure.
- When you complete the code, use a variety of test data to thoroughly test the project. Test with nonnumeric data and blank entries.

Figure 3.12

The form for the hands-on programming example.



The Project Coding Solution

```
'Project:      Ch03HandsOn
'Date:         June 2008
'Programmer:   Bradley/Millspaugh
'Description:  This project inputs sales information for books.
'              It calculates the extended price and discount for
'              a sale and maintains summary information for all
'              sales.
'              Uses variables, constants, calculations, error
'              handling, and a message box to the user.
'Folder:       Ch03HandsOn
```

```
Public Class BookSaleForm

    ' Declare module-level variables and constants.
    Private QuantitySumInteger, SaleCountInteger As Integer
    Private DiscountSumDecimal, DiscountedPriceSumDecimal As Decimal
    Const DISCOUNT_RATE_Decimal As Decimal = 0.15D

    Private Sub PrintButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles PrintButton.Click
        ' Print the form.

        PrintForm1.PrintAction = Printing.PrintAction.PrintToPreview
        PrintForm1.Print()
    End Sub

    Private Sub CalculateButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles CalculateButton.Click
        ' Calculate the price and discount.
        Dim QuantityInteger As Integer
        Dim PriceDecimal, ExtendedPriceDecimal, DiscountDecimal, _
          DiscountedPriceDecimal, AverageDiscountDecimal As Decimal

        Try
            ' Convert quantity to numeric variable.
            QuantityInteger = Integer.Parse(QuantityTextBox.Text)

            Try
                ' Convert price if quantity was successful.
                PriceDecimal = Decimal.Parse(PriceTextBox.Text)
                ' Calculate values for sale.
                ExtendedPriceDecimal = QuantityInteger * PriceDecimal
                DiscountDecimal = Decimal.Round( _
                 (ExtendedPriceDecimal * DISCOUNT_RATE_Decimal), 2)
                DiscountedPriceDecimal = ExtendedPriceDecimal - DiscountDecimal

                ' Calculate summary values.
                QuantitySumInteger += QuantityInteger
                DiscountSumDecimal += DiscountDecimal
                DiscountedPriceSumDecimal += DiscountedPriceDecimal
                SaleCountInteger += 1
                AverageDiscountDecimal = DiscountSumDecimal / SaleCountInteger

                ' Format and display answers for the sale.
                ExtendedPriceTextBox.Text = ExtendedPriceDecimal.ToString("C")
                DiscountTextBox.Text = DiscountDecimal.ToString("N")
                DiscountedPriceTextBox.Text = DiscountedPriceDecimal.ToString("C")

                ' Format and display summary values.
                QuantitySumTextBox.Text = QuantitySumInteger.ToString()
                DiscountSumTextBox.Text = DiscountSumDecimal.ToString("C")
                DiscountAmountSumTextBox.Text = DiscountedPriceSumDecimal.ToString("C")
                AverageDiscountTextBox.Text = AverageDiscountDecimal.ToString("C")

            Catch PriceException As FormatException
                ' Handle a price exception.
                MessageBox.Show("Price must be numeric.", "Data Entry Error", _
                  MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
                With PriceTextBox
                    .Focus()
                    .SelectAll()
                End With
            End Try
```

```
        Catch QuantityException As FormatException
            ' Handle a quantity exception.
            MessageBox.Show("Quantity must be numeric.", "Data Entry Error", _
               MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
            With QuantityTextBox
                .Focus()
                .SelectAll()
            End With

        Catch AnException As Exception
            ' Handle any other exception.
            MessageBox.Show("Error: " & AnException.Message)
        End Try
    End Sub

    Private Sub ClearButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ClearButton.Click
        ' Clear previous amounts from the form.

        TitleTextBox.Clear()
        PriceTextBox.Clear()
        ExtendedPriceTextBox.Clear()
        DiscountTextBox.Clear()
        DiscountedPriceTextBox.Clear()
        With QuantityTextBox
            .Clear()
            .Focus()
        End With
    End Sub

    Private Sub ExitButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ExitButton.Click
        ' Exit the project.

        Me.Close()
    End Sub
End Class
```

Summary

1. Variables are temporary memory locations that have a name (called an *identifier*), a data type, and a scope. A constant also has a name, data type, and scope, but it also must have a value assigned to it. The value stored in a variable can be changed during the execution of the project; the values stored in constants cannot change.
2. The data type determines what type of values may be assigned to a variable or constant. The most common data types are String, Integer, Decimal, Single, and Boolean.
3. Identifiers for variables and constants must follow the Visual Basic naming rules and should follow good naming standards, called *conventions*. An identifier should be meaningful and have the data type appended at the

end. Variable names should begin with an uppercase character and be mixed upper- and lowercase, while constants are all uppercase.

4. Identifiers should include the data type of the variable or constant.
5. Intrinsic constants, such as Color.Red and Color.Blue, are predefined and built into the .NET Framework. Named constants are programmer-defined constants and are declared using the `Const` statement. The location of the `Const` statement determines the scope of the constant.
6. Variables are declared using the `Private` or `Dim` statement; the location of the statement determines the scope of the variable. Use the `Dim` statement to declare local variables inside a procedure; use the `Private` statement to declare module-level variables at the top of the program, outside of any procedure.
7. The scope of a variable may be namespace level, module level, local, or block level. Block-level and local variables are available only within the procedure in which they are declared; module-level variables are accessible in all procedures within a form; namespace variables are available in all procedures of all classes in a namespace, which is usually the entire project.
8. The lifetime of local and block-level variables is one execution of the procedure in which they are declared. The lifetime of module-level variables is the length of time that the form is loaded.
9. Use the `Parse` methods to convert text values to numeric before performing any calculations.
10. Calculations may be performed using the values of numeric variables, constants, and the properties of controls. The result of a calculation may be assigned to a numeric variable or to the property of a control.
11. A calculation operation with more than one operator follows the order of precedence in determining the result of the calculation. Parentheses alter the order of operations.
12. To explicitly convert between numeric data types, use the Convert class. Some conversions can be performed implicitly.
13. The `Decimal.Round` method rounds a decimal value to the specified number of decimal positions.
14. The `ToString` method can be used to specify the appearance of values for display. By using formatting codes, you can specify dollar signs, commas, percent signs, and the number of decimal digits to display. The method rounds values to fit the format.
15. `Try/Catch/Finally` statements provide a technique for checking for user errors such as blank or nonnumeric data or an entry that might result in a calculation error.
16. A run-time error is called an *exception*; catching and taking care of exceptions is called *error trapping* and *error handling*.
17. You can trap for different types of errors by specifying the exception type on the `Catch` statement, and you can have multiple `Catch` statements to catch more than one type of exception. Each exception is an instance of the Exception class; you can refer to the properties of the Exception object for further information.
18. A message box is a window for displaying information to the user.
19. The `Show` method of the MessageBox class is overloaded, which means that the method may be called with different argument lists, called *signatures*.
20. You can calculate a sum by adding each transaction to a module-level variable. In a similar fashion, you can calculate a count by adding to a module-level variable.

Key Terms

argument *120*
assignment operator *124*
block-level variable *117*
casting *128*
class-level variable *117*
constant *110*
data type *111*
declaration *111*
exception *138*
explicit conversion *128*
format *130*
format specifier *130*
identifier *111*
implicit conversion *127*
intrinsic constant *115*
lifetime *117*
local variable *117*
MessageBox *140*
module-level variable *117*
named constant *111*
namespace-level variable *117*
nested `Try/Catch` block *143*
Option Explicit *125*
Option Strict *125*
order of precedence *123*
overloading *141*
scope *117*
`Show` method *140*
signature *141*
string literal *114*
strongly typed *126*
`Try/Catch` block *138*
variable *110*

Review Questions

1. Name and give the purpose of five data types available in Visual Basic.
2. What does *declaring a variable* mean?
3. What effect does the location of a declaration statement have on the variable it declares?
4. Explain the difference between a constant and a variable.
5. What is the purpose of the `Integer.Parse` method? the `Decimal.Parse` method?
6. Explain the order of precedence of operators for calculations.
7. What statement(s) can be used to declare a variable?
8. Explain how to make an interest rate stored in RateDecimal display in RateTextBox as a percentage with three decimal digits.
9. What are implicit conversions? explicit conversions? When would each be used?
10. When should you use `Try/Catch` blocks? Why?
11. What is a message box and when should you use one?
12. Explain why the `MessageBox.Show` method has multiple signatures.
13. Why must you use module-level variables if you want to accumulate a running total of transactions?

Programming Exercises

3.1 Create a project that calculates the total of fat, carbohydrate, and protein calories. Allow the user to enter (in text boxes) the grams of fat, the grams of carbohydrates, and the grams of protein. Each gram of fat is nine calories; a gram of protein or carbohydrate is four calories.

Display the total calories for the current food item in a text box. Use two other text boxes to display an accumulated sum of the calories and a count of the items entered.

Form: The form should have three text boxes for the user to enter the grams for each category. Include labels next to each text box indicating what the user is to enter.

Include buttons to *Calculate*, to *Clear* the text boxes, to *Print the Form*, and to *Exit*.

Make the form's Text property "Calorie Counter".

Code: Write the code for each button. Make sure to catch any bad input data and display a message box to the user.

3.2 Lennie McPherson, proprietor of Lennie's Bail Bonds, needs to calculate the amount due for setting bail. Lennie requires something of value as collateral, and his fee is 10 percent of the bail amount. He wants the screen to provide boxes to enter the bail amount and the item being used for collateral. The program must calculate the fee.

Form: Include text boxes for entering the amount of bail and the description of the collateral. Label each text box.

Include buttons for *Calculate*, *Clear*, *Print*, and *Exit*.

The text property for the form should be "Lennie's Bail Bonds".

Code: Include event procedures for the click event of each button. Calculate the amount due as 10 percent of the bail amount and display it in a text box, formatted as currency. Make sure to catch any bad input data and display a message to the user.

3.3 In retail sales, management needs to know the average inventory figure and the turnover of merchandise. Create a project that allows the user to enter the beginning inventory, the ending inventory, and the cost of goods sold.

Form: Include labeled text boxes for the beginning inventory, the ending inventory, and the cost of goods sold. After calculating the answers, display the average inventory and the turnover formatted in text boxes.

Include buttons for *Calculate*, *Clear*, *Print*, and *Exit*. The formulas for the calculations are

$$\text{Average inventory} = \frac{\text{Beginning inventory} + \text{Ending inventory}}{2}$$

$$\text{Turnover} = \frac{\text{Cost of goods sold}}{\text{Average inventory}}$$

Note: The average inventory is expressed in dollars; the turnover is the number of times the inventory turns over.

Code: Include procedures for the click event of each button. Display the results in text boxes. Format the average inventory as currency and the turnover as a number with one digit to the right of the decimal. Make sure to catch any bad input data and display a message to the user.

Test Data

Beginning	Ending	Cost of Goods Sold	Average Inventory	Turnover
58500	47000	400000	$52,750.00	7.6
75300	13600	515400	44,450.00	11.6
3000	19600	48000	11,300.00	4.2

3.4 A local recording studio rents its facilities for $200 per hour. Management charges only for the number of minutes used. Create a project in which the input is the name of the group and the number of minutes it used the studio. Your program calculates the appropriate charges, accumulates the total charges for all groups, and computes the average charge and the number of groups that used the studio.

Form: Use labeled text boxes for the name of the group and the number of minutes used. The charges for the current group should be displayed formatted in a text box. Create a group box for the summary information. Inside the group box, display the total charges for all groups, the number of groups, and the average charge per group. Format all output appropriately. Include buttons for *Calculate*, *Clear*, *Print*, and *Exit*.

Code: Use a constant for the rental rate per hour; divide that by 60 to get the rental rate per minute. Do not allow bad input data to cancel the program.

Test Data

Group	Minutes
Pooches	95
Hounds	5
Mutts	480

Check Figures

Total Charges for Group	Total Number of Groups	Average Charge	Total Charges for All Groups
$316.67	1	$316.67	$316.67
$16.67	2	$166.67	$333.33
$1,600.00	3	$644.44	$1,933.33

3.5 Create a project that determines the future value of an investment at a given interest rate for a given number of years. The formula for the calculation is

Future value = Investment amount * (1 + Interest rate) ^ Years

Form: Use labeled text boxes for the amount of investment, the interest rate (as a decimal fraction), and the number of years the investment will be held. Display the future value in a text box formatted as currency.

Include buttons for *Calculate*, *Clear*, *Print*, and *Exit*. Format all dollar amounts. Display a message to the user for nonnumeric or missing input data.

Test Data

Amount	Rate	Years
2000.00	.15	5
1234.56	.075	3

Check Figures

Future Value
$4.022.71
$1,533.69

Hint: Remember that the result of an exponentiation operation is a Double data type.

3.6 Write a project that calculates the shipping charge for a package if the shipping rate is $0.12 per ounce.

Form: Use a masked text box for the package-identification code (a six-digit code) and labeled text boxes for the weight of the package—one box for pounds and another one for ounces. Use a text box to display the shipping charge.

Include buttons for *Calculate*, *Clear*, *Print*, and *Exit*.

Code: Include event procedures for each button. Use a constant for the shipping rate, calculate the shipping charge, and display it formatted in a text box. Display a message to the user for any bad input data.

Calculation hint: There are 16 ounces in a pound.

ID	Weight	Shipping Charge
L5496P	0 lb. 5 oz.	$0.60
J1955K	2 lb. 0 oz.	$3.84
Z0000Z	1 lb. 1 oz.	$2.04

3.7 Create a project for the local car rental agency that calculates rental charges. The agency charges $15 per day plus $0.12 per mile.

Form: Use text boxes for the customer name, address, city, state, ZIP code, beginning odometer reading, ending odometer reading, and the number of days the car was used. Use text boxes to display the miles driven and the total charge. Format the output appropriately.

Include buttons for *Calculate*, *Clear*, *Print*, and *Exit*.

Code: Include an event procedure for each button. For the calculation, subtract the beginning odometer reading from the ending odometer reading to get the number of miles traveled. Use a constant for the $15 per day charge and the $0.12 mileage rate. Display a message to the user for any bad input data.

3.8 Create a project that will input an employee's sales and calculate the gross pay, deductions, and net pay. Each employee will receive a base pay of $900 plus a sales commission of 6 percent of sales.

After calculating the net pay, calculate the budget amount for each category based on the percentages given.

Pay

Base pay	$900; use a named constant
Commission	6% of sales
Gross pay	Sum of base pay and commission
Deductions	18% of gross pay
Net pay	Gross pay minus deductions

Budget

Housing	30% of net pay
Food and clothing	15% of net pay
Entertainment	50% of net pay
Miscellaneous	5% of net pay

Form: Use text boxes to input the employee's name and the dollar amount of the sales. Use text boxes to display the results of the calculations.

Provide buttons for *Calculate*, *Clear*, *Print*, and *Exit*. Display a message to the user for any bad input data.

Case Studies

VB Mail Order

The company has instituted a bonus program to give its employees an incentive to sell more. For every dollar the store makes in a four-week period, the employees receive 2 percent of sales. The amount of bonus each employee receives is based upon the percentage of hours he or she worked during the bonus period (a total of 160 hours).

The screen will allow the user to enter the employee's name, the total hours worked, and the amount of the store's total sales. The amount of sales needs to be entered only for the first employee. (*Hint*: Don't clear it.)

The *Calculate* button will determine the bonus earned by this employee, and the *Clear* button will clear only the name, hours-worked, and bonus amount fields. A *Print* button allows the user to print the form. Do not allow missing or bad input data to cancel the program; instead display a message to the user.

VB Auto Center

Salespeople for used cars are compensated using a commission system. The commission is based on the costs incurred for the vehicle:

Commission = Commission rate *
(Sales price – Cost value)

The form will allow the user to enter the salesperson's name, the selling price of the vehicle, and the cost value of the vehicle. Use a constant of 20 percent for the commission rate.

The *Calculate* button will determine the commission earned by the salesperson; the *Clear* button will clear the text boxes. A *Print* button allows the user to print the form. Do not allow bad input data to cancel the program; instead display a message to the user.

Video Bonanza

Design and code a project to calculate the amount due and provide a summary of rentals. All movies rent for $1.80 and all customers receive a 10 percent discount.

The form should contain input for the member number and the number of movies rented. Inside a group box, display the rental amount, the 10 percent discount, and the amount due. Inside a second group box, display the number of customers served and the total rental income (after discount).

Include buttons for *Calculate*, *Clear*, *Print*, and *Exit*. The *Clear* button clears the information for the current rental but does not clear the summary information. A *Print* button allows the user to print the form. Do not allow bad input data to cancel the program; instead display a message to the user.

Very Very Boards

Very Very Boards rents snowboards during the snow season. A person can rent a snowboard without boots or with boots. Create a project that will calculate and display the information for each rental. In addition, calculate the summary information for each day's rentals.

For each rental, input the person's name, the driver's license or ID number, the number of snowboards, and the number of snowboards with boots. Snowboards without boots rent for $20; snowboards with boots rent for $30.

Calculate and display the charges for snowboards and snowboards with boots, and the rental total. In addition, maintain summary totals. Use constants for the snowboard rental rate and the snowboard with boots rental rate.

Create a summary frame with boxes to indicate the day's totals for the number of snowboards and snowboards with boots rented, total charges, and average charge per customer.

Include buttons for *Calculate Order*, *Clear*, *Clear All*, *Print*, and *Exit*. The *Clear All* command should clear the summary totals to begin a new day's summary. *Hint*: You must set each of the summary variables to zero as well as clear the summary boxes.

Make your buttons easy to use for keyboard entry. Make the *Calculate* button the Accept button and the *Clear* button the Cancel button.

Do not allow bad input data to cancel the program; instead display a message to the user.

CHAPTER

4

Decisions and Conditions

at the completion of this chapter, you will be able to . . .

1. Use `If` statements to control the flow of logic.
2. Understand and use nested `If` statements.
3. Read and create action diagrams that illustrate the logic in a selection process.
4. Evaluate conditions using the comparison operators (>, <, =, >=, <=, <>).
5. Combine conditions using `And`, `Or`, `AndAlso`, and `OrElse`.
6. Test the Checked property of radio buttons and check boxes.
7. Perform validation on numeric fields.
8. Use a `Case` structure for multiple decisions.
9. Use one event procedure to respond to the events for multiple controls and determine which control caused the event.
10. Call an event procedure from another procedure.
11. Create message boxes with multiple buttons and choose alternate actions based on the user response.
12. Debug projects using breakpoints, stepping program execution, and displaying intermediate results.

In this chapter you will learn to write applications that can take one action or another, based on a condition. For example, you may need to keep track of sales separately for different classes of employees, different sections of the country, or different departments. You also will learn alternate techniques for checking the validity of input data and how to display multiple buttons in a message box and take different actions depending on the user response.

If Statements

A powerful capability of the computer is its ability to make decisions and to take alternate courses of action based on the outcome.

A decision made by the computer is formed as a question: Is a given condition true or false? If it is true, do one thing; if it is false, do something else.

```
If the sun is shining Then      (condition)
   go to the beach              (action to take if condition is true)
Else
   go to class                  (action to take if condition is false)
End If                          (See Figure 4.1.)
```

or

```
If you don't succeed Then       (condition)
   try, try again               (action)
End If                          (See Figure 4.2.)
```

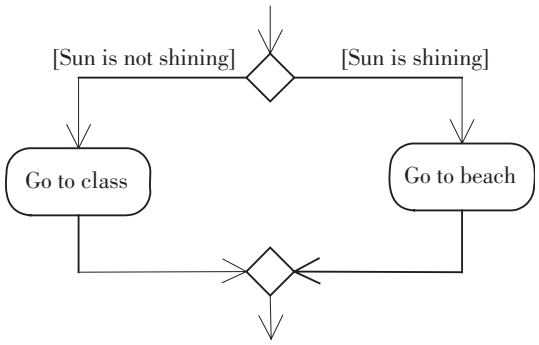


Figure 4.1

The logic of an `If / Then / Else` *statement in Unified Modeling Language (UML) activity diagram form.*

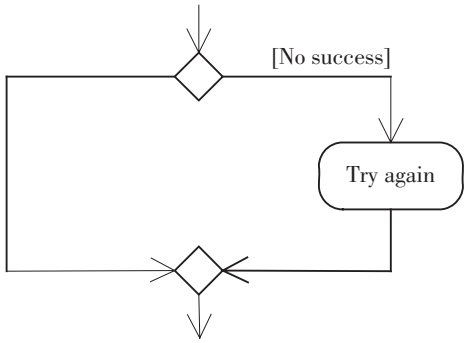


Figure 4.2

The logic of an `If` *statement without an* `Else` *action in UML activity diagram form.*

Notice in the second example that no action is specified if the condition is not true.

In an `If` statement, when the condition is true, only the `Then` clause is executed. When the condition is false, only the `Else` clause, if present, is executed.

If / Then / Else Statement—General Form

General Form

```
If (condition) Then
    statement(s)
[ElseIf (condition) Then
    statement(s)]
[Else
    statements(s)]
End If
```

A block **`If / Then / Else`** must always conclude with **`End If`**. The word `Then` must appear on the same line as the `If` with nothing following `Then` (except a remark). `End If` and `Else` (if used) must appear alone on a line. The statements under the `Then` and `Else` clauses are indented for readability and clarity.

Notice that the keyword `ElseIf` is all one word but that `End If` is two words.

If / Then / Else Statement—Example

When the number of units in UnitsDecimal is less than 32, select the radio button for Freshman; otherwise, make sure the radio button is deselected (see Figure 4.3). Remember that when a radio button is selected, the Checked property has a Boolean value of True.

Example

```
UnitsDecimal = Decimal.Parse(UnitsTextBox.Text)
If UnitsDecimal < 32D Then
    FreshmanRadioButton.Checked = True
Else
    FreshmanRadioButton.Checked = False
End If
```

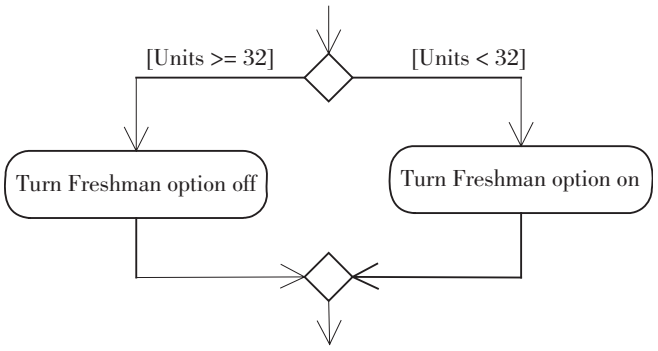


Figure 4.3

The `If` statement logic in UML activity diagram form. If the number of units is fewer than 32, the Freshman radio button will be selected; otherwise the Freshman radio button will be deselected.

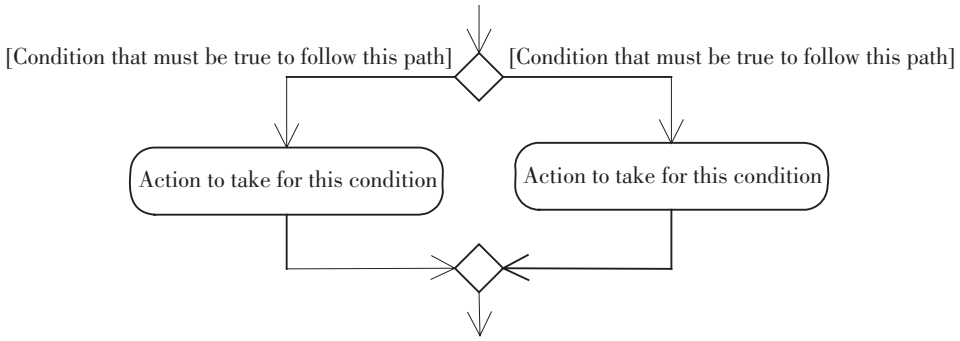
Charting If Statements

A Unified Modeling Language (UML) activity diagram is a useful tool for showing the logic of an `If` statement. It has been said that one picture is worth a thousand words. Many programmers find that a diagram helps them organize their thoughts and design projects more quickly.

The UML specification includes several types of diagrams. The activity diagram is a visual planning tool for decisions and actions for an entire application or a single procedure. The diamond-shape symbol (called a *decision symbol*) represents a condition. The branches from the decision symbol indicate which path to take for different results of the decision (Figure 4.4).

Figure 4.4

The UML activity diagram symbols used for program decisions and activities.



The Helpful Editor

You will find that the code editor can be very helpful as you enter `If` statements. When you type an `If` statement and the condition and press Enter, the editor automatically adds the `Then` and `End If` statements and places the insertion point on a blank line, indented from the `If`. And if you type `EndIf` without the space, the editor adds the space for you.

The editor also attempts to correct some errors for you. If you type the word `Else` and another statement on the same line, which is illegal syntax, the editor adds a colon. A colon is a statement terminator, which allows you to have multiple statements on one line. However, good programming practices dictate that you should have only one statement per line, so if you find an extra colon in your code, remove it and correct the syntax.

Here is an example of illegal syntax:

```
' Illegal syntax.
If UnitsDecimal < 32D Then
    FreshmanRadioButton.Checked = True
Else FreshmanRadioButton.Checked = False
End If
```

The editor's automatic correction, which you will fix, is

```
' The editor's automatic correction.
If UnitsDecimal < 32D Then
    FreshmanRadioButton.Checked = True
Else : FreshmanRadioButton.Checked = False
End If
```

Fix this poor solution by separating the two statements into two separate lines:

```
' The preferred syntax.
If UnitsDecimal < 32D Then
    FreshmanRadioButton.Checked = True
Else
    FreshmanRadioButton.Checked = False
End If
```

Boolean Expressions

The test in an `If` statement is a Boolean expression, which evaluates as True or False. To form **Boolean expressions**, also referred to as ***conditions***, you use **comparison operators** (Table 4.1), also called ***relational operators***. The comparison is evaluated and the result is either True or False.

Boolean expressions can be formed with numeric variables and constants, string variables and constants, object properties, and arithmetic expressions. However, it is important to note that comparisons must be made on like types; that is, strings can be compared only to other strings, and numeric values can be compared only to other numeric values, whether a variable, constant, property, or arithmetic expression.

The Comparison Operators **Table 4.1**

Symbol	Relation Tested	Examples
>	greater than	`Decimal.Parse(AmountTextBox.Text) > LimitDecimal` `CorrectInteger > 75`
<	less than	`Integer.Parse(SalesTextBox.Text) < 10000` `NameTextBox.Text < NameString`
=	equal to	`PasswordTextBox.Text = "101"`
<>	not equal to	`FreshmanRadioButton.Checked <> True` `NameTextBox.Text <> ""`
>=	greater than or equal to	`Integer.Parse(QuantityTextBox.Text) >= 500`
<=	less than or equal to	`Name1TextBox.Text <= Name2TextBox.Text`

Comparing Numeric Variables and Constants

When numeric values are involved in a test, an algebraic comparison is made; that is, the sign of the number is taken into account. Therefore, negative 20 is less than 10, and negative 2 is less than negative 1.

An equal sign (=) means replacement in an assignment statement. In a comparison, the equal sign is used to test for equality. For example, the Boolean expression in the statement:

```
If Decimal.Parse(PriceTextBox.Text) = MaximumDecimal Then
```

means "Is the current numeric value stored in PriceTextBox.Text equal to the value stored in MaximumDecimal?"

Sample Comparisons

AlphaInteger
5

BravoInteger
4

CharlieInteger
–5

Boolean Expression	Evaluates
AlphaInteger = BravoInteger	False
CharlieInteger < 0	True
BravoInteger > AlphaInteger	False
CharlieInteger <= BravoInteger	True
AlphaInteger >= 5	True
AlphaInteger <> CharlieInteger	True

Comparing Strings

String variables can be compared to other string variables, string properties, or string literals enclosed in quotation marks. The comparison begins with the left-most character and proceeds one character at a time from left to right. As soon as a character in one string is not equal to the corresponding character in the second string, the comparison is terminated, and the string with the lower-ranking character is judged less than the other.

The determination of which character is less than another is based on the code used to store characters internally in the computer. The code, called the **ANSI code**, has an established order (called the *collating sequence*) for all letters, numbers, and special characters. (ANSI stands for American National Standards Institute.) In Table 4.2, A is less than B, L is greater than K, and all numeric digits are less than all letters. Some special symbols are lower than the numbers, some are higher, and the blank space is lower than the rest of the characters shown.

Note: VB actually stores string characters in Unicode, a coding system that uses 2 bytes to store every character. Using Unicode, all characters and symbols in foreign languages can be represented. For systems that do not use the foreign symbols, only the first byte of each character is used. And the first byte of Unicode is the same as the ANSI code. For comparison, Unicode can store 65,536 unique characters, ANSI code can store 256 unique characters, and ASCII, the earlier coding method, can store 128 unique characters. The first 128 characters of ANSI and Unicode are the same as the ASCII characters.

Person1TextBox.Text
JOHN

Person2TextBox.Text
JOAN

The expression `Person1TextBox.Text < Person2TextBox.Text` evaluates False. The *A* in JOAN is lower ranking than the *H* in JOHN.

The ANSI collating sequence **Table 4.2**

Code	Character	Code	Character	Code	Character
32	Space (blank)	64	@	96	‘
33	!	65	A	97	a
34	“	66	B	98	b
35	#	67	C	99	c
36	$	68	D	100	d
37	%	69	E	101	e
38	&	70	F	102	f
39	’ (apostrophe)	71	G	103	g
40	(	72	H	104	h
41	)	73	I	105	i
42	*	74	J	106	j
43	+	75	K	107	k
44	, (comma)	76	L	108	l
45	-	77	M	109	m
46	.	78	N	110	n
47	/	79	O	111	o
48	0	80	P	112	p
49	1	81	Q	113	q
50	2	82	R	114	r
51	3	83	S	115	s
52	4	84	T	116	t
53	5	85	U	117	u
54	6	86	V	118	v
55	7	87	W	119	w
56	8	88	X	120	x
57	9	89	Y	121	y
58	:	90	Z	122	z
59	;	91	[	123	{
60	<	92	\	124	|
61	=	93	]	125	}
62	>	94	^	126	~
63	?	95	_	127	Del

Word1TextBox.Text
HOPE

Word2TextBox.Text
HOPELESS

The expression `Word1TextBox.Text < Word2TextBox.Text` evaluates True. When one string is shorter than the other, it compares as if the shorter string is padded with blanks to the right of the string, and the blank space is compared to a character in the longer string.

Car1Label.Text
300ZX

Car2Label.Text
Porsche

The expression `Car1Label.Text < Car2Label.Text` evaluates True. When the number 3 is compared to the letter P, the 3 is lower, since all numbers are lower ranking than all letters.

Feedback 4.1

CountOneInteger	CountTwoInteger	CountThreeInteger	FourTextBox.Text	FiveTextBox.Text
5	5	–5	"Bit"	"bit"

Determine which expressions will evaluate True and which ones will evaluate False.

1. `CountOneInteger >= CountTwoInteger`
2. `CountThreeInteger < 0`
3. `CountThreeInteger < CountTwoInteger`
4. `CountOneInteger <> CountTwoInteger`
5. `CountOneInteger + 2 > CountTwoInteger + 2`
6. `FourTextBox.Text < FiveTextBox.Text`
7. `FourTextBox.Text <> FiveTextBox.Text`
8. `FourTextBox.Text > "D"`
9. `"2" <> "Two"”`
10. `"$" <= "?"`

Testing for True or False

You can use shortcuts when testing for True or False. Visual Basic evaluates the condition in an `If` statement. If the condition is a Boolean variable, it holds the values True or False.

For example:

```
If SuccessfulOperationBoolean = True Then . . .
```

is equivalent to

```
If SuccessfulOperationBoolean Then . . .
```

Comparing Uppercase and Lowercase Characters

When comparing strings, the case of the characters is important. An uppercase *Y* is not equal to a lowercase *y*. Because the user may type a name or word in uppercase, in lowercase, or as a combination of cases, we must check all possibilities. The best way is to use the **`ToUpper`** and **`ToLower` methods** of the

String class, which return the uppercase or lowercase equivalent of a string, respectively.

The ToUpper and ToLower Methods—General Forms

General Forms

```
TextString.ToUpper()
TextString.ToLower()
```

The ToUpper and ToLower Methods—Examples

Examples

NameTextBox.Text Value	NameTextBox.Text.ToUpper()	NameTextBox.Text.ToLower()
Basic	BASIC	basic
PROGRAMMING	PROGRAMMING	programming
Robert Jones	ROBERT JONES	robert jones
hello	HELLO	hello

An example of a Boolean expression using the `ToUpper` method follows.

```
If NameTextBox.Text.ToUpper() = "BASIC" Then
   ' Do something.
End If
```

Note: When you convert NameTextBox.Text to uppercase, you must compare it to an uppercase literal ("BASIC") if you want it to evaluate as True.

Compound Boolean Expressions

You can use **compound Boolean expressions** to test more than one condition. Create compound expressions by joining conditions with **logical operators**, which compare each expression and return a Boolean result. The logical operators are `Or`, `And`, `Not`, `AndAlso`, `OrElse`, and `Xor`.

Logical Operator	Meaning	Example	Explanation
`Or`	If one expression or both expressions are True, the entire expression is True.	`Integer.Parse(NumberLabel.Text) = 1 Or _` `  Integer.Parse(NumberLabel.Text) = 2`	Evaluates True when NumberLabel.Text is either "1" or "2".
`And`	Both expressions must be True for the entire expression to be True.	`Integer.Parse(NumberTextBox.Text) > 0 And _` `  Integer.Parse(NumberTextBox.Text) < 10`	Evaluates True when NumberTextBox.Text is "1", "2", "3", "4", "5", "6", "7", "8", or "9".
`Not`	Reverses the condition so that a True expression will evaluate False and vice versa.	`Not Integer.Parse(NumberLabel.Text) = 0`	Evaluates True when NumberLabel.Text is any value other than "0".
`AndAlso`	Short-circuiting version of `And`. If the first expression is False, the entire expression returns False and the second expression is not evaluated.	`BalanceDecimal > 0D AndAlso WithinLimitBoolean`	If BalanceDecimal is not greater than 0, the condition evaluates False and the second condition is not tested; otherwise works the same as an `And`.

continued

Logical Operator	Meaning	Example	Explanation
OrElse	Short-circuiting version of Or. If the first expression is True, the entire expression returns True and the second expression is not evaluated.	NumberCorrectInteger > 70 OrElse WaiverBoolean	If NumberCorrectInteger is greater than 70, the condition evaluates True and the second condition is not tested.
Xor	Exclusive Or; evaluates True if one or the other expression is True, but not both.	CountInteger > 10 Xor VipBoolean	Evaluates True when CountInteger > 10 or VipBoolean is True. If *both* conditions evaluate either True or False, this condition evaluates False.

Compound Boolean Expressions—Examples

Examples

```
If MaleRadioButton.Checked And Integer.Parse(AgeTextBox.Text) < 21 Then
     MinorMaleCountInteger += 1
End If

If JuniorRadioButton.Checked Or SeniorRadioButton.Checked Then
     UpperClassmanInteger += 1
End If
```

The first example requires that both the radio button test and the age test be True for the count to be incremented. In the second example, only one of the conditions must be True.

One caution when using compound expressions: Each side of the logical operator must be a complete expression. For example,

```
CountInteger > 10 Or < 0
```

is incorrect. Instead, it must be

```
CountInteger > 10 Or CountInteger < 0
```

Combining Logical Operators

You can create compound Boolean expressions that combine multiple logical conditions. When you have both an And and an Or, the And is evaluated before the Or. However, you can change the order of evaluation by using parentheses; any expression inside parentheses will be evaluated first.

For example, will the following condition evaluate True or False? Try it with various values for SaleDecimal, DiscountRadioButton, and StateTextBox.Text.

```
If SaleDecimal > 1000.0D Or DiscountRadioButton.Checked And StateTextBox.Text.ToUpper() <> "CA" Then
       ' Code here to calculate the discount.
End If
```

SaleDecimal	DiscountRadioButton.Checked	StateTextBox.Text.ToUpper	Evaluates
1500.0	False	CA	True
1000.0	True	OH	True
1000.0	True	CA	False
1500.0	True	NY	True
1000.0	False	CA	False

Short-Circuit Operations

Visual Basic has two operators that provide **short-circuit** evaluation for compound expressions: the `AndAlso` and `OrElse`. When evaluating a compound expression formed with an `And`, VB evaluates both expressions for True or False, then evaluates the `And`. But you might prefer to not evaluate the second expression if the first expression evaluates False. For example, the following two statements both evaluate False when CountInteger = 0, but the first statement evaluates both expressions and the second one stops after evaluating the first expression:

```
CountInteger >= 0 And CountInteger <= 10 ' Always tests both conditions.
CountInteger >= 0 AndAlso CountInteger <= 10 ' Short circuits when the first
                                             ' expression evaluates False.
```

The `OrElse` is designed to short circuit when the first expression evaluates True. In a regular `Or` operation, if one or the other expression is True, the entire compound expression is True. So if the first expression is True, it really isn't necessary to test the second expression. These two examples both evaluate False if TotalInteger = –1 (negative 1), but the second example will perform one less comparison:

```
TotalInteger < 0 Or TotalInteger > 10
TotalInteger < 0 OrElse TotalInteger > 10
```

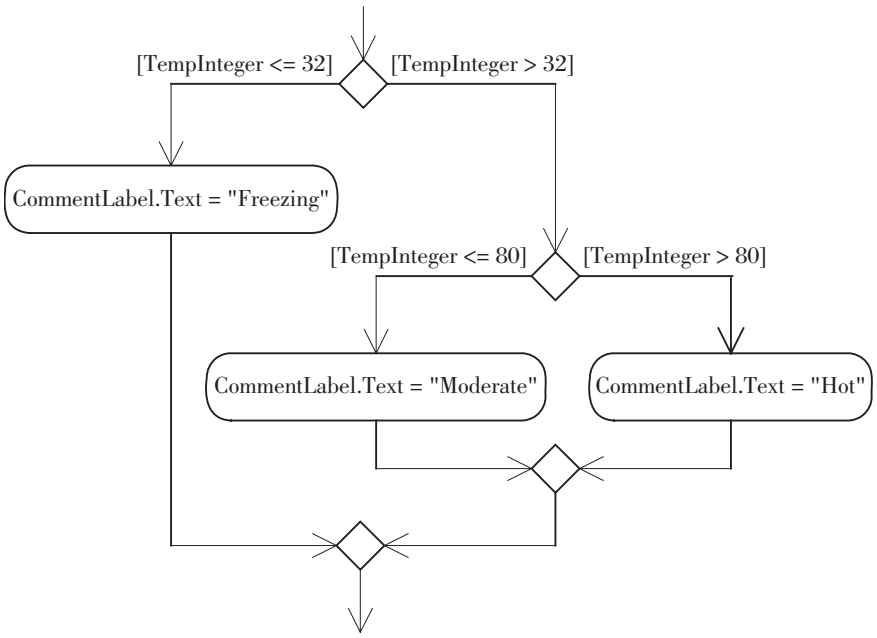
You may be wondering whether to use these short-circuit operators, which are included here for completeness. Generally, the `AndAlso` and `OrElse` are used for more advanced programming, when the second expression should not be executed for some reason. For your programs in this chapter, you can stick with the `And` and `Or` operators.

Nested If Statements

In many programs, another `If` statement is one of the statements to be executed when a condition tests True or False. `If` statements that contain additional `If` statements are said to be ***nested If*** statements. The following example shows a nested `If` statement in which the second `If` occurs in the `Then` portion of the first `If` (Figure 4.5).

Figure 4.5

Diagramming a nested `If` *statement.*




```
If TempInteger > 32 Then
     If TempInteger > 80 Then
          CommentLabel.Text = "Hot"
     Else
          CommentLabel.Text = "Moderate"
     End If
Else
     CommentLabel.Text = "Freezing"
End If
```

To nest `If` statements in the `Else` portion, you may use either of the following approaches; however, your code is simpler if you use the second method (using `ElseIf / Then`).

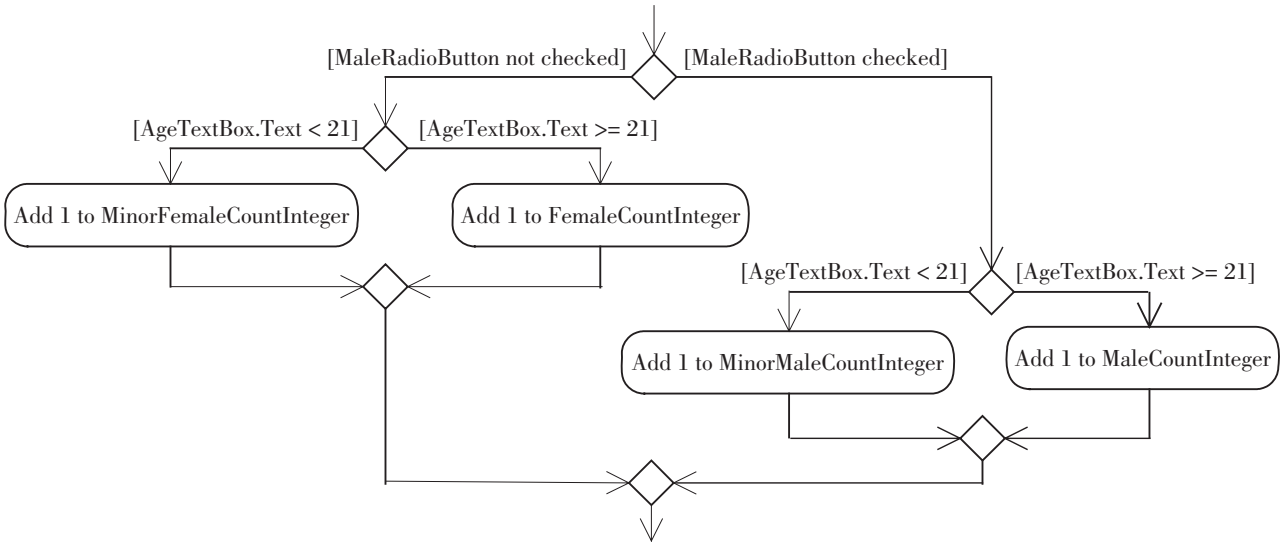
```
' One approach.
If TempInteger <= 32 Then
     CommentLabel.Text = "Freezing"
Else
     If TempInteger > 80 Then
          CommentLabel.Text = "Hot"
     Else
          CommentLabel.Text = "Moderate"
     End If
End If
```

```
' A simpler approach.
If TempInteger <= 32 Then
     CommentLabel.Text = "Freezing"
ElseIf tempInteger > 80 Then
     CommentLabel.Text = "Hot"
Else
     CommentLabel.Text = "Moderate"
End If
```

You can nest `If`s in both the `Then` and `Else`. In fact, you may continue to nest `If`s within `If`s as long as each `If` has an `End If`. However, projects become very difficult to follow (and may not perform as intended) when `If`s become too deeply nested (Figure 4.6).

Figure 4.6

A diagram of a nested `If` *statement with* `If`*s nested on both sides of the original* `If`.




```
If MaleRadioButton.Checked Then
     If Integer.Parse(AgeTextBox.Text) < 21 Then
          MinorMaleCountInteger += 1
     Else
          MaleCountInteger += 1
     End If
Else
     If Integer.Parse(AgeTextBox.Text) < 21 Then
          MinorFemaleCountInteger += 1
     Else
          FemaleCountInteger += 1
     End If
End If
```

Feedback 4.2

Assume that `FrogsInteger = 10`, `ToadsInteger = 5`, and `PolliwogsInteger = 6`. What will be displayed for each of the following statements?

1.
```
If FrogsInteger > PolliwogsInteger Then
    FrogsRadioButton.Checked = True
Else
    FrogsRadioButton.Checked = False
End If
```
2.
```
If FrogsInteger > ToadsInteger + PolliwogsInteger Then
    ResultTextBox.Text = "It's the frogs."
Else
    ResultTextBox.Text = "It's the toads and the polliwogs."
End If
```
3.
```
If PolliwogsInteger > ToadsInteger And FrogsInteger <> 0 _
  Or ToadsInteger = 0 Then
    ResultTextBox.Text = "It's true."
Else
    ResultTextBox.Text = "It's false."
End If
```
4. Write the statements necessary to compare the numeric values stored in ApplesTextBox.Text and OrangesTextBox.Text. Display in MostTextBox.Text which has more, the apples or the oranges.
5. Write the Basic statements that will test the current value of BalanceDecimal. When BalanceDecimal is greater than zero, the check box for Funds Available, called FundsCheckBox, should be selected, the BalanceDecimal set back to zero, and CountInteger incremented by one. When BalanceDecimal is zero or less, FundsCheckBox should not be selected (do not change the value of BalanceDecimal or increment the counter).

TIP

Indentation can help you catch errors. Visual Basic always matches an `Else` with the last unmatched `If` regardless of the indentation. ■

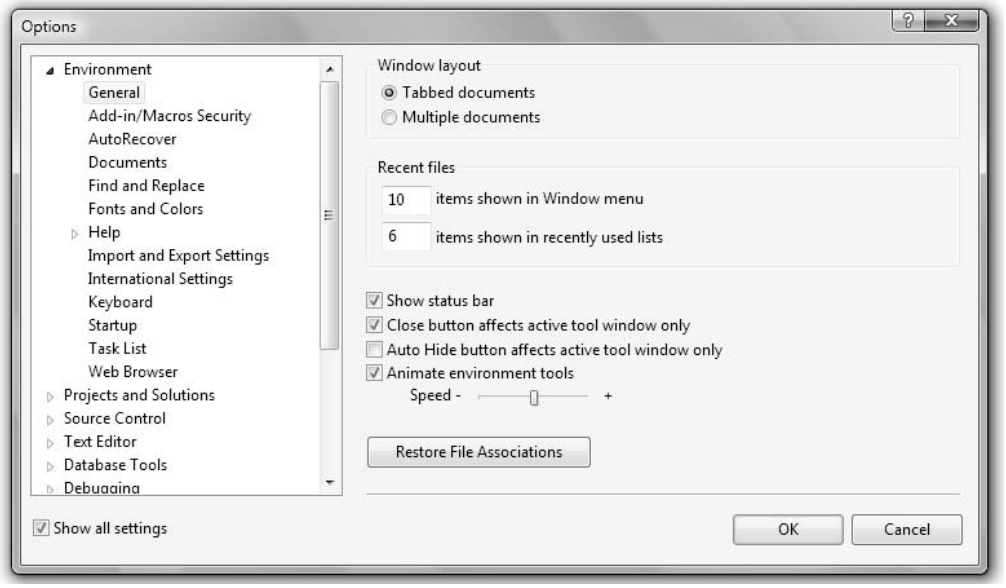
Using If Statements with Radio Buttons and Check Boxes

In Chapter 2 you used the CheckedChanged event for radio buttons and check boxes to carry out the desired action. Now that you can use `If` statements, you should not take action in the CheckedChanged event procedures for these controls. Instead, use `If` statements to determine which options are selected.

To conform to good programming practice and make your programs consistent with standard Windows applications, place your code in the Click event of buttons, such as an OK button or an Apply button. For example, refer to the Visual Studio *Tools / Options* dialog box (Figure 4.7); no action will occur when you click on a radio button or check box. Instead, when you click on the OK button, VS checks to see which options are selected.

Figure 4.7

The Options dialog box. When the user clicks OK, the program checks the state of all radio buttons and check boxes.



In an application such as the radio button color change project in Chapter 2 (refer to Figure 2.23), you could modify the code for the *Display* button to include code similar to the following:

```
If BeigeRadioButton.Checked Then
    BackColor = Color.Beige
ElseIf BlueRadioButton.Checked Then
    BackColor = Color.Blue
ElseIf YellowRadioButton.Checked Then
    BackColor = Color.Yellow
Else
    BackColor = Color.Gray
End If

If BlackRadioButton.Checked Then
    ForeColor = Color.Black
Else
    ForeColor = Color.White
End If
```

Additional Examples

```
If FastShipCheckBox.Checked Then
     TotalDecimal += FastShipRateDecimal
End If

If GiftWrapCheckBox.Checked Then
     TotalDecimal += WRAP_AMOUNT_Decimal
End If
```

A "Simple Sample"

Test your understanding of the use of the `If` statement by coding some short examples.

Test the Value of a Check Box

Create a small project that contains a check box, a label, and a button. Name the button TestButton, the check box TestCheckBox, and the label MessageLabel. In the Click event procedure for TestButton, check the value of the check box. If the check box is currently checked, display "Check box is checked" in MessageLabel.

```
Private Sub TestButton_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) _
  Handles TestButton.Click
    ' Test the value of the check box.

    If TestCheckBox.Checked Then
        MessageLabel.Text = "Check box is checked."
    End If
```

Test your project. When it works, add an `Else` to the code that displays "Check box is not checked."

Test the State of Radio Buttons

Remove the check box from the previous project and replace it with two radio buttons, named FreshmanRadioButton and SophomoreRadioButton and labeled "<= 32 units" and "> 32 units". Now change the `If` statement to display "Freshman" or "Sophomore" in the label.

```
If FreshmanRadioButton.Checked Then
    MessageLabel.Text = "Freshman"
Else
    MessageLabel.Text = "Sophomore"
End If
```

Can you modify the sample to work for Freshman, Sophomore, Junior, and Senior? In the sections that follow, you will see code for testing multiple radio buttons and check boxes.

Checking the State of a Radio Button Group

Nested `If` statements work very well for determining which button of a radio button group is selected. Recall that in any group of radio buttons, only one button can be selected. Assume that your form has a group of radio buttons for Freshman, Sophomore, Junior, or Senior. In a calculation procedure, you want to add 1 to one of four counter variables, depending on which radio button is selected:

```
If FreshmanRadioButton.Checked Then
   FreshmanCountInteger += 1
ElseIf SophomoreRadioButton.Checked Then
   SophomoreCountInteger += 1
ElseIf JuniorRadioButton.Checked Then
   JuniorCountInteger += 1
ElseIf SeniorRadioButton.Checked Then
   SeniorCountInteger += 1
End If
```

Note that in most situations, the final condition test is unnecessary. You should be able to use an `Else` and add to SeniorRadioButton if the first three expressions are false. You might prefer to code the condition to make the statement more clear, if no radio button is set initially, or if the program sets all radio buttons to False.

Checking the State of Multiple Check Boxes

Although nested `If` statements work very well for groups of radio buttons, the same is not true for a series of check boxes. Recall that if you have a series of check boxes, any number of the boxes may be selected. In this situation, assume that you have check boxes for Discount, Taxable, and Delivery. You will need separate `If` statements for each condition.

```
If DiscountCheckBox.Checked Then
   ' Calculate the discount.
End If
If TaxableCheckBox.Checked Then
   ' Calculate the tax.
End If
If DeliveryCheckBox.Checked Then
   ' Calculate the delivery charges.
End If
```

Enhancing Message Boxes

In Chapter 3 you learned to display a message box to the user. Now it's time to add such features as controlling the format of the message, displaying multiple buttons, checking which button the user clicks, and performing alternate actions depending on the user's selection.

Displaying the Message String

The message string you display in a message box may be a string literal enclosed in quotes or it may be a string variable. You also may want to concatenate several items, for example, combining a literal with a value from a

variable. It's usually a good idea to create a variable for the message and format the message before calling the Show method; if nothing else, it makes your code easier to read and follow.

Combining Values into a Message String

You can concatenate a literal such as "Total Sales:" with the value from a variable. You may need to include an extra space inside the literal to make sure that the value is separated from the literal.

TIP

Specify only the message for a "quick and dirty" message box for debugging purposes. It will display an OK button and an empty title bar: `MessageBox.Show("I'm here.")` ■

```
Dim MessageString As String

MessageString = "Total Sales: " & TotalSalesDecimal.ToString("C")
MessageBox.Show(MessageString, "Sales Summary", MessageBoxButtons.OK)
```

Creating Multiple Lines of Output

If your message is too long for one line, VB wraps it to a second line. But if you would like to control the line length and position of the split, you can insert a NewLine character into the string message. Use the Visual Studio intrinsic constant `Environment.NewLine` to determine line endings. You can concatenate this constant into a message string to set up multiple lines.

In this example, a second line is added to the MessageBox from the previous example.

```
Dim FormattedTotalString           As String
Dim FormattedAvgString             As String
Dim MessageString                  As String

FormattedTotalString = TotalSalesDecimal.ToString("N")
FormattedAvgString = AverageSaleDecimal.ToString("N")
MessageString = "Total Sales:  " & FormattedTotalString & Environment.NewLine _
  & "Average Sale:  " & FormattedAvgString

MessageBox.Show(MessageString, "Sales Summary", MessageBoxButtons.OK)
```

You can combine multiple `NewLine` constants to achieve double spacing and create multiple message lines (Figure 4.8).

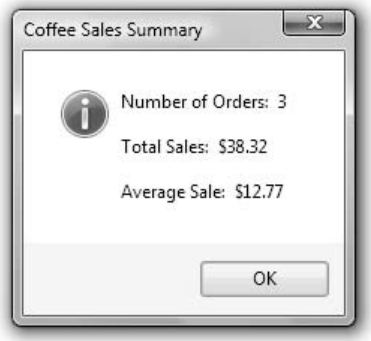


Figure 4.8

A message box with multiple lines of output, created by concatenating two NewLine characters at the end of each line.

```
' Concatenate the message string.
MessageString = "Number of Orders:  " & CustomerCount.ToString() _
  & Environment.NewLine & Environment.NewLine _
  & "Total Sales:  " & GrandTotalDecimal.ToString("C") _
  & Environment.NewLine & Environment.NewLine _
  & "Average Sale:  " & AverageDecimal.ToString("C")

' Display the message box.
MessageBox.Show(MessageString, "Coffee Sales Summary", MessageBoxButtons.OK, _
  MessageBoxIcon.Information)
```

Using the ControlChars Constants

In addition to the `Environment.Newline` constant, you also can use VB's `ControlChars.Newline` constant. The `ControlChars` constants are part of the Visual Basic library, while the `Environment` constants come from the System library and are more generic.

The VB `ControlChars` constant list includes several other intrinsic constants in addition to the `NewLine` constant. Type "ControlChars" and a period into the editor to see the complete list.

ControlChar Constant	Description
`CrLf`	Carriage return/line feed character combination.
`Cr`	Carriage return.
`Lf`	Line feed.
`NewLine`	Newline character. Same effect as a carriage return/line feed character combination.
`NullChar`	Character with a value of zero.
`Tab`	Tab character.
`Back`	Backspace character.
`FormFeed`	Formfeed character (not useful in Microsoft Windows).
`VerticalTab`	Vertical tab character (not useful in Microsoft Windows).
`Quote`	Quotation mark character.

Displaying Multiple Buttons

You can choose the buttons to display on the message box using the `MessageBoxButtons` constants (Figure 4.9). Figure 4.10 shows a MessageBox with two buttons using the `MessageBoxButtons.YesNo` constant. The `Show` method returns a **DialogResult object** that you can check to see which button the user clicked.

Figure 4.9

Choose the button(s) to display from the `MessageBoxButtons` *constants.*

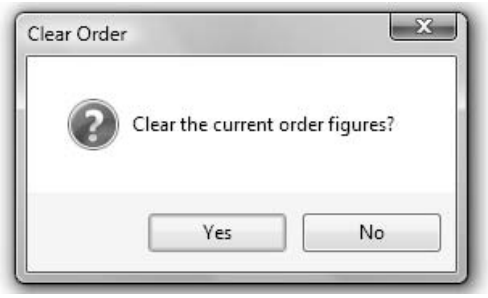


Figure 4.10

Display Yes and No buttons on a message box using `MessageBoxButtons.YesNo`.

Determining the Return Type of a Method

How do you know that the `Show` method returns an object of the DialogResult class? An easy way is to point to the `Show` keyword and pause; the argument list that you are using pops up (Figure 4.11).

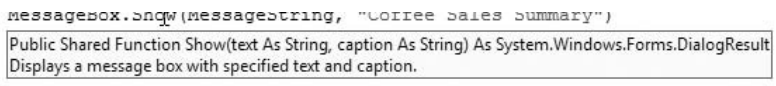


Figure 4.11

Pause the mouse pointer over the `Show` *keyword and IntelliSense pops up with the argument list you are using. It also shows the method's return type.*

Declaring an Object Variable for the Method Return

To capture the information about the outcome of the `Show` method, you must declare a variable that can hold an instance of the DialogResult type.

```
Dim WhichButtonDialogResult As DialogResult
```

Then you assign the return value of the `Show` method to the new variable.

```
WhichButtonDialogResult = MessageBox.Show("Clear the current order figures?", "Clear Order", _
   MessageBoxButtons.YesNo, MessageBoxIcon.Question)
```

The next step is to check the value of the return, comparing to the DialogResult constants, such as `Yes`, `No`, `OK`, `Retry`, `Abort`, and `Cancel`.

```
If WhichButtonDialogResult = DialogResult.Yes Then
   ' Code to clear the order.
End If
```

Specifying a Default Button and Options

Two additional signatures for the `MessageBox.Show` method are as follows:

```
MessageBox.Show(TextMessage, TitlebarText, MessageBoxButtons, MessageBoxIcons, _
  MessageBoxDefaultButton)
MessageBox.Show(TextMessage, TitlebarText, MessageBoxButtons, MessageBoxIcons, _
  MessageBoxDefaultButton, MessageBoxOptions)
```

When you display multiple buttons, you may want one of the buttons to be the default (the Accept button). For example, to make the second button (the *No* button) the default, use this statement:

```
ResponseDialogResult = MessageBox.Show("Clear the current order figures?", "Clear Order", _
  MessageBoxButtons.YesNo, MessageBoxIcon.Question, MessageBoxDefaultButton.Button2)
```

You can right-align the message in the message box by setting the MessageBoxOptions argument:

```
ResponseDialogResult = MessageBox.Show("Clear the current order figures?", "Clear Order", _
  MessageBoxButtons.YesNo, MessageBoxIcon.Question, MessageBoxDefaultButton.Button2, _
  MessageBoxOptions.RightAlign)
```

Input Validation

Careful programmers check the values entered into text boxes before beginning the calculations. Validation is a form of self-protection; it is better to reject bad data than to spend hours (and sometimes days) trying to find an error only to discover that the problem was caused by a "user error." Finding and correcting the error early can often keep the program from producing erroneous results or halting with a run-time error.

Checking to verify that appropriate values have been entered for a text box is called ***validation***. The validation may include making sure that the input is numeric, checking for specific values, checking a range of values, or making sure that required items are entered.

In Chapter 3 you learned to use `Try/Catch` blocks to trap for nonnumeric values. This chapter presents some additional validation techniques using `If` statements.

Note: Chapter 14 has some advanced validation techniques using the Validating event and error providers.

Checking for a Range of Values

Data validation may include checking the reasonableness of a value. Assume you are using a text box to input the number of hours worked in a day. Even with overtime, the company does not allow more than 10 work hours in a single day. You could check the input for reasonableness with this code:

```
If Integer.Parse(HoursTextBox.Text) <= 10 Then
    ' Code to perform calculations.
Else
    MessageBox.Show("Too many hours.", "Invalid Data", MessageBoxButtons.OK)
End If
```

Checking for a Required Field

Sometimes you need to be certain that a value has been entered into a text box before proceeding. You can compare a text box value to an empty string literal.

```
If NameTextBox.Text <> "" Then
    ' Code to perform some action.
Else
    MessageBox.Show("Required Entry", "Sales Summary", MessageBoxButtons.OK)
End If
```

By checking separately for blank or nonnumeric data, you can display a better message to the user. Make sure to check for blanks first, since a blank field will throw an exception with a parsing method. For example, if you reverse the order of the `If` and `Try` blocks in the following example, blanks in QuantityTextBox will always trigger the nonnumeric message in the `Catch` block.

```
If QuantityTextBox.Text <> "" Then           ' Not blank.
    Try
       QuantityDecimal = Decimal.Parse(QuantityTextBox.Text)
    Catch ' Nonnumeric data.
       MessageString = "Nonnumeric data entered for quantity."
       MessageBox.Show(MessageString, "Data Entry Error")
    End Try
Else                  ' Missing data.
    MessageString = "Enter the quantity."
    MessageBox.Show(MessageString, "Data Entry Error")
End If
```

Performing Multiple Validations

When you need to validate several input fields, how many message boxes do you want to display for the user? Assume that the user has neglected to fill five text boxes or make a required selection and clicked on *Calculate*. You can avoid displaying multiple message boxes in a row by using a nested `If` statement. This way you check the second value only if the first one passes, and you can exit the processing if a problem is found with a single field.

```
If NameTextBox.Text <> "" Then
    Try
         UnitsDecimal = Decimal.Parse(UnitsTextBox.Text)
         If FreshmanRadioButton.Checked Or SophomoreRadioButton.Checked _
            Or JuniorRadioButton.Checked Or SeniorRadioButton.Checked Then

             ' Data valid – Do calculations or processing here.

         Else
              MessageBox.Show ("Please select a Grade Level.", "Data Entry Error", _
                MessageBoxButtons.OK)
         End If
    Catch AnException As FormatException
         MessageBox.Show ("Enter number of units.", "Data Entry Error", _
           MessageBoxButtons.OK)
         UnitsTextBox.Focus()
    End Try
Else
    MessageBox.Show ("Please enter a name.", "Data Entry Error", _
      MessageBoxButtons.OK)
    NameTextBox.Focus()
End If
```

The Case Structure

Earlier you used the `If` statement for testing conditions and making decisions. Whenever you want to test a single variable for multiple values, the **`Case` structure** provides a flexible and powerful solution. Any decisions that you can code with a `Case` structure also can be coded with nested `If` statements, but usually the `Case` structure is simpler and clearer.

The Select Case Statement—General Form

General Form

```
Select Case expression
     Case ConstantList
          [Statement(s)]
     [Case ConstantList
          [Statement(s)]]
     .
     .
     .
     [Case Else]
          [Statement(s)]
End Select
```

The expression in a `Case` structure is usually a variable or property that you wish to test.

The constant list is the value that you want to match; it may be a numeric or string constant or variable, a range of values, a relational expression, or a combination of these.

There is no limit to the number of statements that can follow a `Case` statement.

The Select Case Statement—Examples

Examples

```
Select Case ScoreInteger
     Case Is >= 100
          MessageLabel1.Text = "Excellent Score"
          MessageLabel2.Text = "Give yourself a pat on the back."
     Case 80 To 99
          MessageLabel1.Text = "Very Good"
          MessageLabel2.Text = "You should be proud."
     Case 60 To 79
          MessageLabel1.Text = "Satisfactory Score"
          MessageLabel2.Text = "You should have a nice warm feeling."
     Case Else
          MessageLabel1.Text = "Your score shows room for improvement."
          MessageLabel2.Text = ""
End Select

Select Case ListIndexInteger
     Case 0
          ' Code to handle item zero.
     Case 1, 2, 3
          ' Code to handle items 1, 2, or 3.
     Case Else
          ' Code to handle any other value.
End Select
```

The examples show a combination of comparison operators, constant ranges, and multiple constants. Notice these points from the examples:

- When using a comparison operator (e.g., `Is >= 100`), the word `Is` must be used.
- To indicate a range of constants, use the word `To` (e.g., `80 To 99`).
- Multiple constants should be separated by commas.

The elements used for the constant list may have any of these forms:

```
constant [, constant...]                    Case 2, 5, 9
constant To constant                        Case 25 To 50
Is comparison-operator constant             Case Is > 100
```

You could also use all these forms in one `Case` statement to test for multiple conditions:

```
Case 2, 5, 9, 25 To 50, Is > 100
```

When you want to test for a string value, you must include quotation marks around the literals.

Example

```
Select Case TeamNameTextBox.Text
    Case "Tigers"
        ' Code for Tigers.
    Case "Leopards"
        ' Code for Leopards.
    Case "Cougars", "Panthers"
        ' Code for Cougars and Panthers.
    Case Else
        ' Code for any nonmatch.
End Select
```

Note that in the previous example, the capitalization must also match exactly. A better solution would be

```
Select Case TeamNameTextBox.Text.ToUpper()
    Case "TIGERS"
        ' Code for Tigers.
    Case "LEOPARDS"
        ' Code for Leopards.
    Case "COUGARS", "PANTHERS"
        ' Code for Cougars and Panthers.
    Case Else
        ' Code for any nonmatch.
End Select
```

Although the `Case Else` clause is optional, generally you will want to include it in **`Select Case`** statements. The statements you code beneath `Case Else` execute only if none of the other `Case` expressions is matched. This clause provides checking for any invalid or unexpected values of the expression being tested. If the `Case Else` clause is omitted and none of the `Case` conditions is True, the program continues execution at the statement following the `End Select`.

If more than one `Case` value is matched by the expression, only the statements in the *first* matched `Case` clause execute.

Feedback 4.3

Convert the following `If` statements to `Select Case` statements.

1.
```
If TempInteger <= 32 Then
   CommentLabel.Text = "Freezing"
ElseIf TempInteger > 80 Then
   CommentLabel.Text = "Hot"
Else
   CommentLabel.Text = "Moderate"
End If
```
2.
```
If CountInteger = 0 Then
   MessageBox.Show("No items were entered.")
ElseIf CountInteger < 11 Then
   MessageBox.Show("1 – 10 items were entered.")
ElseIf CountInteger < 21 Then
   MessageBox.Show("11 – 20 items were entered.")
Else
   MessageBox.Show("More than 20 items were entered.")
End If
```

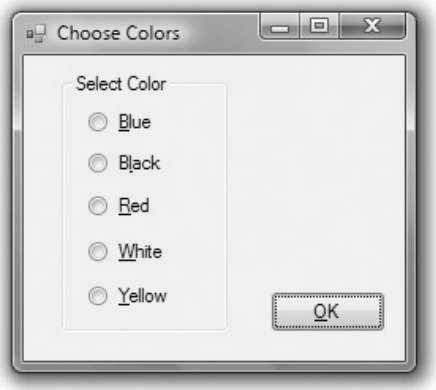
Sharing an Event Procedure

A very handy feature of VB is the ability to share an event procedure for several controls. For example, assume that you have a group of five radio buttons to allow the user to choose a color (Figure 4.12). Each of the radio buttons must have its own name and will ordinarily have its own event procedure. But you can add events to the `Handles` clause at the top of an event procedure to make the procedure respond to events of other controls.

```
Private Sub RadioButtons_CheckedChanged(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) _
  Handles BlueRadioButton.CheckedChanged, BlackRadioButton.CheckedChanged, _
  RedRadioButton.CheckedChanged, WhiteRadioButton.CheckedChanged, _
  YellowRadioButton.CheckedChanged
```

Figure 4.12

The five radio buttons allow the user to choose the color.



After you have added the additional events to the `Handles` clause, this event procedure will execute when the user selects *any* of the radio buttons.

A good, professional technique is to set up a module-level variable to hold the selection that the user makes. Then, in the OK button's event procedure you can take action based on which of the buttons was selected.

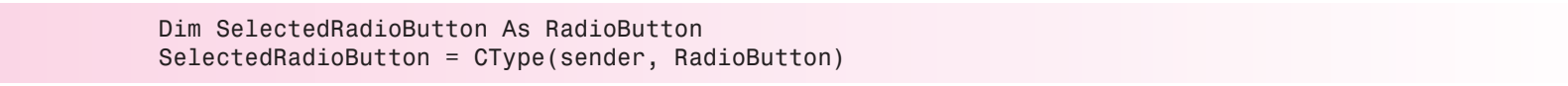
The key to using the shared event procedure is the `sender` argument that is passed to the CheckedChanged event procedure. The `sender` is defined as an object, which has a Name property. However, if you refer to `sender.Name` with Option Strict turned on, you generate a compiler error telling you that late binding is not allowed. **Late binding** means that the type cannot be determined at compile time but must be determined at run time. Late binding is allowed with Option Strict turned off but should be avoided if possible for performance reasons.

You can use the properties of the `sender` argument if you first cast (convert) `sender` to a specific object type instead of the generic object. You can use VB's **`CType` function** to convert from one object type to another:

```
CType(ValueToConvert, NewType)
```

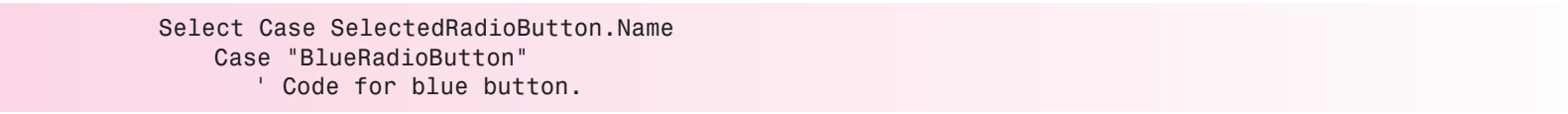
The `CType` function returns an object of the new type. If the *`ValueToConvert`* is not in the range of legal values for *`NewType`*, an exception is generated at run time.

For the radio button example, declare a variable as RadioButton data type, cast the `sender` argument to a RadioButton object type, and assign it to the new variable:



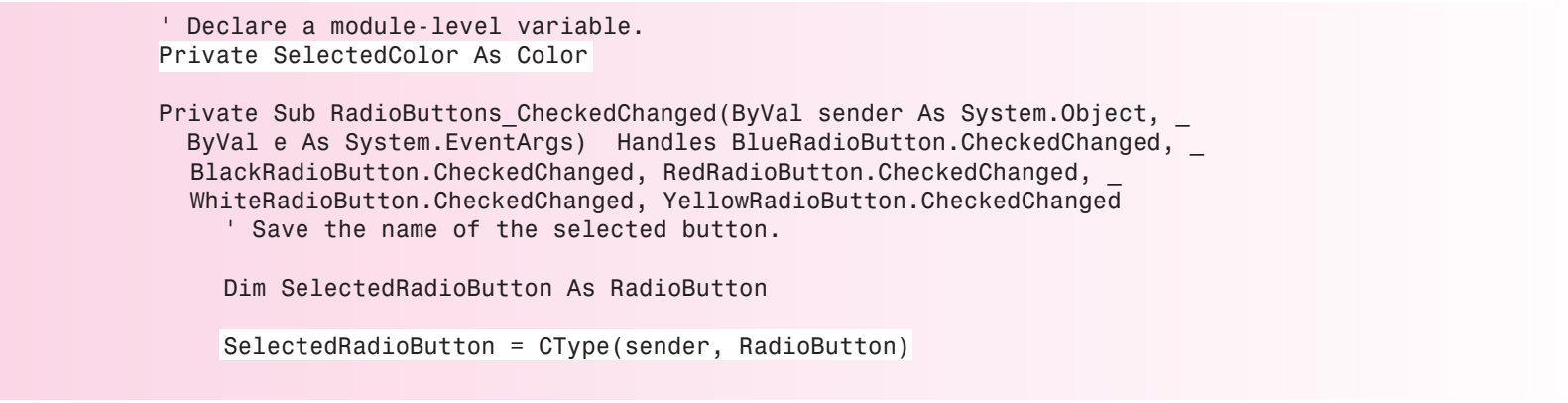
```
Dim SelectedRadioButton As RadioButton
SelectedRadioButton = CType(sender, RadioButton)
```

After these statements, you can refer to SelectedRadioButton.Name to determine which radio button was selected:



```
Select Case SelectedRadioButton.Name
    Case "BlueRadioButton"
       ' Code for blue button.
```

You can declare a module-level variable as a Color data type, assign the chosen color in the shared event procedure, and then apply the color in the OK button's click event.



```
' Declare a module-level variable.
Private SelectedColor As Color

Private Sub RadioButtons_CheckedChanged(ByVal sender As System.Object, _
  ByVal e As System.EventArgs)  Handles BlueRadioButton.CheckedChanged, _
   BlackRadioButton.CheckedChanged, RedRadioButton.CheckedChanged, _
   WhiteRadioButton.CheckedChanged, YellowRadioButton.CheckedChanged
      ' Save the name of the selected button.

     Dim SelectedRadioButton As RadioButton

     SelectedRadioButton = CType(sender, RadioButton)
```

When you share an event procedure, rename the procedure to more clearly reflect the purpose of the procedure, such as RadioButtons_CheckedChanged instead of BlueRadioButton_CheckedChanged. ■

```
    Select Case SelectedRadioButton.Name
        Case "BlueRadioButton"
           SelectedColor = Color.Blue
        Case "BlackRadioButton"
           SelectedColor = Color.Black
        Case "RedRadioButton"
           SelectedColor = Color.Red
        Case "WhiteRadioButton"
           SelectedColor = Color.White
        Case "YellowRadioButton"
           SelectedColor = Color.Yellow
    End Select
End Sub

Private Sub OkButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles OkButton.Click
     ' Change the color based on the selected radio button.

    Me.BackColor = SelectedColor
End Sub
```

Calling Event Procedures

If you wish to perform a set of instructions in more than one location, you should never duplicate the code. Write the instructions once, in an event procedure, and "call" the procedure from another procedure. When you **call** an event procedure, the entire procedure is executed and then execution returns to the statement following the call.

The Call Statement—General Form

General Form

```
[Call] ProcedureName()
```

Notice that the keyword `Call` is optional and rarely used. You must include the parentheses; if the procedure that you are calling requires arguments, then place the arguments within the parentheses; otherwise leave them empty. Note that all procedure calls in this chapter do require arguments.

The Call Statement—Examples

Examples

```
Call ClearButton_Click(sender, e)
ClearButton_Click(sender, e)     ' Equivalent to the previous statement.
```

Notice the arguments for both of the example `Call` statements. You are passing the same two arguments that were passed to the calling procedure. If you examine any of the editor-generated event procedure headers, you can see that every event procedure requires these two arguments, which can be used to track the object that generated the event.

```
Private Sub SummaryButton_Click( _
  ByVal sender As System.Object, ByVal e As System.EventArgs) Handles SummaryButton.Click
...
  NewOrderButton_Click(sender, e) ' Call the NewOrderButton_Click event procedure.
```

In the programming example that follows, you will accumulate individual items for one customer. When that customer's order is complete, you need to clear the entire order and begin an order for the next customer. Refer to the interface in Figure 4.13; notice the two buttons: *Clear for Next Item* and *New Order*. The button for next item clears the text boxes on the screen. The button for a new order must clear the screen text boxes and clear the subtotal fields. Rather than repeat the instructions to clear the individual screen text boxes, we can call the event procedure for ClearButton_Click from the NewOrderButton_Click procedure.

```
Private Sub NewOrderButton_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) _
  Handles NewOrderButton.Click
    ' Clear the current order and add to totals.

    ClearButton_Click(sender, e)  ' Call the ClearButton_Click event procedure.
    ' Continue with statements to clear subtotals.
```

In the NewOrderButton_Click procedure, all the instructions in ClearButton_Click are executed. Then execution returns to the next statement following the call.

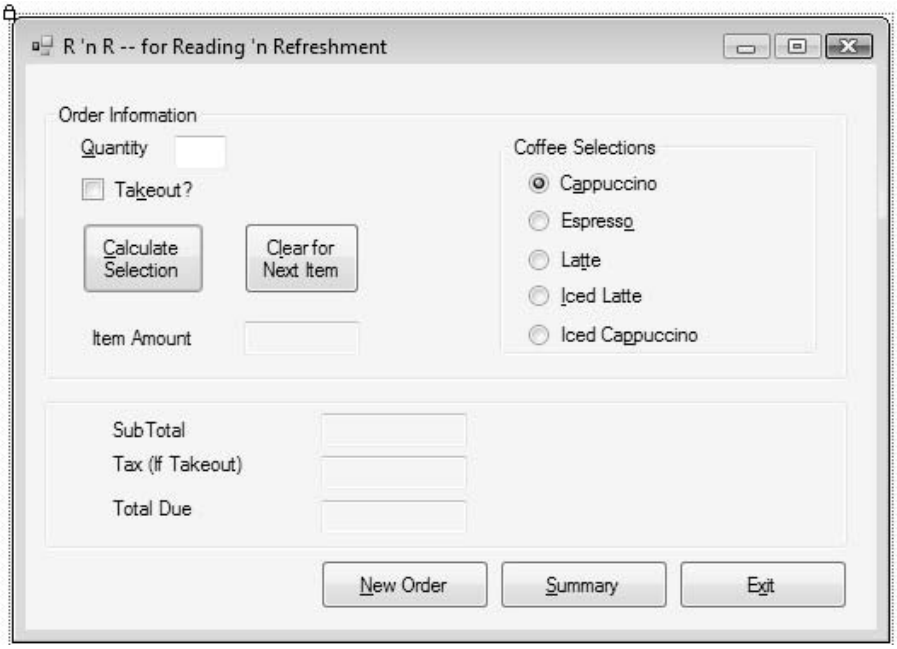


Figure 4.13

A form with buttons that perform overlapping functions. The New Order *button must include the same tasks as* Clear for Next Item.

Your Hands-On Programming Example

Create a project for R 'n R—for Reading 'n Refreshment that calculates the amount due for individual orders and maintains accumulated totals for a summary. Have a check box for takeout items, which are taxable at 8 percent; all other orders are nontaxable. Include radio buttons for the five coffee selections: Cappuccino, Espresso, Latte, Iced Cappuccino, and Iced Latte. The prices for each will be assigned using these constants:

Cappuccino	2.00
Espresso	2.25
Latte	1.75
Iced (either)	2.50

Use a button for *Calculate Selection*, which will calculate and display the amount due for each item. Display appropriate error messages for missing or nonnumeric data.

A button for *Clear for Next Item* will clear the selections and the amount for the current item and set the focus back to the quantity. The *Clear* button should be disabled when the program begins and be enabled after the user begins an order.

Additional text boxes in a separate group box will display the summary information for the current order, including subtotal, tax, and total.

Buttons at the bottom of the form will be used for *New Order*, *Summary*, and *Exit*. The *New Order* button will confirm that the user wants to clear the current order. If the user agrees, clear the current order and add to the summary totals. The *Summary* button should display a message box with the number of orders, the total dollar amount, and the average sale amount per order.

Planning the Project

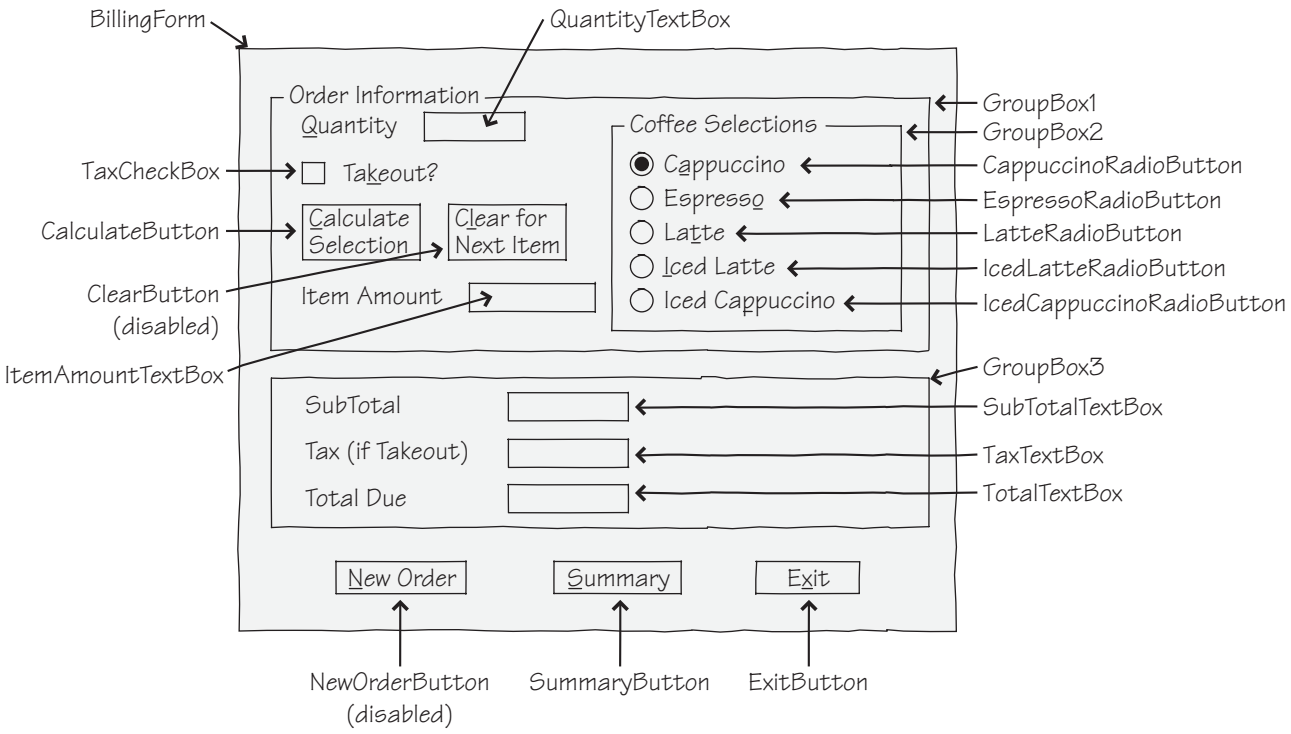
Sketch a form (Figure 4.14), which your users sign as meeting their needs.

Plan the Objects and Properties Plan the property settings for the form and each of the controls.

Object	Property	Setting
BillingForm	Name	BillingForm
	Text	R 'n R--for Reading 'n Refreshment
	AcceptButton	CalculateButton
	CancelButton	ClearButton
GroupBox1	Text	Order Information
GroupBox2	Text	Coffee Selections
GroupBox3	Text	(blank)
CappuccinoRadioButton	Name	CappuccinoRadioButton
	Text	C&appuccino
	Checked	True
EspressoRadioButton	Name	EspressoRadioButton
	Text	Espress&o

Figure 4.14

The planning sketch of the form for the hands-on programming exercise example.



Object	Property	Setting
LatteRadioButton	Name	LatteRadioButton
	Text	La&tte
IcedLatteRadioButton	Name	IcedLatteRadioButton
	Text	&Iced Latte
IcedCappuccinoRadioButton	Name	IcedCappuccinoRadioButton
	Text	Iced Ca&ppuccino
Label1	Text	&Quantity
QuantityTextBox	Name	QuantityTextBox
	Text	(blank)
TaxCheckBox	Name	TaxCheckBox
	Text	Ta&keout ?
Label2	Text	Item Amount
Label3	Text	SubTotal
Label4	Text	Tax (if Takeout)
Label5	Text	Total Due
ItemAmountTextBox	Name	ItemAmountTextBox
	ReadOnly	True
	TabStop	False

Object	Property	Setting
SubTotalTextBox	Name	SubTotalTextBox
	ReadOnly	True
	TabStop	False
TaxTextBox	Name	TaxTextBox
	ReadOnly	True
	TabStop	False
TotalTextBox	Name	TotalTextBox
	ReadOnly	True
	TabStop	False
CalculateButton	Name	CalculateButton
	Text	&Calculate Selection
ClearButton	Name	ClearButton
	Text	C&lear for Next Item
	Enabled	False
NewOrderButton	Name	NewOrderButton
	Text	&New Order
	Enabled	False
SummaryButton	Name	SummaryButton
	Text	&Summary
ExitButton	Name	ExitButton
	Text	E&xit

Plan the Event Procedures You need to plan the actions for five event procedures for the buttons.

Object	Procedure	Action
CalculateButton	Click	Validate for blank or nonnumeric amount. Find price of drink selection. Multiply price by quantity. Add amount to subtotal. Calculate tax if needed. Calculate total = subtotal + tax. Format and display the values. Disable the Takeout check box. Enable the Clear button and New Order button.
ClearButton	Click	Clear the coffee selections. Clear the quantity and the item price. Set the focus to the quantity.

NewOrderButton	Click	Confirm clearing current order.
		Clear the current order.
		If subtotal > 0
		  Accumulate total sales and count.
		  Set subtotal and total due to 0.
		Enable Takeout check box.
		Disable the Clear button and New Order button.

SummaryButton	Click	If current order not added to totals Call NewOrderButton_Click. Calculate the average. Display the summary totals in a message box.
ExitButton	Click	Terminate the project.

Write the Project Follow the sketch in Figure 4.14 to create the form. Figure 4.15 shows the completed form.

- Set the properties of each object as you have planned.
- Write the code. Working from the pseudocode, write each event procedure.
- When you complete the code, use a variety of data to thoroughly test the project. Make sure the tab order is set correctly so that the insertion point begins in QuantityTextBox.

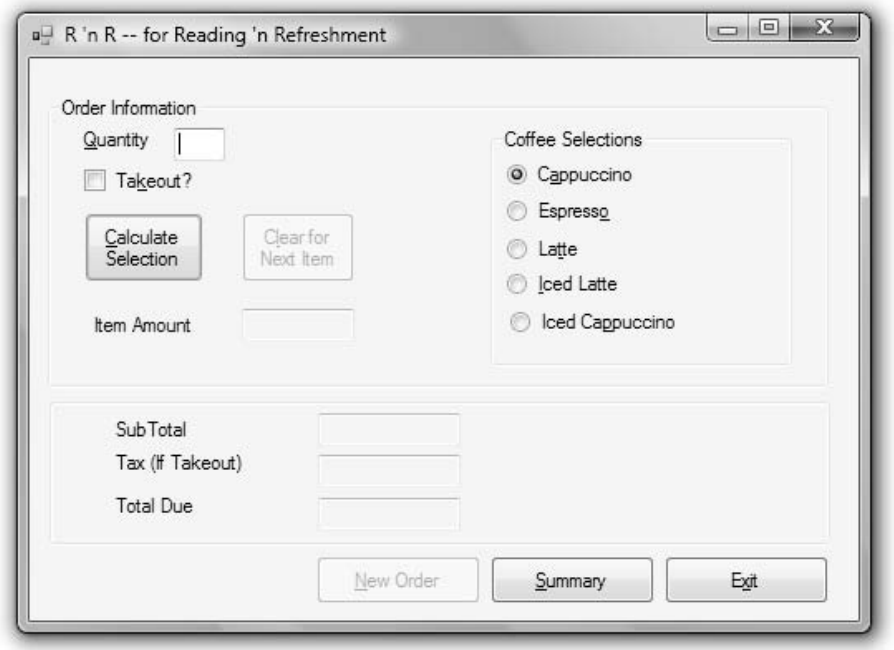


Figure 4.15

The form for the hands-on programming exercise.

The Project Coding Solution

```
'Program Name:   Ch04HandsOn
'Programmer:     Bradley/Millspaugh
'Date:           June 2008
'Description:    This project calculates the amount due
'                based on the customer selection
'                and accumulates summary data for the day.
'Folder:         Ch04HandsOn

Public Class BillingForm
    ' Declare module-level constants.
    Const TAX_RATE_Decimal As Decimal = 0.08D
    Const CAPPUCCINO_PRICE_Decimal As Decimal = 2D
    Const ESPRESSO_PRICE_Decimal As Decimal = 2.25D
    Const LATTE_PRICE_Decimal As Decimal = 1.75D
    Const ICED_PRICE_Decimal As Decimal = 2.5D
```

```
' Declare module-level variables for summary information.
Private SubtotalDecimal, TotalDecimal, GrandTotalDecimal As Decimal
Private CustomerCountInteger As Integer

Private Sub CalculateButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles CalculateButton.Click
    ' Calculate and display the current amounts and add to totals.

    Dim PriceDecimal, TaxDecimal, ItemAmountDecimal As Decimal
    Dim QuantityInteger As Integer

    ' Find the price.
    If CappuccinoRadioButton.Checked Then
        PriceDecimal = CAPPUCCINO_PRICE_Decimal
    ElseIf EspressoRadioButton.Checked Then
        PriceDecimal = ESPRESSO_PRICE_Decimal
    ElseIf LatteRadioButton.Checked Then
        PriceDecimal = LATTE_PRICE_Decimal
    ElseIf IcedCappuccinoRadioButton.Checked Or _
        IcedLatteRadioButton.Checked Then
            PriceDecimal = ICED_PRICE_Decimal
    End If

    ' Calculate extended price and add to order total.
    Try
        QuantityInteger = Integer.Parse(QuantityTextBox.Text)
        ItemAmountDecimal = PriceDecimal * QuantityInteger
        SubtotalDecimal += ItemAmountDecimal
        If TaxCheckBox.Checked Then
            TaxDecimal = SubtotalDecimal * TAX_RATE_Decimal
        Else
            TaxDecimal = 0
        End If
        TotalDecimal = SubtotalDecimal + TaxDecimal
        ItemAmountTextBox.Text = ItemAmountDecimal.ToString("C")
        SubTotalTextBox.Text = SubtotalDecimal.ToString("N")
        TaxTextBox.Text = TaxDecimal.ToString("N")
        TotalTextBox.Text = TotalDecimal.ToString("C")
        ' Allow a change only for new order.
        TaxCheckBox.Enabled = False
        ' Allow Clear after an order is begun.
        ClearButton.Enabled = True
        NewOrderButton.Enabled = True
    Catch QuantityException As FormatException
        MessageBox.Show("Quantity must be numeric.", _
          "Data Entry Error", MessageBoxButtons.OK, _
          MessageBoxIcon.Information)
        With QuantityTextBox
            .Focus()
            .SelectAll()
        End With
    End Try
End Sub
```

```
Private Sub ClearButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles ClearButton.Click
    ' Clear the appropriate controls.

    CappuccinoRadioButton.Checked = True  ' All others are false.
    ItemAmountTextBox.Clear()
    With QuantityTextBox
        .Clear()
        .Focus()
    End With
End Sub

Private Sub NewOrderButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles NewOrderButton.Click
    ' Clear the current order and add to the totals.

    Dim ReturnDialogResult As DialogResult
    Dim MessageString As String

    ' Confirm clear of current order.
    MessageString = "Clear the current order figures?"
    ReturnDialogResult = MessageBox.Show(MessageString, "Clear Order", _
      MessageBoxButtons.YesNo, MessageBoxIcon.Question, _
      MessageBoxDefaultButton.Button2)

    If ReturnDialogResult = DialogResult.Yes Then      ' User said Yes.
        ClearButton_Click(sender, e)      ' Clear the screen fields.
        SubTotalTextBox.Clear()
        TaxTextBox.Clear()
        TotalTextBox.Clear()

        ' Add to Totals.
        ' Add only if not a new order/customer.
        If SubtotalDecimal <> 0 Then
            GrandTotalDecimal += TotalDecimal
            CustomerCountInteger += 1
            ' Reset totals for next customer.
            SubtotalDecimal = 0
            TotalDecimal = 0
        End If

        ' Clear appropriate display items and enable check box.
        With TaxCheckBox
            .Enabled = True
            .Checked = False
        End With
        ClearButton.Enabled = False
        NewOrderButton.Enabled = False
    End If
End Sub
```

```
    Private Sub SummaryButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles SummaryButton.Click
        ' Calculate the average and display the totals.

        Dim AverageDecimal As Decimal
        Dim MessageString As String

        If TotalDecimal <> 0 Then
            ' Make sure last order is counted.
            NewOrderButton_Click(sender, e)
        End If

        If CustomerCountInteger > 0 Then
            ' Calculate the average.
            AverageDecimal = GrandTotalDecimal / CustomerCountInteger

            ' Concatenate the message string.
            MessageString = "Number of Orders:  " _
              & CustomerCountInteger.ToString() _
              & Environment.NewLine & Environment.NewLine _
              & "Total Sales:  " & GrandTotalDecimal.ToString("C") _
              & Environment.NewLine & Environment.NewLine _
              & "Average Sale:  " & AverageDecimal.ToString("C")
            MessageBox.Show(MessageString, "Coffee Sales Summary", _
              MessageBoxButtons.OK, MessageBoxIcon.Information)
        Else
            MessageString = "No sales data to summarize."
            MessageBox.Show(MessageString, "Coffee Sales Summary", _
              MessageBoxButtons.OK, MessageBoxIcon.Information)
        End If
    End Sub

    Private Sub ExitButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ExitButton.Click
        ' Terminate the project.

        Me.Close()
    End Sub
End Class
```

Debugging Visual Basic Projects

One of the advantages of programming in the Visual Studio environment is the availability of debugging tools. You can use these tools to help find and eliminate logic and run-time errors. The debugging tools also can help you to follow the logic of existing projects to better understand how they work.

Sometimes it's helpful to know the result of a Boolean expression, the value of a variable or property, or the sequence of execution of your program. You can follow program logic in Debugging mode by single-stepping through code; you also can get information about execution without breaking the program run, using the `WriteLine` method of the Debug class.

In the following sections, you will learn to use many of the debugging tools on the VB standard toolbar (Figure 4.16) and the *Debug* menu (Figure 4.17).

Figure 4.16

The debugging buttons on the VB standard toolbar.

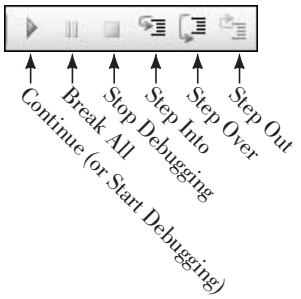
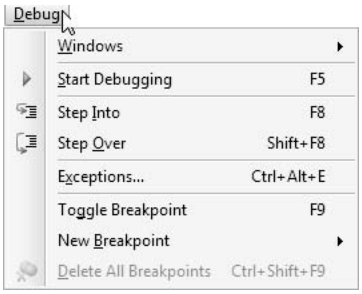


Figure 4.17

The debugging options on the Professional Edition Debug *menu showing the keyboard shortcut keys. The Express Edition has one less option.*



Writing Debug Output

You can place a **`Debug.WriteLine` method** in your code, which sends output to the Immediate window during program execution. In the argument for the `WriteLine` method, you can specify a message to write or an object that you want tracked.

The Debug.WriteLine Method—General Form

General Form

```
Debug.WriteLine(TextString)
Debug.WriteLine(Object)
```

The `Debug.WriteLine` method is overloaded, so you can pass it a string argument or the name of an object.

The Debug.WriteLine Method—Examples

Examples

```
Debug.WriteLine("CalculateButton procedure entered.")
Debug.WriteLine(QuantityTextBox)
Debug.WriteLine("QuantityInteger = " & QuantityInteger.ToString())
```

When the `Debug.WriteLine` method executes, its output appears in the Immediate window. Figure 4.18 shows the output of the three example statements above. Notice the second line of output, for QuantityTextBox—the class of the object displays along with its current contents.

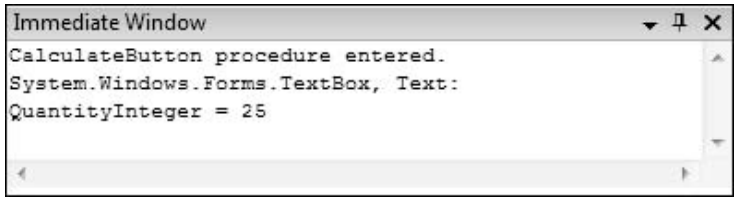


Figure 4.18

The Output window shows the output of the `Debug.WriteLine` *method.*

You may find it useful to place `WriteLine` methods in `If` statements, so that you can see which branch the logic followed.

```
If CountInteger > 10 Then
    Debug.WriteLine("Count is greater than 10.")
    ' Other processing.
Else
    Debug.WriteLine("Count is not greater than 10.")
    ' Other processing.
End If
```

An advantage of using `WriteLine`, rather than the other debugging techniques that follow, is that you do not have to break program execution.

Clearing the Immediate Window

You can clear the Immediate window: Right-click in the window and choose *Clear All*.

Pausing Execution with the Break All Button

You can click on the *Break All* toolbar button to pause execution. This step places the project into debug time at whatever line the program is executing. However, you will generally prefer to break in the middle of a procedure. To choose the location of the break, you can force a break with a breakpoint.

Forcing a Break

During the debugging process, often you want to stop at a particular location in code and watch what happens (e.g., which branch of an `If / Then / Else`; which procedures were executed; the value of a variable just before or just after a calculation). You can force the project to break by inserting a **breakpoint** in code.

```
Try
   AmountDueLabel.Text = (PriceDecimal* Decimal.Parse(QuantityTextBox.Text)).ToString()
Catch
   MessageBox.Show( "Please Enter a Numeric Value.", "Error", MessageBoxButtons.OK)
End Try
```

To set a breakpoint, place the mouse pointer in the gray margin indicator area at the left edge of the Editor window and click; the line will be highlighted in red and a large red dot will display in the margin indicator (Figure 4.19).

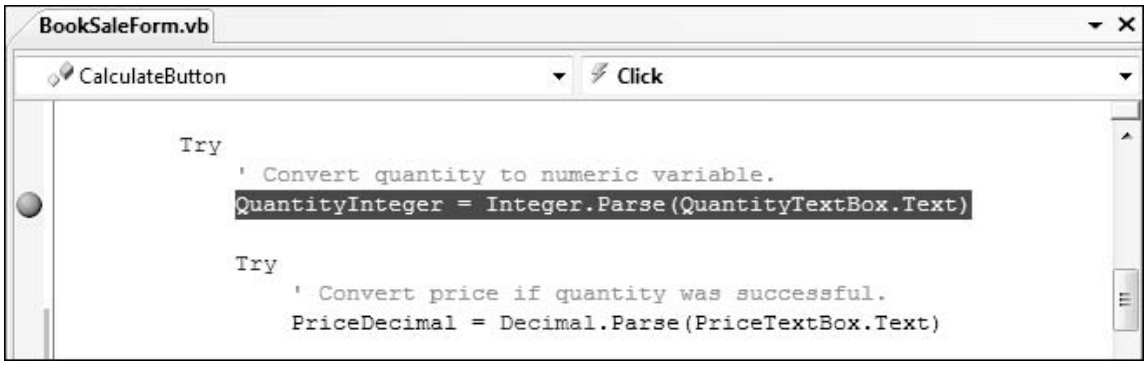
After setting a breakpoint, start execution. When the project reaches the breakpoint, it will halt, display the line, and go into debug time.

TIP

Place the insertion point in the code line you want as a breakpoint and press F9. Press F9 again to toggle the breakpoint off. ■

Figure 4.19

A program statement with a breakpoint set appears highlighted, and a dot appears in the gray margin indicator area.



You can remove a breakpoint by clicking again in the gray margin area, or clear all breakpoints from the *Debug* menu.

Checking the Current Values of Expressions

You can quickly check the current value of an expression such as a variable, a control, a Boolean expression, or an arithmetic expression. During debug time, display the Editor window and point to the expression that you want to view; a small label, called a *DataTip*, pops up and displays the current contents of the expression.

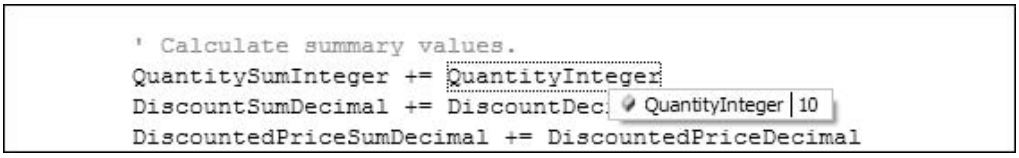
The steps for viewing the contents of a variable during run time are as follows:

1. Break the execution using a breakpoint.
2. If the code does not appear in the Editor, click on the Editor's tab in the Document window.
3. Point to the variable or expression you wish to view.

The current contents of the expression will pop up in a DataTip (Figure 4.20).

Figure 4.20

Point to a variable name in code and its current value displays in a DataTip.



Stepping through Code

The best way to debug a project is to thoroughly understand what the project is doing every step of the way. In early programming days, this task was performed by following each line of code manually to understand its effect. But you can now use the Visual Studio debugging tools to trace program execution line by line and see the progression of the program as it executes through your code.

You step through code at debug time. You can use one of the techniques already mentioned to break execution or choose one of the stepping commands at design time; the program will begin running and immediately transfer to debug time.

Two of the stepping commands on the *Debug* menu in Debugging mode are *Step Into* and *Step Over*. You also can use the toolbar buttons for stepping or the keyboard shortcuts shown on the menu (refer to Figure 4.17).

These debugging commands force the project to execute a single line at a time and to display the Editor window with the current statement highlighted. As you execute the program, by pressing a button, for example, the Click event occurs. Execution transfers to the Click event procedure, the Editor window for that procedure appears on the screen, and you can follow line-by-line execution.

Step Into

Most likely you will use the ***Step Into*** command more than the *Step Over* command. When you choose *Step Into* (from the menu, the toolbar button, or F8), the next line of code executes and the program pauses again in debug time. If the line of code is a call to another procedure, the first line of code of the other procedure displays.

To continue stepping through your program execution, continue choosing the *Step Into* command. When a procedure is completed, your form will display again, awaiting an event. You can click on one of the form's buttons to continue stepping through code in an event procedure. If you want to continue rapid execution without stepping, choose the *Continue* command (from the menu, the toolbar button, or F5).

Note: The keyboard shortcuts may differ, depending on the keyboard mapping selected in the *Options* dialog box. The shortcuts shown here are for Visual Basic development settings; if you are using General development settings, perhaps in a shared environment with other language development, the keyboard shortcut for *Step Into* is F11 and *Step Over* is F10.

Step Over

The ***Step Over*** command also executes one line of code at a time. The difference between *Step Over* and *Step Into* occurs when your code has calls to other procedures. *Step Over* displays only the lines of code in the current procedure being analyzed; it does not display lines of code in the called procedures.

You can choose *Step Over* from the menu, from the toolbar button, or by pressing Shift + F8. Each time you choose the command, one more program statement executes.

Continuing Program Execution

When you have seen what you want to see, continue rapid execution by pressing F5 or choosing *Continue* from the toolbar or the *Debug* menu.

Stopping Execution

Once you have located a problem in the program's code, usually you want to stop execution, correct the error, and run again. Stop execution by selecting *Stop Debugging* from the *Debug* menu or the toolbar button, or press the keyboard shortcut: Ctrl + Alt + Break.

Note: The keyboard shortcuts differ depending on the keyboard mapping scheme selected in *Tools / Options / Show All Options*.

Edit and Continue

Another helpful feature for debugging programs is Edit-and-Continue. When your program goes into Debugging mode and you make minor modifications to the code in the Editor, you may be able to continue execution without stopping to recompile. Press F5 or choose *Debug / Continue*. If the changes to the code are too major to continue, the debugger does not allow the changes. Stop program execution, make the changes, and recompile the program.

To use any of the debugging windows, you must be in debug mode or run time. ■

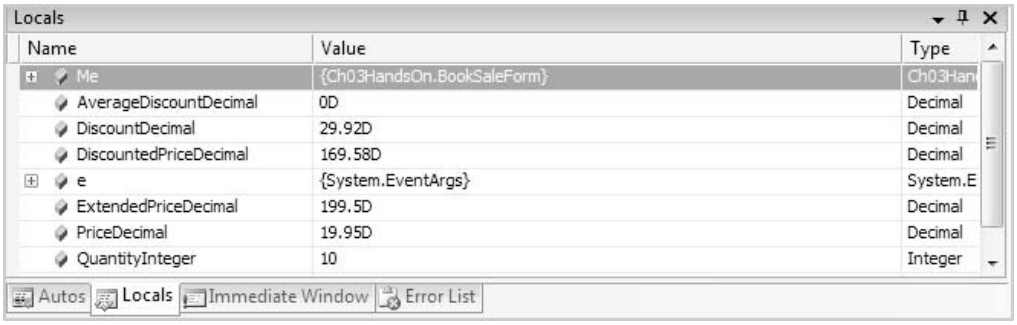
The Locals Window

Sometimes you may find that the **Locals window** displays just the information that you want (Figure 4.21). The Locals window displays all objects and variables that are within scope at debug time. That means that if you break execution in the CalculateButton_Click event procedure, all variables local to that procedure display. You also can expand the `Me` entry to see the state of the form's controls and the values of module-level variables. Display the Locals window from the toolbar button or the *Debug / Windows / Locals* menu item, which appears only when a program is running, either in run time or debug mode.

Note: The Locals window is not available in the Express Edition.

Figure 4.21

The Locals window shows the values of the local variables that are within scope of the current statement.



The Autos Window

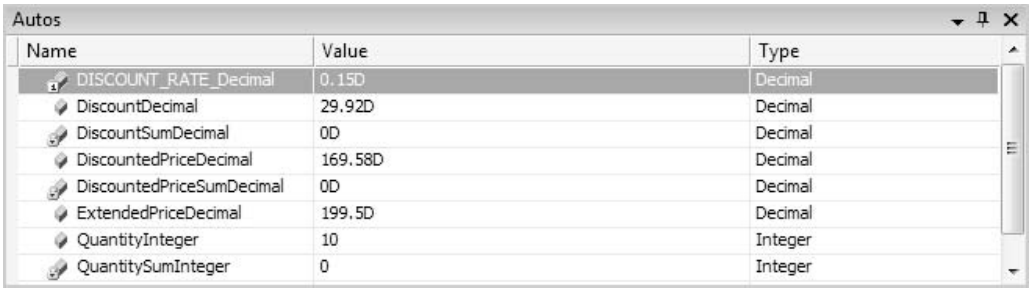
Another helpful debugging window is the **Autos window**. The Autos window "automatically" displays all variables and control contents that are referenced in the current statement and a few statements on either side of the current one (Figure 4.22). Note that the highlighted line is about to execute next; the "current" statement is the one just before the highlighted one.

You can view the Autos window when your program stops at a breakpoint. Click on the Autos window tab if it appears, or open it using the *Debug / Windows / Autos* menu item. Again, you must be in either run time or debug mode to see the menu item.

Note: The Autos window is not available in the Express Edition.

Figure 4.22

The Autos window automatically adjusts to show the variables and properties that appear in the previous few lines and the next few lines.



Debugging Step-by-Step Tutorial

In this exercise you will learn to set a breakpoint; pause program execution; single step through program instructions; display the current values in properties, variables, and expressions; and debug a Visual Basic project.

Test the Project

STEP 1: Open the debugging project on your student CD. The project is found in the Ch04Debug folder.

STEP 2: Run the program.

STEP 3: Enter color Blue, quantity "100", and press Enter or click on the *Calculate* button.

STEP 4: Enter another color Blue, quantity "50", and press Enter. Are the totals correct?

STEP 5: Enter color Red, quantity "30", and press Enter.

STEP 6: Enter color Red, quantity "10", and press Enter. Are the totals correct?

STEP 7: Enter color White, quantity "50", and press Enter.

STEP 8: Enter color White, quantity "100", and press Enter. Are the totals correct?

STEP 9: Exit the project. You are going to locate and correct the errors in the Red and White totals.

Break and Step Program Execution

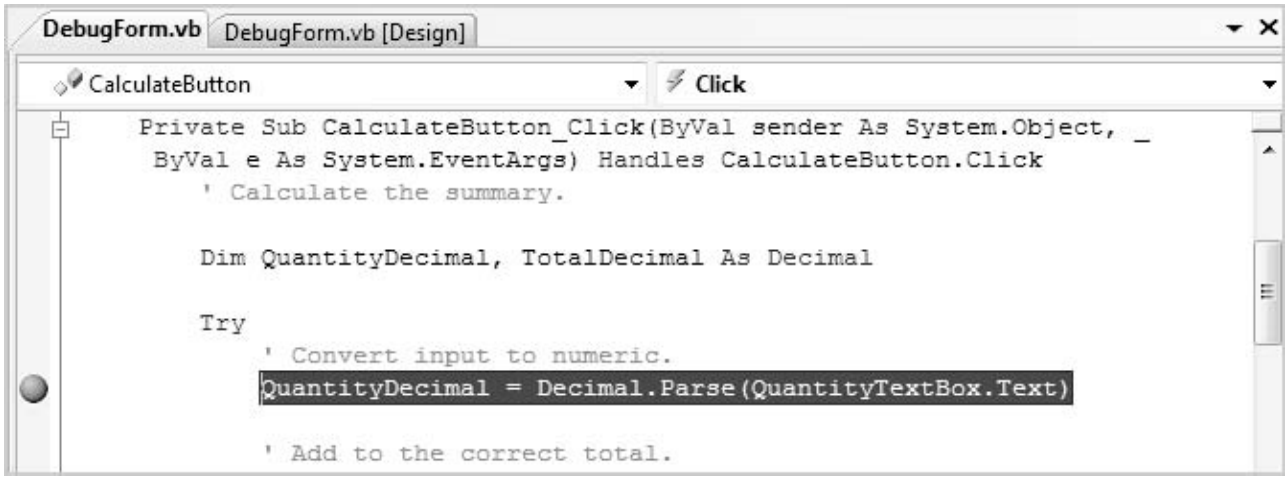
STEP 1: Display the program code. Scroll to locate this line, which is the first calculation line in the CalculateButton_Click event procedure:

```
QuantityDecimal = Decimal.Parse(QuantityTextBox.Text)
```

STEP 2: Click in the gray margin indicator area to set a breakpoint on the selected line. Your screen should look like Figure 4.23.

Figure 4.23

A program statement with a breakpoint set appears highlighted and a dot appears in the gray margin indicator area.

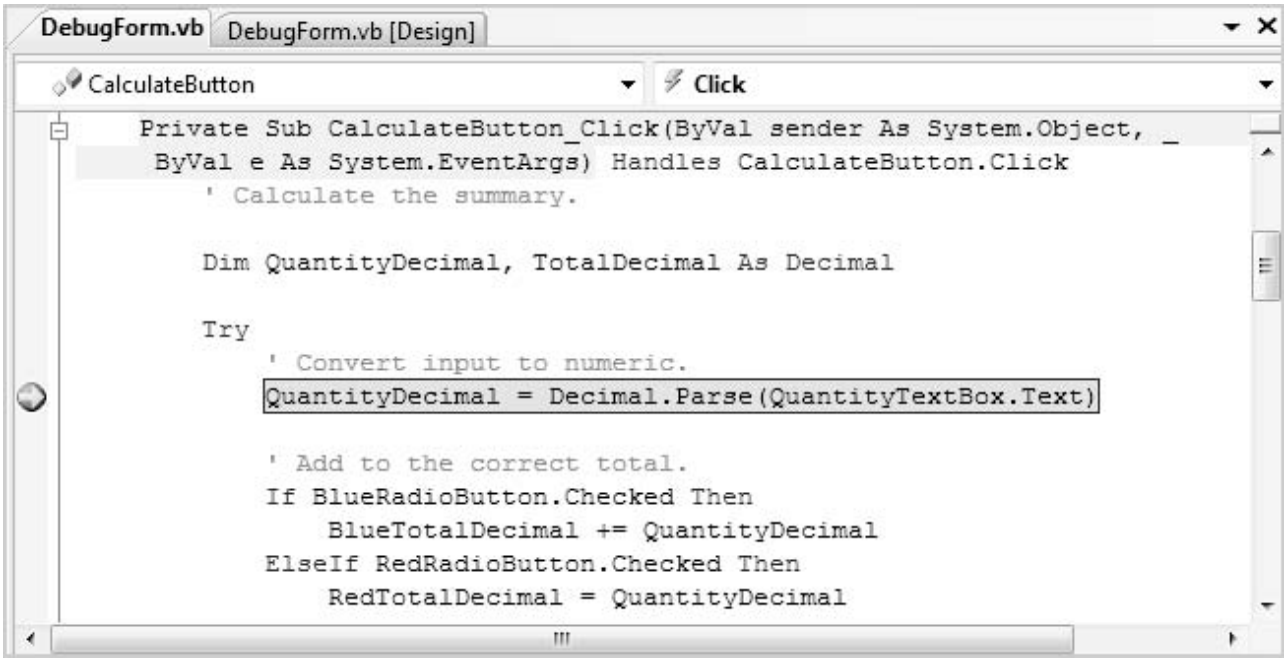


STEP 3: Run the project, enter Red, quantity "30", and press Enter. The project will transfer control to the CalculateButton_Click procedure, stop when it reaches the breakpoint, highlight the current line, and enter debug mode (Figure 4.24).

Note: The highlighted line has not yet executed.

Figure 4.24

When a breakpoint is reached during program execution, Visual Basic enters debug time, displays the Editor window, and highlights the breakpoint line.



STEP 4: Press the F8 key, which causes VB to execute the current program statement (the assignment statement). (F8 is the keyboard shortcut for *Debug / Step Into*.) The statement is executed and the highlight moves to the next statement (the `If` statement).

Note: If the F8 key is not the correct shortcut key, the keyboard defaults likely have been modified. Select *Tools / Options / Environment / Keyboard*. Click the *Reset* button to reset the keyboard mappings to their default values.

STEP 5: Press F8 again; the expression (`BlueRadioButton.Checked`) is tested and found to be False.

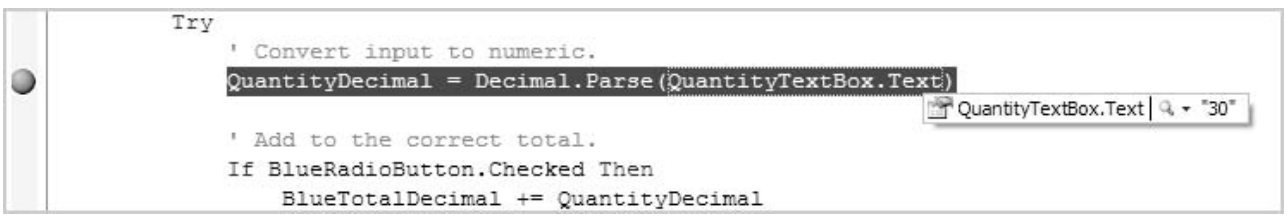
STEP 6: Continue pressing F8 a few more times and watch the order in which program statements execute.

View the Contents of Properties, Variables, and Boolean Expressions

STEP 1: Scroll up if necessary and point to `QuantityTextBox.Text` in the breakpoint line; the contents of the Text property pop up (Figure 4.25).

Figure 4.25

Point to a property reference in code and the current contents pop up.



STEP 2: Point to QuantityDecimal and view the contents of that variable. Notice that the Text property is enclosed in quotes and the numeric variable is not. The 30D means 30 Decimal.

STEP 3: Point to `BlueRadioButton.Checked` in the `If` statement; then point to `RedRadioButton.Checked`. You can see the Boolean value for each of the radio buttons.

STEP 4: Point to RedTotalDecimal to see the current value of that total variable. This value looks correct, since you just entered 30, which was added to the total.

Continue Program Execution

STEP 1: Press F5, the keyboard shortcut for the *Continue* command. The *Continue* command continues rapid execution.

STEP 2: Enter color Red and quantity "10". When you press Enter, program execution will again break at the breakpoint. (If the VS IDE window does not appear on top of your form, click its Taskbar button.)

The 10 you just entered should be added to the 30 previously entered for Red, producing 40 in the Red total.

STEP 3: Use the *Step Into* button on the toolbar to step through execution. Keep pressing *Step Into* until the 10 is added to RedTotalDecimal. Display the current contents of the total. Can you see what the problem is?

Hint: RedTotalDecimal has only the current amount, not the sum of the two amounts. The answer will appear a little later; try to find it yourself first.

You will fix this error soon, after testing the White total.

Test the White Total

STEP 1: Press F5 to continue execution. If the form does not reappear, click the project's Taskbar button.

STEP 2: Enter color White, quantity "100", and press Enter.

STEP 3: When execution halts at the breakpoint, make sure that the IDE window is on top and press F5 to continue. This returns to rapid execution until the next breakpoint is reached.

STEP 4: Enter color White, quantity "50", and press Enter.

STEP 5: Press F8 several times when execution halts at the breakpoint until you execute the line for the White total. Remember that the highlighted line has not yet executed; press *Step Into* (F8) one more time, if necessary, to execute the addition statement.

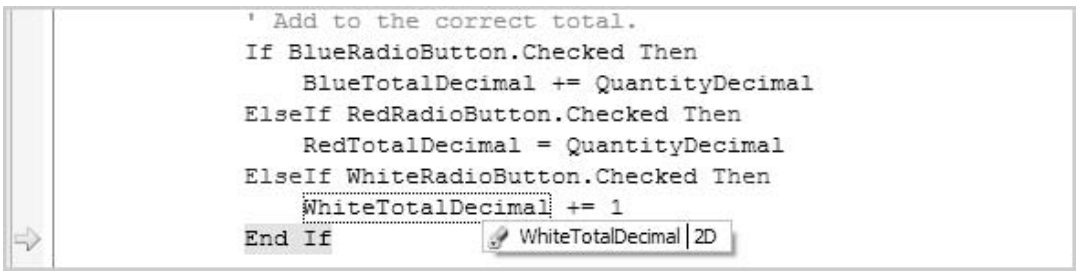
STEP 6: Point to each variable name to see the current values (Figure 4.26). Can you see the problem?

TIP

Switch between the IDE window and your running application using the Taskbar buttons. ■

Figure 4.26

Point to the variable name in code and its current value displays as 2 Decimal.

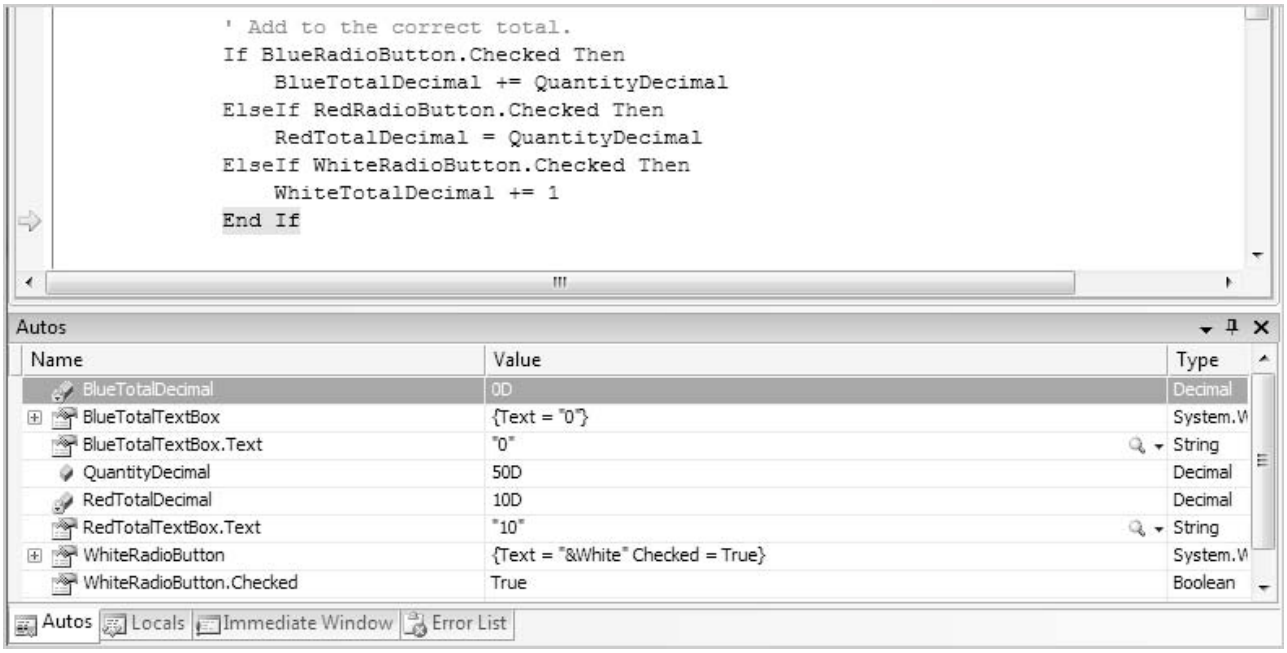


STEP 7: Display the Autos window by clicking on its tab. If the tab does not appear, select *Debug / Windows / Autos*. The Autos window displays the current value of all properties and variables referred to by a few statements before and after the current statement (Figure 4.27).

STEP 8: Identify all the errors. When you are ready to make the corrections, continue to the next step.

Figure 4.27

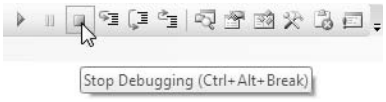
The Autos window displays the current contents of variables and properties in the statements before and after the current statement.



Correct the Red Total Error

STEP 1: Stop program execution by clicking on the *Stop Debugging* toolbar button (Figure 4.28).

Figure 4.28



Click on the Stop Debugging button on the Debug toolbar to halt program execution.

STEP 2: Locate this line:

```
RedTotalDecimal = QuantityDecimal
```

This statement replaces the value of RedTotalDecimal with QuantityDecimal rather than adding to the total.

STEP 3: Change the line to read:

```
RedTotalDecimal += QuantityDecimal
```

TIP

Display keyboard shortcuts on ToolTips, as in Figure 4.28, by selecting *Tools / Customize / Show shortcut keys in ScreenTips*. ■

Correct the White Total Error

STEP 1: Locate this line:

```
WhiteTotalDecimal += 1
```

Do you see the problem with this line? It adds 1 to the total, rather than adding the quantity.

STEP 2: Change the statement to read:

```
WhiteTotalDecimal += QuantityDecimal
```

STEP 3: Press F5 to start program execution. Enter color White and "100" and press Enter.

STEP 4: Press F5 to continue when the project halts at the breakpoint.

STEP 5: Enter White, "50", and press Enter.

STEP 6: At the breakpoint, clear the breakpoint by clicking on the red margin dot for the line.

STEP 7: Press F5 to continue and check the total on the form. It should be correct now.

STEP 8: Test the totals for all three colors carefully and then click *Exit*.

Test the Exception Handling

STEP 1: Set a breakpoint again on the first calculation line in the CalculateButton_Click event procedure.

STEP 2: Run the program, this time entering nonnumeric characters for the amount. Click on *Calculate*; when the program stops at the breakpoint, press F8 repeatedly and watch program execution. The message box should appear.

Force a Run-Time Error

For this step, you will use a technique called *commenting out* code. Programmers often add apostrophes to the beginning of code lines to test the code without those lines. Sometimes it works well to copy a section of code, comment out the original to keep it unchanged, and modify only the copy. You'll find it easy to uncomment the code later, after you finish testing.

STEP 1: Select *Delete All Breakpoints* from the *Debug* menu if the menu item is available. The item is available only when there are breakpoints set in the program.

STEP 2: At the left end of the line with the `Try` statement, add an apostrophe, turning the line into a comment.

STEP 3: Scroll down and locate the exception-handling code. Highlight the lines beginning with `Catch` and ending with `End Try` (Figure 4.29).

STEP 4: Click on the *Comment out the selected lines* button on the Editing toolbar (Figure 4.30). The Editor adds an apostrophe to the start of each of the selected lines.

STEP 5: Run the project. This time click the *Calculate* button without entering a quantity. A run-time error will occur (Figure 4.31).

You can click on the Close button for the exception error message or click the *Stop Debugging* button on the toolbar. Either will cancel execution.

TIP

You can change the current line of execution in Debugging mode by dragging the current line indicator arrow on the left side of the Editor window. ■

STEP 6: After you are finished testing the program, select the commented lines and click on *Uncomment the selected lines* button (Figure 4.32).

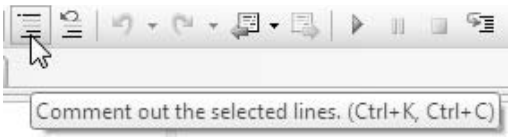
Note: You can just click an insertion point in a line or select the entire line when you comment and uncomment lines.

Figure 4.29

Select the lines to convert to comments for debugging.

```
        Catch
            MessageBox.Show("Enter numeric data.", "Data Error", _
              MessageBoxButtons.OK, MessageBoxIcon.Information)
            With QuantityTextBox
                .Focus()
                .SelectAll()
            End With
        End Try
    End Sub
```

Figure 4.30

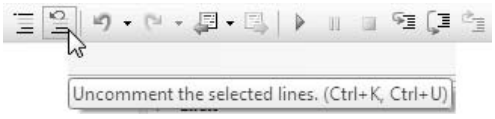


Click the Comment out the selected lines toolbar button to temporarily make program lines into comments.

Figure 4.31

The missing data cause an exception and run-time error.

Figure 4.32



Click the Uncomment the selected lines toolbar button after testing the program.

Summary

1. Visual Basic uses the `If / Then / Else` statement to make decisions. An `Else` clause is optional and specifies the action to be taken if the expression evaluates as False. An `If / Then / Else` statement must conclude with an `End If`.
2. UML activity diagrams can help visualize the logic of an `If / Then / Else` statement.
3. The Boolean expressions for an `If` statement are evaluated for True or False.
4. Boolean expressions can be composed of the comparison operators, which compare items for equality, greater than, or less than. The comparison of numeric values is based on the quantity of the number, while string comparisons are based on the ANSI code table.
5. The `ToUpper` and `ToLower` methods of the String class can convert a text value to upper- or lowercase.
6. The `And`, `Or`, `AndAlso`, and `OrElse` logical operators may be used to combine multiple Boolean expressions. With the `And` operator, both expressions must be true for the entire expressions to evaluate True. For the `Or` operator, if either or both conditions are true, the entire expression evaluates as True. When both `And` and `Or` are used in a Boolean expression, the `And` expression is evaluated before the `Or` expression. `AndAlso` and `OrElse` short circuit the expression so that the second part of a compound expression may not have to be tested.
7. A nested `If` statement contains an `If` statement within either the true or false actions of a previous `If` statement. Nesting an `If` statement inside of another requires the use of the `End If` clause. An `Else` clause always applies to the last unmatched `If` regardless of indentation.
8. The state of radio buttons and check boxes is better tested with `If` statements in the event procedure for a button rather than coding event procedures for the radio button or check box. Use individual `If` statements for check boxes and nested `If` statements for radio buttons.
9. The `MessageBox.Show` method can display a multiple-line message if you concatenate a NewLine character to specify a line break.
10. You can choose to display multiple buttons in a message box. The `MessageBox.Show` method returns an object of the DialogResult class, which you can check using the DialogResult constants.
11. Data validation checks the reasonableness or appropriateness of the value in a variable or property.
12. A single event procedure can be assigned to multiple controls, so that the controls share the procedure.
13. You can use the `sender` argument in an event procedure to determine which control caused the procedure to execute.
14. One procedure can call another procedure. To call an event procedure, you must supply the `sender` and `e` arguments.
15. A variety of debugging tools are available in Visual Studio. These include writing to the Immediate window, breaking program execution, displaying the current contents of variables, and stepping through code.

Key Terms

ANSI code *164*
Autos window *198*
breakpoint *195*
Boolean Expression *163*
call *185*
`Case` structure *181*
comparison operator *163*
compound Boolean Expression *167*
condition *163*
`CType` function *184*
`Debug.WriteLine` method *194*
DialogResult object *177*
`End If` *161*
`If / Then / Else` *161*
late binding *184*
Locals window *198*
logical operator *167*
nested `If` *169*
relational operator *163*
`Select Case` *182*
short circuit *169*
Step Into *197*
Step Over *197*
`ToLower` method *166*
`ToUpper` method *166*
validation *179*

Review Questions

1. What is the general format of the statement used to code decisions in an application?
2. What is a Boolean expression?
3. Explain the purpose of comparison operators and logical operators.
4. How does a comparison performed on numeric data differ from a comparison performed on string data?
5. How does Visual Basic compare the Text property of a text box?
6. Why would it be useful to include the `ToUpper` method in a comparison?
7. Name the types of items that can be used in a comparison.
8. Explain a Boolean variable test for True and False. Give an example.
9. Give an example of a situation where nested `If`s would be appropriate.
10. Define the term *validation*. When is it appropriate to do validation?
11. Define the term *checking a range*.
12. When would it be appropriate to use a `Case` structure? Give an example.
13. Explain the difference between *Step Into* and *Step Over*.
14. What steps are necessary to view the current contents of a variable during program execution?

Programming Exercises

4.1 Lynette Rifle owns an image consulting shop. Her clients can select from the following services at the specified regular prices: Makeover $125, Hair Styling $60, Manicure $35, and Permanent Makeup $200. She has distributed discount coupons that advertise discounts of 10 percent and 20 percent off the regular price. Create a project that will allow the receptionist to select a discount rate of 10 percent, 20 percent, or none, and then select a service. Display the total price for the currently selected service and the total due for all services. A visit may include several services. Include buttons for *Calculate*, *Clear*, *Print*, and *Exit*.

4.2 Modify Programming Exercise 4.1 to allow for sales to additional patrons. Include buttons for *Next Patron* and *Summary*. When the receptionist clicks

the *Summary* button, display in a summary message box the number of clients and the total dollar value for all services rendered. For *Next Patron*, confirm that the user wants to clear the totals for the current customer.

4.3 Create a project to compute your checking account balance.
Form: Include radio buttons to indicate the type of transaction: deposit, check, or service charge. A text box will allow the user to enter the amount of the transaction. Display the new balance in a ReadOnly text box or a label. Calculate the balance by adding deposits and subtracting service charges and checks. Include buttons for *Calculate*, *Clear*, *Print*, and *Exit*.

4.4 Add validation to Programming Exercise 4.3. Display a message box if the new balance would be a negative number. If there is not enough money to cover a check, do not deduct the check amount. Instead, display a message box with the message "Insufficient Funds" and deduct a service charge of $10.

4.5 Modify Programming Exercise 4.3 or 4.4 by adding a *Summary* button that will display the total number of deposits, the total dollar amount of deposits, the number of checks, and the dollar amount of the checks. Do not include checks that were returned for insufficient funds, but do include the service charges. Use a message box to display the summary information.

4.6 (`Select Case`) Piecework workers are paid by the piece. Workers who produce a greater quantity of output are often paid at a higher rate.
Form: Use text boxes to obtain the person's name and the number of pieces completed. Include a *Calculate* button to display the dollar amount earned. You will need a *Summary* button to display the total number of pieces, the total pay, and the average pay per person. A *Clear* button should clear the name and the number of pieces for the current employee and a *Clear All* button should clear the summary totals after confirming the operation with the user.

Include validation to check for missing data. If the user clicks on the *Calculate* button without first entering a name and the number of pieces, display a message box. Also, you need to make sure to not display a summary before any data are entered; you cannot calculate an average when no items have been calculated. You can check the number of employees in the Summary event procedure or disable the *Summary* button until the first order has been calculated.

Pieces Completed	Price Paid per Piece for All Pieces
1–199	.50
200–399	.55
400–599	.60
600 or more	.65

4.7 Modify Programming Exercise 2.3 (the weather report) to treat radio buttons the proper way. Do not change the image and message in an event procedure for each radio button; instead use an *OK* button to display the correct image and message.

Note: For help in basing a new project on an existing project, see "Copy and Move a Project" in Appendix C.

4.8 Modify Programming Exercise 2.2 (the flag viewer) to treat radio buttons and check boxes in the proper way. Include a *Display* button and check the settings of the radio buttons and check boxes in the button's event procedure, rather than making the changes in event procedures for each radio button and check box.

Note: For help in basing a new project on an existing project, see "Copy and Move a Project" in Appendix C.

4.9 Create an application to calculate sales for Catherine's Catering. The program must determine the amount due for an event based on the number of guests, the menu selected, and the bar options. Additionally, the program maintains summary figures for multiple events.

Form: Use a text box to input the number of guests and radio buttons to allow a selection of Prime Rib, Chicken, or Pasta. Check boxes allow the user to select an Open Bar and/or Wine with Dinner. Include buttons for *Calculate*, *Clear*, *Summary*, and *Exit*. Display the amount due for the event in a label or a ReadOnly text box.

Rates per Person

Prime Rib	25.95
Chicken	18.95
Pasta	12.95
Open Bar	25.00
Wine with dinner	8.00

Summary: Display the number of events and the total dollar amount in a message box. Prompt the user to determine if he or she would like to clear the summary information. If the response is Yes, set the number of events and the total dollar amount to zero. Do not display the summary message box if there is no summary information. (Either disable the *Summary* button until a calculation has been made or test the total for a value.)

Case Studies

VB Mail Order

Calculate the amount due for an order. For each order, the user should enter the following information into text boxes: customer name, address, city, state (two-letter abbreviation), and ZIP code. An order may consist of multiple items. For each item, the user will enter the product description, quantity, weight, and price into text boxes.

You will need buttons for *Add This Item*, *Update Summary*, *Clear*, *Print*, and *Exit*.

For the *Add This Item* button, validate the quantity, weight, and price. Each must be present and numeric. For any bad data, display a message box. Calculate the charge for the current item and add the charge and weight into the appropriate totals, but do not display the summary until the user clicks the *Update Summary* button. Do not calculate shipping and handling on individual items; rather, calculate shipping and handling on the entire order.

When the user clicks *Add This Item* for a new order, the customer information should be disabled so that the state cannot be changed until the next customer.

When the *Update Summary* button is clicked, calculate the sales tax, shipping and handling, and the total amount due for the order. Sales tax is 8 percent of the total charge and is charged only for shipments to a California address. Do not charge sales tax on the shipping and handling charges. The shipping and handling should be calculated only for a complete order.

Optional: Disable the *Add This Item* button when the *Summary* button is pressed.

The *Clear* button clears the data and totals for the current customer.

The shipping and handling charges depend on the weight of the products. Calculate the shipping charge as $.25 per pound and add that amount to the handling charge (taken from the following table).

Weight	Handling
Less than 10 pounds	$1.00
10 to 100 pounds	$3.00
Over 100 pounds	$5.00

Display the entire amount of the bill in controls titled Dollar amount due, Sales tax, Shipping and handling, and Total amount due.

Test Data

Description	Quantity	Weight	Price
Planter	2	3	19.95
Mailbox	1	2	24.95
Planter	2	3	19.95

Test Data Output for Taxable (if shipped to a California address)

Dollar Amount Due	$104.75
Sales Tax	8.38
Shipping and Handling	6.50
Total Amount Due	$119.63

Test Data Output for Nontaxable (if shipped outside of California)

Dollar Amount Due	$104.75
Sales Tax	0.00
Shipping and Handling	6.50
Total Amount Due	$111.25

VB Auto Center

Create a project that determines the total amount due for the purchase of a vehicle. Include text boxes for the base price and the trade-in allowance. Check boxes will indicate if the buyer wants additional accessories: stereo system, leather interior, and/or computer navigation. A group box for the exterior finish will contain radio buttons for Standard, Pearlized, or Customized detailing.

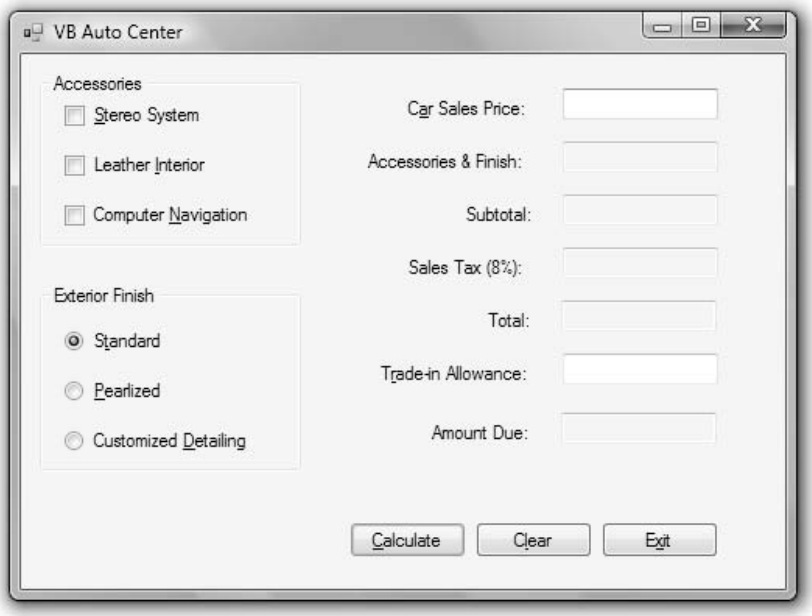
Have the trade-in amount default to zero; that is, if the user does not enter a trade-in amount, use zero in your calculation. Validate the values from the text boxes, displaying a message box if necessary.

To calculate, add the price of selected accessories and exterior finish to the base price and display the result in a control called Subtotal. Calculate the sales tax on the subtotal and display the result in a Total control. Then subtract any trade-in amount from the total and display the result in an Amount Due control.

Include buttons for *Calculate*, *Clear*, and *Exit*. The *Calculate* button must display the total amount due after trade-in.

Hint: Recall that you can make an ampersand appear in the Text property of a control by including two ampersands. See the tip on page 82 (Chapter 2).

Item	Price
Stereo System	425.76
Leather Interior	987.41
Computer Navigation	1,741.23
Standard	No additional charge
Pearlized	345.72
Customized Detailing	599.99
Tax Rate	8%



Video Bonanza

Design and code a project to calculate the amount due for rentals. Movies may be in VHS (videotape) format or DVD format. Videotapes rent for $1.80 each and DVDs rent for $2.50. New releases are $3 for DVD and $2 for VHS.

On the form include a text box to input the movie title and radio buttons to indicate whether the movie is in DVD or VHS format. Use one check box to indicate whether the person is a member; members receive a 10 percent discount. Another check box indicates a new release.

Use buttons for *Calculate*, *Clear for Next Item*, *Order Complete*, *Summary*, *Print*, and *Exit*. The *Calculate* button should display the item amount and add to the subtotal. The *Clear for Next Item* button clears the check box for new releases, the movie title, and the radio buttons; the member check box cannot be changed until the current order is complete. Include validation to check for missing data. If the user clicks on the *Calculate* button without first entering the movie title and selecting the movie format, display a message box.

For the *Order Complete* button, first confirm the operation with the user and clear the controls on the form for a new customer.

The *Summary* button displays the number of customers and the sum of the rental amounts in a message box. Make sure to add to the customer count and rental sum for each customer order.

Very Very Boards

Very Very Boards does a big business in shirts, especially for groups and teams. They need a project that will calculate the price for individual orders, as well as a summary for all orders.

The store employee will enter the orders in an order form that has text boxes for customer name and order number. To specify the shirts, use a text box for the quantity, radio buttons to select the size (small, medium, large, extra large, and XXL), and check boxes to specify a monogram and/or a pocket. Display the shirt price for the current order and the order total in ReadOnly text boxes or labels.

Include buttons to add a shirt to an order, clear the current item, complete the order, and display the summary of all orders. Do not allow the summary to display if the current order is not complete. Also, disable the text boxes for customer name and order number after an order is started; enable them again when the user clicks on the button to begin a new order. Confirm the operation before clearing the current order.

When the user adds shirts to an order, validate the quantity, which must be greater than zero. If the entry does not pass the validation, do not perform any calculations but display a message box and allow the user to correct the value. Determine the price of the shirts from the radio buttons and check boxes for the monogram and pockets. Multiply the quantity by the price to determine the extended price, and add to the order total and summary total.

Use constants for the shirt prices.

Prices for the Shirts

Small, medium, and large	$10
Extra large	11
XXL	12
Monogram	Add $2
Pocket	Add $1

Display the order summary in a message box. Include the number of shirts, the number of orders, and the dollar total of the orders.

CHAPTER

5

Menus, Common Dialog Boxes, Sub Procedures, and Function Procedures

at the completion of this chapter, you will be able to . . .

1. Create menus and submenus for program control.
2. Display and use the Windows common dialog boxes.
3. Create context menus for controls and the form.
4. Write reusable code in sub procedures and function procedures and call the procedures from other locations.

Menus

You have undoubtedly used menus quite extensively while working with the computer. **Menus** consist of a menu bar that contains menus, each of which drops down to display a list of menu items. You can use menu items in place of or in addition to buttons to execute a procedure.

Menu items are actually controls; they have properties and events. Each menu item has a Name property, a Text property, and a Click event, similar to a button. When the user selects a menu item, with either the mouse or the keyboard, the menu item's Click event procedure executes.

It is easy to create menus for a Windows form using the Visual Studio environment's **Menu Designer**. Your menus will look and behave like standard Windows menus.

Defining Menus

To create menus for your application, you add a **MenuStrip component** to a form. The MenuStrip is a container to which you can add ToolStripMenuItems. You also can add ToolStripComboBoxes, ToolStripSeparators, and ToolStripTextBoxes, making the new menus considerably more powerful than those in versions of VB prior to VB 2005.

The Visual Studio Menu Designer allows you to add menus and menu items to your forms. You must add a MenuStrip component from the *Menus & Toolbars* tab of the toolbox (Figure 5.1), which appears in the component tray below the form. Once you have added the MenuStrip component, it is extremely easy to create the menu items for your menu. The words *Type Here* appear at the top of the form, so that you can enter the text for your first menu (Figure 5.2). After you type the text for the first menu name and press Enter, the words *Type Here* appear both below the menu name and to the right of the menu name. You can choose next to enter menu items for the first menu or to type the words for the

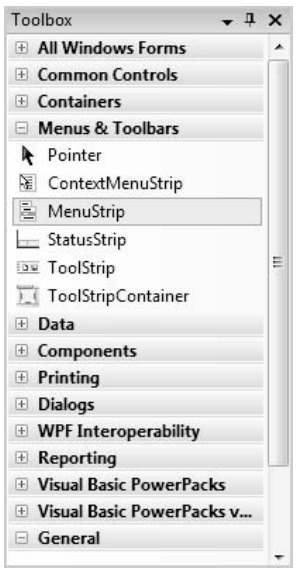


Figure 5.1

Add a MenuStrip component to the form using the MenuStrip tool from the toolbox.

second menu (Figure 5.3). Each time you type the text for a new menu, you are automatically adding a ToolStripMenuItem to the MenuStrip's Items collection.

Note: If you click elsewhere on the form, you deactivate the Menu Designer. You can click on the menu at the top of the form or on the MenuStrip component to activate the Menu Designer again.

Figure 5.2

The MenuStrip component appears in the component tray below the form and the Menu Designer allows you to begin typing the text for the menu items.

Figure 5.3

After typing the text for the first menu, you can add a second menu or add menu items below the menu name.

The Text Property

When you type the words for a menu or menu item, you are entering the Text property for an item. The Text property holds the words that you want to appear on the screen (just like the Text property of a button or label). To conform to Windows standards, your first menu's Text property should be File, with a keyboard access key. Use the ampersand (&) in the text to specify the key to use for keyboard access, as you learned to do in Chapter 2. For example, for File, the Text property should be &File.

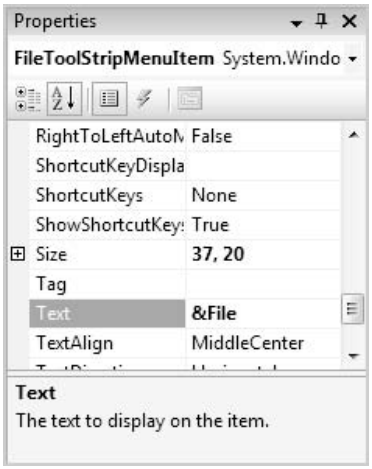
TIP

Do not use the same access key on a top-level menu as you use on a form control. However, access keys on menu items and submenus do not conflict with menu or control access keys. ■

You can enter and change the Text property for each of your menus and menu items using the Menu Designer. You also can change the Text property using the Properties window (Figure 5.4). Click on a menu or menu item to make its properties appear in the Properties window.

Figure 5.4

Modify the Text property of a menu item in the Properties window or the Menu Designer.



The Name Property

The Menu Designer is smart enough to give good names to the menu items. The *File* menu item that you add is automatically named *FileToolStripMenuItem*. Since the new items are named so well, you won't have to change the Name property of any menu component. However, if you change the Text property of any menu item, the item is not automatically renamed; you'll have to rename it yourself in the Properties window.

The MenuStrip Items Collection

As you create new menus using the Menu Designer, each menu is added to the Items collection that belongs to the MenuStrip. You can display the ToolStripMenuItems in the collection, set other properties of the items, as well as reorder, add, and delete items, using the Items Collection Editor (Figure 5.5). To display the Items Collection Editor, first select the MenuStrip (be sure you've selected the MenuStrip and not one of the ToolStripMenuItems) and then use one of these three techniques: (1) in the Items property in the Properties window, click on the ellipses button; (2) right-click on the MenuStrip in the Menu Designer and select *Edit Items* from the context menu; or (3) click on the MenuStrip's smart-tag arrow (at the right end of the strip) to display the smart tag and select *Edit Items*.

A Menu's DropDownItems Collection

The MenuStrip's Items collection holds the top-level menus; each of the menus has its own collection of the menu items that appear in that menu. The ToolStripMenuItems that appear below a menu name belong to the menu's DropDownItems collection. Therefore, if the *File* menu contains menu items for *Print*, *Save*, and *Exit*, the menu's DropDownItems collection will contain three ToolStripMenuItems. Notice the title bar in Figure 5.6, which shows the DropDownItems collection for the *File* menu (FileToolStripMenuItem).

Figure 5.5

Use the MenuStrip's Items Collection Editor to display and modify properties of the menus. You also can add new menus to the collection or modify the order of the menus.

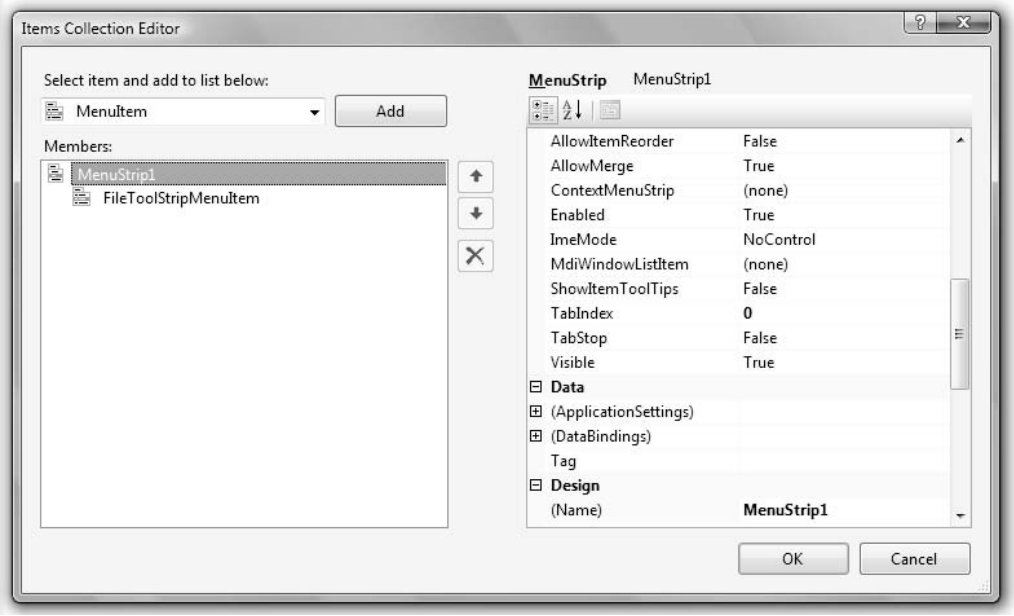
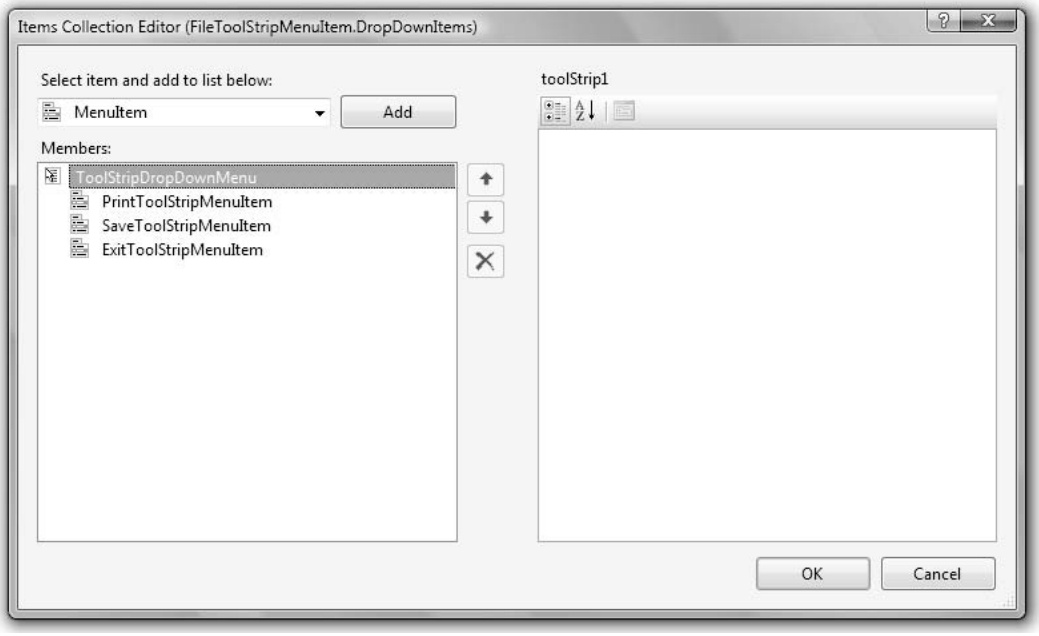


Figure 5.6

The Items Collection Editor for the DropDownItems collection, a property of the File menu's ToolStripMenuItem.



You can use the Items Collection Editor to rearrange or delete menu items. You also can accomplish the same tasks using the MenuDesigner; just drag a menu item to a new location or right-click a menu item and select *Delete*.

Submenus

The drop-down list of items below a menu name is called a *menu item*. When an item on the menu has another list of items that pops up, the new list is called a ***submenu***. A filled triangle to the right of the item indicates that a menu item has a submenu (Figure 5.7). You create a submenu in the Menu Designer by moving to the right of a menu item and typing the next item's text (Figure 5.8).

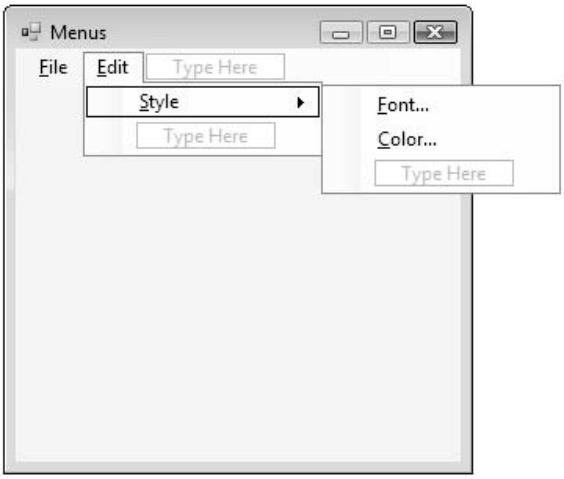


Figure 5.7

A filled triangle on a menu item indicates that a submenu will appear.

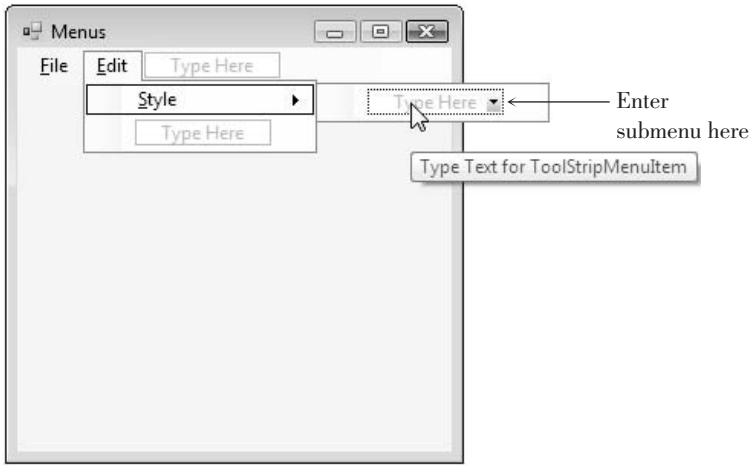


Figure 5.8

Create a submenu by typing to the right of the parent menu item.

Separator Bars

When you have many items in a menu, you should group the items according to their purpose. You can create a **separator bar** in a menu, which draws a bar across the entire menu.

To create a separator bar, add a new menu item and click on its drop-down arrow (Figure 5.9). Drop down the list and select *Separator* (Figure 5.10).

Other Features of ToolStrip Controls

You also can select ComboBox and TextBox for the type of menu item from the drop-down list. Using these features you can create very powerful and professional menus and toolbars.

Another nice feature of the MenuStrip component is that you can add a menu to other components on the form. For example, you could add a menu to a group box if it was appropriate.

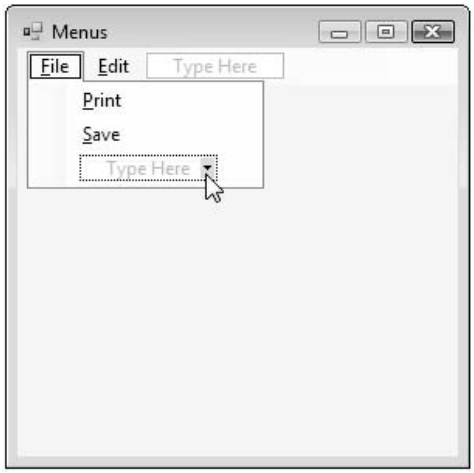


Figure 5.9

To create a menu item separator bar, click on the drop-down arrow for an item.

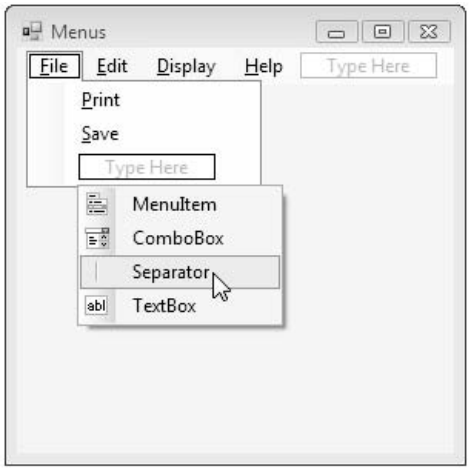


Figure 5.10

Select Separator *from the drop-down list.*

Creating a Menu—Step-by-Step

You are going to create a project with one form and a menu bar that contains these menu items:

```
File          Help
 Exit          About
```

Create the Menu Items

STEP 1: Begin a new Windows Forms project (or open an existing one to which you want to add a menu).

STEP 2: Add a MenuStrip component to the form. You can double-click or drag the tool to the form; the component will appear in the component tray at the bottom of the form (Figure 5.11).

STEP 3: With the words *Type Here* selected, type "&File" over the words.

STEP 4: Move down to the *Type Here* words below the *File* menu and type "E&xit".

STEP 5: Move up and to the right and add the *Help* menu ("&Help").

STEP 6: Below the *Help* menu, add the *About* menu item ("&About").

Figure 5.11

Add a MenuStrip component to the form. It will appear in the component tray at the bottom of the form.

Coding for Menu Items

After you create your form's menu bar, it appears on the form in design time. Double-click any menu item and the Editor window opens in the item's Click event procedure where you can write the code. For example, in design time, open your form's *File* menu and double-click on *Exit*. The Editor window will open with the ExitToolStripMenuItem_Click procedure displayed.

Write the Code

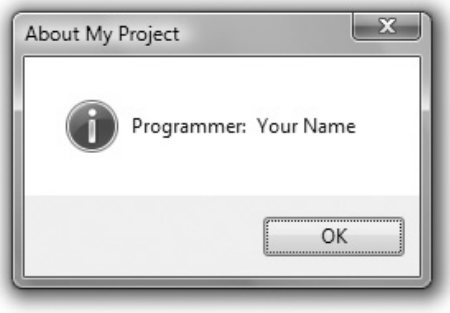
STEP 1: Code the procedure for the *Exit* by pulling down the menu and double-clicking on the word *Exit*. Type a remark and a `Me.Close()` statement.

STEP 2: Open the AboutToolStripMenuItem_Click event procedure. Use a `MessageBox.Show` statement to display the About box. The message string should say "Programmer:" followed by your name (Figure 5.12).

STEP 3: Run the program and test your menu items.

Figure 5.12

Display a message box for an About box.



The Enabled Property

By default, all new menu items have their **Enabled property** set to True. An enabled menu item appears in black text and is available for selection, whereas the grayed out or **disabled** (Enabled = False) items are not available (Figure 5.13). You can set the Enabled property at design time or run time, in code.

```
DisplayInstructionsToolStripMenuItem.Enabled = False
```

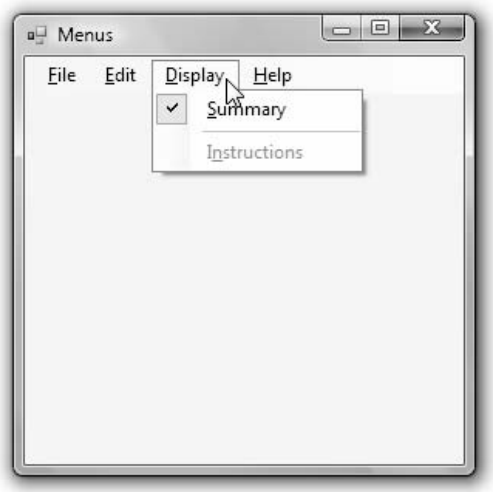


Figure 5.13

Menu items can be disabled (grayed) or checked. A check mark usually indicates that the item is currently selected.

The Checked Property

A menu item may contain a check mark beside it (indicating that the item is **checked**). Usually a check mark next to a menu item indicates that the option is currently selected (refer to Figure 5.13). By default, the **Checked property** is set to False; you can change it at design time or in code.

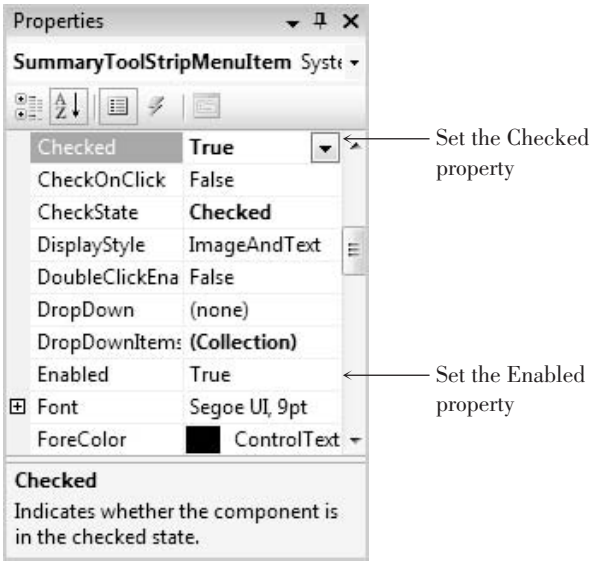
```
DisplaySummaryToolStripMenuItem.Checked = True
```

Toggling Check Marks On and Off

If you create a menu item that can be turned on and off, you should include a check mark to indicate its current state. Set the initial state of the Checked property in the Properties window (Figure 5.14).

Figure 5.14

You can set the Enabled and Checked properties of a menu item in the Properties window.



To change a menu item's state in code, set its Checked property to True or False. For example, for a menu item that displays or hides a summary, called *DisplaySummaryToolStripMenuItem*, a check mark indicates that the summary is currently selected. Choosing the menu item a second time should remove the check mark and hide the summary.

```
Private Sub DisplaySummaryToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles DisplaySummaryToolStripMenuItem.Click
    ' Hide or display the summary.

    If DisplaySummaryToolStripMenuItem.Checked Then
        ' Hide the summary information.
        DisplaySummaryToolStripMenuItem.Checked = False
    Else
        ' Show the summary information.
        DisplaySummaryToolStripMenuItem.Checked = True
    End If
End Sub
```

Setting Keyboard Shortcuts

Many computer users prefer to use keyboard shortcuts for selecting menu items. For example, most applications from Microsoft use Ctrl + P for the *Print* menu item and Ctrl + S for *Save*. You can create keyboard shortcuts for your menu items and choose whether or not to display the shortcuts on the menu. (For example, you can exit most Windows applications using Alt + F4, but the keyboard shortcut rarely appears on the menu.)

To set a keyboard shortcut for a menu item, first select the menu item in the designer. Then in the Properties window, select the ShortcutKeys property. Drop down the list to see the available choices and make your selection. You can use many combinations of function keys, the Alt key, the Shift key, and the Ctrl key. By default, the ShowShortcutKeys property is set to True; you can change it to False if you don't want the shortcut to show up on the menu.

TIP

You can toggle a Boolean value on and off using the `Not` operator: `DisplaySummaryToolStripMenuItem.Checked = Not DisplaySummaryToolStripMenuItem.Checked`. ■

Standards for Windows Menus

When you write applications that run under Windows, your programs should follow the Windows standards. You should always include keyboard access keys; if you include keyboard shortcuts, such as Ctrl + key, stick with the standard keys, such as Ctrl + P for printing. Also follow the Windows standards for placing the *File* menu on the left end of the menu bar and ending the menu with an *Exit* command. If you have a *Help* menu, it belongs at the right end of the menu bar.

Any menu item that will display a dialog box asking for more information from the user should have "..." appended to its Text property. Following Windows standards, the "..." indicates that a dialog box with further choices will appear if the user selects the menu item. You do not use the "..." for menu items that display dialog boxes that are informational only, such as an About box or a Summary form.

Plan your menus so that they look like other Windows programs. Your users will thank you.

Common Dialog Boxes

You can use a set of predefined standard dialog boxes in your projects for such tasks as specifying colors and fonts, printing, opening, and saving. Use the **common dialog** components in the *Dialogs* tab of the toolbox to display the dialog boxes that are provided as part of the Windows environment. The common dialog components provided with Visual Studio are ColorDialog, FolderBrowserDialog, FontDialog, OpenFileDialog, and SaveFileDialog (Figure 5.15).

To use a common dialog component, add the component to the form, placing it in the component tray. You can keep the default names for the components, such as ColorDialog1 and FontDialog1, since you will have only one component of each type.

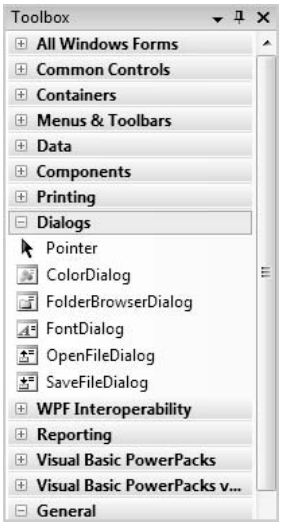


Figure 5.15

The common dialog tools in the Dialogs tab of the toolbox.

Displaying a Windows Common Dialog Box

After you place a common dialog component on your form, you can display the dialog box at run time using the **`ShowDialog` method**.

ShowDialog Method—General Form

General Form

```
DialogObject.ShowDialog()
```

The DialogObject is the name of the common dialog component that you placed on the form. The name will be the default name, such as ColorDialog1 or FontDialog1.

ShowDialog Method—Examples

Examples

```
ColorDialog1.ShowDialog()
FontDialog1.ShowDialog()
```

Place the code to show the dialog in the event procedure for a menu item or button.

Modal versus Modeless Windows

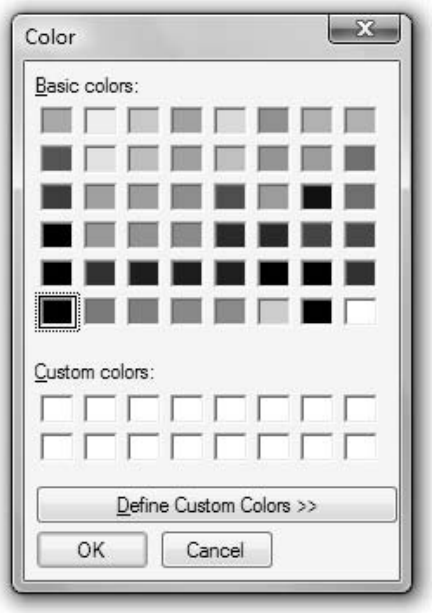
You probably have noticed that when you display a Windows dialog box, it remains on top until you respond. But in many applications, you can display additional windows and switch back and forth between the windows. A dialog box is said to be **modal**, which means that it stays on top of the application and must be responded to. You use the `ShowDialog` method to display a dialog box, which is just a window displayed modally. In Chapter 6 you will learn to display additional windows that are **modeless**, which do not demand that you respond. You will use the `Show` method to display a modeless window.

Using the Information from the Dialog Box

Displaying the *Color* dialog box (Figure 5.16) doesn't make the color of anything change. You must take care of that in your program code. When the user clicks on *OK*, the selected color is stored in a property that you can access. You can assign the value to the properties of controls in your project.

Figure 5.16

The Color common dialog box.



Using the Color Dialog Box

The color selected by the user is stored in the Color property. You can assign this property to another object, such as a control.

```
TitleLabel.BackColor = ColorDialog1.Color
```

Because Basic executes the statements in sequence, you would first display the dialog box with the `ShowDialog` method. (Execution then halts until the user responds to the dialog box.) Then you can use the Color property:

```
Public Sub ColorToolStripMenuItem_Click(ByVal sender As System.Object, _
 ByVal e As System.EventArgs) Handles ColorToolStripMenuItem.Click
   ' Change the color of the total labels.

   With ColorDialog1
       .ShowDialog()
       SubTotalLabel.ForeColor = .Color
       TaxLabel.ForeColor = .Color
       TotalLabel.ForeColor = .Color
   End With
End Sub
```

Using the Font Dialog Box

When you display the *Font* common dialog box (Figure 5.17), the available fonts for the system display. After the user makes a selection, you can use the Font property of the dialog box object. You may want to assign the Font property to the Font property of other objects on your form.

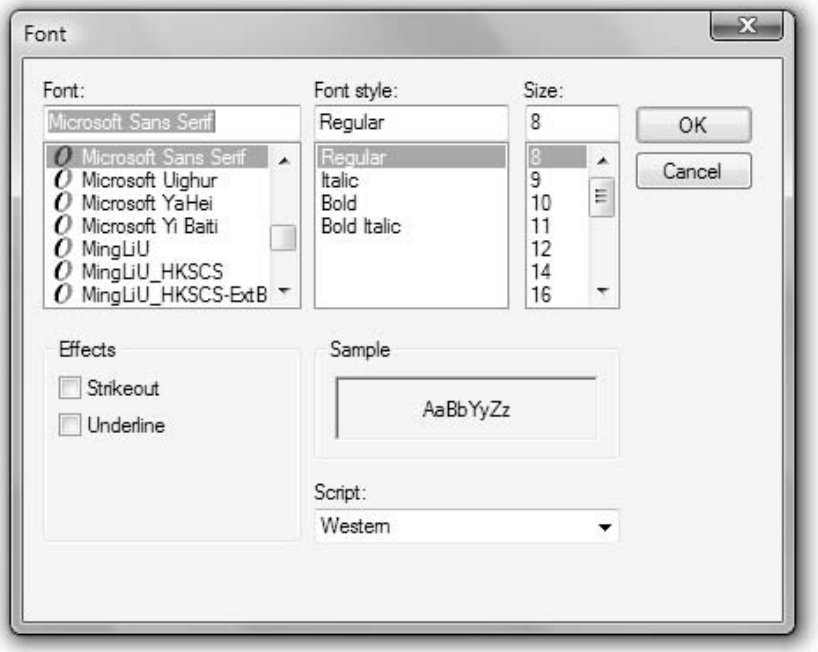


Figure 5.17

The Font common dialog box. The fonts that display are those installed on the user's system.

```
Public Sub FontToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles FontToolStripMenuItem.Click
   ' Change the font name for the labels.

   With FontDialog1
       .ShowDialog()
       SubTotalLabel.Font = .Font
       TaxLabel.Font = .Font
       TotalLabel.Font = .Font
   End With
End Sub
```

When the user clicks on the *Font* menu item, the *Font* dialog box appears on the screen. Execution halts until the user responds to the dialog box, either by clicking *OK* or *Cancel*.

Setting Initial Values

When a common dialog box for colors or fonts appears, what color or font do you want to display? It's best to assign initial values before showing the dialog box. Before executing the `ShowDialog` method, you should assign the existing values of the object's properties that will be altered. This step makes the current values selected when the dialog box appears. It also means that if the user selects the *Cancel* button, the property settings for the objects will remain unchanged.

```
FontDialog1.Font = SubTotalLabel.Font
```

or

```
ColorDialog1.Color = Me.BackColor
```

Creating Context Menus

You also can add **context menus** to your applications. Context menus are the **shortcut menus** that pop up when you right-click. Generally, the items in a context menu are specific to the component to which you are pointing, reflecting the options available for that component or that situation.

Creating a context menu is similar to creating a menu. You add a **ContextMenuStrip component**, which appears in the component tray below the form. At the top of the form, in the Menu Designer, the words say *ContextMenuStrip* (Figure 5.18). A context menu does not have a top-level menu, only the menu items. Click on the words *Type Here* to type the text of your first menu item.

Your application can have more than one context menu. You assign the context menu to the form or control by setting its ContextMenuStrip property. For example, a form has a ContextMenuStrip property, a button has a ContextMenuStrip property, and all visible controls have ContextMenuStrip properties. You can assign the same ContextMenuStrip to the form and each of the controls, or a different context menu to each. If you have only one context menu, attach it to the form—it will pop up if the user right-clicks anywhere on

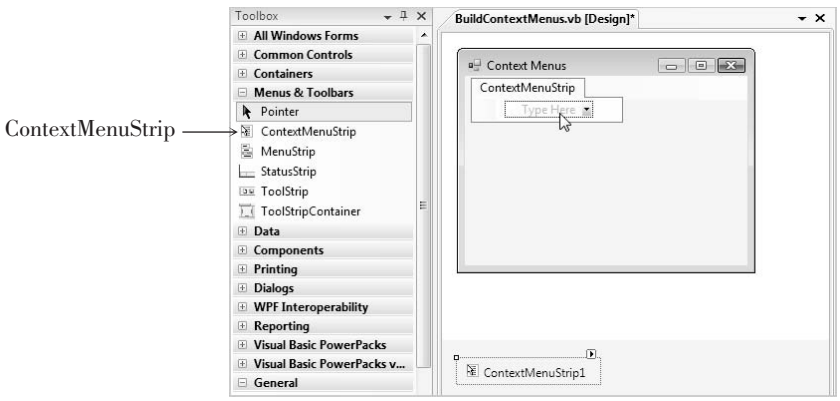


Figure 5.18

Add a ContextMenuStrip component to the component tray and create the context menu using the Menu Designer.

the form, including on a control. However, some controls have an "automatic" context menu. For example, a text box has an automatic context menu that allows the user to cut, copy, and paste text. If you set the ContextMenuStrip property of a text box to your own context menu, your context menu will appear instead of the original (automatic) context menu.

Creating a Context Menu—Step-by-Step

You are going to create a context menu that contains these menu items:

```
Color...
Font...
Exit
```

Add the ContextMenuStrip to a Form

STEP 1: Begin a new Windows project (or open an existing one to which you want to add a context menu). For a new project, name the form ContextMenuForm.

STEP 2: Add a ContextMenuStrip component from the *Menus & Toolbars* tab of the toolbox; the component will appear in the component tray at the bottom of the form (refer to Figure 5.18).

STEP 3: Click on the words *ContextMenuStrip* in the Menu Designer to make a *Type Here* menu item appear.

STEP 4: Click on the words *Type Here* and type the text for the first menu item: "&Color...".

STEP 5: Type the text for the second and third menu items: "&Font..." and "E&xit".

STEP 6: Add a label named MessageLabel to your form and set the Text property to "Right-click for the Context Menu".

STEP 7: Set the form's ContextMenuStrip property to ContextMenuStrip1. Notice that the property box has a drop-down list. If you have more than one context menu defined, you can choose from the list.

STEP 8: Add a ColorDialog component from the *Dialogs* tab of the toolbox.

STEP 9: Add a FontDialog component.

In this example, right-clicking anywhere on the form allows you to change the foreground color or the font of the form. As you know, if you haven't set those properties for individual controls, the form's properties apply to all controls on the form.

TIP

It's a good idea to set a ContextMenu property for all controls and for the form to allow users the option of using context menus. ■

STEP 10: Code the form as follows:

```
'Program:          Ch05ContextMenus
'Programmer:       Your Name
'Date:             Today's Date
'Description:      Create and apply a context menu.

Public Class ContextMenuForm
  Private Sub ColorToolStripMenuItem_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles ColorToolStripMenuItem.Click
      ' Change the form's ForeColor.
      ' Applies to all controls on the form that haven't had their
      '    ForeColor explicitly modified.
```

```
        With ColorDialog1
          ' Initialize the dialog box.
          .Color = Me.ForeColor
          .ShowDialog()
          ' Assign the new color.
          Me.ForeColor = .Color
        End With
    End Sub

    Private Sub FontToolStripMenuItem_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles FontToolStripMenuItem.Click
        ' Change the label's font.

        With FontDialog1
          ' Initialize the dialog box.
          .Font = MessageLabel.Font
          .ShowDialog()
          ' Assign the new font.
          MessageLabel.Font = .Font
        End With
    End Sub

    Private Sub ExitToolStripMenuItem_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ExitToolStripMenuItem.Click
        ' Terminate the project.

        Me.Close()
    End Sub
End Class
```

Test the Program

STEP 1: Experiment with right-clicking on the form and on the label. Test each of the options.

After you have the program working, experiment with adding more controls, adding more ContextMenuStrip components, and setting the ContextMenuStrip property of controls.

Sharing Procedures

Most frequently a context menu is added as an additional way to access a feature that is also available from another menu or a button. Recall from Chapter 4 that you can use the same procedure for several events by adding to the `Handles` clause.

```
Private Sub FontToolStripMenuItem_Click (ByVal sender As System.Object, _
  ByVal e As System.EventArgs) _
  Handles FontToolStripMenuItem.Click, FontButton.Click
    ' Change the label's font.

    With FontDialog1
      ' Initialize the dialog box.
      .Font = MessageLabel.Font
      .ShowDialog()
      ' Assign the new font.
      MessageLabel.Font = .Font
    End With
End Sub
```

Writing General Procedures

Often you will encounter programming situations in which multiple procedures perform the same operation. This condition can occur when the user can select either a button or a menu item to do the same thing. Rather than retyping the code, you can write reusable code in a **general procedure** and call it from both event procedures.

General procedures are also useful in breaking down large sections of code into smaller units that perform a specific task. By breaking down your calculations into smaller tasks, you simplify any maintenance that needs to be done in a program in the future. For example, bowling statistics for a league may require calculations for handicap and series total. If the formula for calculating handicaps changes, wouldn't it be nice to have a procedure that calculates handicaps only instead of one that performs all the calculations?

You can choose from two types of general procedures: **sub procedures** and **function procedures**:

- A sub procedure performs actions.
- A function procedure performs actions and returns a value (the **return value**).

You will likely use a sub procedure if you need to set property values for a series of objects. However, if you need to calculate a result, then a function procedure is the appropriate choice. Both sub procedures and function procedures are considered the **methods** of object-oriented programming.

Creating a New Sub Procedure

You can create a sub procedure in the Editor window by enclosing the desired lines of code within a set of `Sub` and `End Sub` statements.

Sub...End Sub Statements—General Form

General Form

```
Private Sub ProcedureName()
    '... Statements in the procedure.
End Sub
```

When you type the line

```
Private Sub ProcedureName
```

and press Enter, the editor automatically adds the parentheses to the `Sub` statement, adds the `End Sub` statement, and places the insertion point on the line between the two new lines.

Sub...End Sub Statements—Example

Example

```
Private Sub SelectColor()
    ' Display the color dialog box.

    ColorDialog1.ShowDialog()
End Sub
```

Note that VB has choices other than `Private` for the access, such as `Public`, `Friend`, and `Protected`. In a later chapter, you will learn about the other types of procedures; for now use `Private` for all general procedures.

The coding for the new procedure is similar to the other procedures we have been coding but is not yet attached to any event. Therefore, this code cannot be executed unless we specifically **call** the procedure from another procedure. To call a sub procedure, just give the procedure name, which in this case is SelectColor.

```
Private Sub ChangeMessageButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles ChangeMessageButton.Click
    ' Change the color of the message.

    SelectColor()
    MessageLabel.ForeColor = ColorDialog1.Color
End Sub

Private Sub ChangeTitleButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles ChangeTitleButton.Click
    ' Change the color of the title.

    SelectColor()
    TitleLabel.ForeColor = ColorDialog1.Color
End Sub
```

Passing Arguments to Procedures

At times you may need to use the value of a variable in one procedure and then again in a second procedure that is called from the first. In this situation, you could declare the variable as module level, but that approach makes the variable visible to all other procedures. To keep the scope of a variable as narrow as possible, consider declaring the variable as local and passing it to any called procedures.

As an example, we will expand the capabilities of the previous SelectColor sub procedure to display the original color when the dialog box appears. Because the SelectColor procedure can be called from various locations, the original color must be passed to the procedure.

```
Private Sub SelectColor(IncomingColor As Color)
    ' Allow the user to select a color.

    With ColorDialog1
      ' Set the initial color.
      .Color = IncomingColor
      .ShowDialog()
    End With
End Sub

Private Sub ChangeMessageButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles ChangeMessageButton.Click
    ' Change the color of the message.
    Dim OriginalColor As Color

    OriginalColor = MessageLabel.ForeColor
    SelectColor(OriginalColor)
    MessageLabel.ForeColor = ColorDialog1.Color
End Sub
```

```
Private Sub ChangeTitleButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles ChangeTitleButton.Click
    ' Change the color of the title.
    Dim OriginalColor As Color

    OriginalColor = TitleLabel.ForeColor
    SelectColor(OriginalColor)
    TitleLabel.ForeColor = ColorDialog1.Color
End Sub
```

Notice that in this example the SelectColor procedure now has a parameter inside the parentheses. This syntax specifies that when called, an argument must be supplied.

When a sub procedure definition names a parameter, any call to that procedure must supply a value, called an *argument*. In addition, the data type of the parameter and supplied argument must be the same. Notice that in the two calling procedures (ChangeMessageButton_Click and ChangeTitleButton_Click), the variable OriginalColor is declared as a Color data type.

Another important point is that the *names* of the parameter and of the supplied argument do not have to be the same. The SelectColor sub procedure will take whatever Color value it is passed and refer to it as IncomingColor inside the procedure.

You may specify multiple parameters in the sub procedure header and supply multiple arguments in the call to the procedure. *The number of arguments, their sequence, and their data types must match the parameter list.* You will see some examples of multiple parameters in the sections that follow.

Passing Arguments ByVal or ByRef

When you pass an argument to a procedure, you may pass it **`ByVal`** or **`ByRef`** (for *by value* or *by reference*). `ByVal` sends a copy of the argument's value to the procedure so that the procedure cannot alter the original value. `ByRef` sends a reference indicating where the value is stored in memory, allowing the called procedure to actually change the argument's original value. You can specify how you want to pass the argument by using the `ByVal` or `ByRef` keyword before the parameter in the procedure header. If you don't specify `ByVal` or `ByRef`, arguments are passed by value.

```
' Argument passed by reference.
Private Sub SelectColor(ByRef IncomingColor As Color)

' Argument passed by value.
Private Sub SelectColor(ByVal IncomingColor As Color)

' Argument passed by value (the default).
Private Sub SelectColor(IncomingColor As Color)
```

Writing Function Procedures

As a programmer, you may need to calculate a value that will be needed in several different procedures or programs. You can write your own function that will calculate a value and call the function from the locations where it is needed. As an example, we will create a function procedure called `Commission` that calculates and returns a salesperson's commission.

Typing in a block of code using the `Function...End Function` statements creates a function procedure. Since the procedure returns a value, you must specify a data type for the value.

Function...End Function Statements—General Form

General Form

```
Private Function ProcedureName() As Datatype

End Function
```

Functions also can be declared as `Public`, `Protected`, or `Friend`, which you will learn about later. `Private` is appropriate for all functions for now.

Function...End Function Statements—Example

Example

```
Private Function Commission() As Decimal
    ' Statements in function.
End Function
```

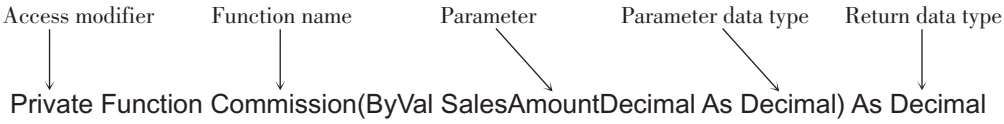
Notice that this procedure looks just like a sub procedure except that the word `Function` replaces the word `Sub` on both the first line and the last line. The procedure header also includes a data type, which is the type of the value returned by the function.

Remember that functions also have parameters. You supply arguments for the function parameters when you call the function by placing a value or values inside the parentheses. Arguments are passed `ByVal` or `ByRef`.

When you write a function, you declare the parameter(s) that the function needs. You give each parameter an identifier and a data type. The name that you give a parameter in the function procedure header is the identifier that you will use inside the function to refer to the value passed as an argument (Figure 5.19).

Figure 5.19

A procedure header for a function procedure.



Examples

```
Private Function Commission(ByVal SalesAmountDecimal As Decimal) As Decimal
Private Function Payment(RateDecimal As Decimal, TimeDecimal As Decimal, _
  AmountDecimal As Decimal) As Decimal
```

In the function procedure, the parameter list you enter establishes the number of parameters, their type, and their sequence. When using multiple parameters, the sequence of the supplied arguments is critical, just as when you use the predefined Visual Basic functions.

Returning the Result of a Function

The main difference between coding a function procedure and coding a sub procedure is that in a function procedure you must set up the return value. This return value is placed in a variable that Visual Basic names with the same

name as the function name. In the example in Figure 5.19, the variable name is Commission.

You can choose from two techniques for returning the result of the function:

- Somewhere inside the `Commission` function, set the function name to a value. Example: `Commission = 0.15D * SalesAmountDecimal`
- Use the `Return` statement. If you use the `Return` statement, you do not use the function's name as a variable name.
  Example: `Return 0.15D * SalesAmountDecimal`

Writing a Commission Function

Here is the `Commission` function procedure coded using the first technique for returning a value.

```
Private Function Commission(ByVal SalesAmountDecimal As Decimal) As Decimal
  ' Calculate the sales commission.

  If SalesAmountDecimal < 1000D Then
    Commission = 0D
  ElseIf SalesAmountDecimal <= 2000D Then
    Commission = 0.15D * SalesAmountDecimal
  Else
    Commission = 0.2D * SalesAmountDecimal
  End If
End Function
```

And here is the same `Commission` function procedure using the `Return` statement.

```
Private Function Commission(ByVal SalesAmountDecimal As Decimal) As Decimal
  ' Calculate the sales commission.

  If SalesAmountDecimal < 1000D Then
    Return 0D
  ElseIf SalesAmountDecimal <= 2000D Then
    Return 0.15D * SalesAmountDecimal
  Else
    Return 0.2D * SalesAmountDecimal
  End If
End Function
```

Calling the Commission Function

In another procedure in the form, you can call your function by using it in an expression.

```
Private Sub CalculateButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles CalculateButton.Click
    ' Calculate the commission.
    Dim SalesDecimal As Decimal

    SalesDecimal = Decimal.Parse(SalesTextBox.Text)
    CommissionLabel.Text = Commission(SalesDecimal).ToString("C")
  End With
End Sub
```

Notice in the preceding example that the argument passed in the function call does not have the same name as the parameter specified in the function definition. When the function is called, a copy of the value of SalesDecimal is passed to the function and is assigned to the named parameter, in this case SalesAmountDecimal. As the calculations are done (inside the function), for every reference to SalesAmountDecimal, the value that was passed in for SalesDecimal is actually used.

You can combine the functions, if you wish:

```
CommissionLabel.Text = _
   Commission(Decimal.Parse(SalesTextBox.Text)).ToString("C")
```

To read this statement, begin with the inner parentheses: SalesTextBox.Text is passed to `Decimal.Parse` for conversion to Decimal; the result of that conversion is passed as an argument to the `Commission` function; the value returned by the `Commission` function is formatted as it is converted to a string and then assigned to CommissionLabel.Text.

Converting SelectColor to a Function Procedure

The SelectColor procedure that we wrote earlier is a good candidate for a function procedure, since we need to return one value: the color.

```
Private Function SelectColor(ByVal IncomingColor As Color) As Color
     ' Allow the user to select a color.

     With ColorDialog1
        ' Set the initial color.
        .Color = IncomingColor
        .ShowDialog()
       Return .Color
     End With
End Function

Private Sub ChangeMessageButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles ChangeMessageButton.Click
     ' Call the new SelectColor function (with a single line of code).

     MessageLabel.ForeColor = SelectColor(MessageLabel.ForeColor)
End Sub
```

Functions with Multiple Parameters

A function can have multiple parameters. The sequence and data type of the arguments in the call must exactly match the parameters in the function procedure header.

Writing a Function with Multiple Parameters

When you create a function with multiple parameters such as a `Payment` function, you enclose the list of parameters in the parentheses. The following example indicates that three arguments are needed in the call: The first argument is the annual interest rate, the second is the time in years, and the third is the

loan amount. All three argument values must have a data type of decimal, and the return value will be decimal. Look carefully at the following formula and notice how the identifiers in the parentheses are used.

```
Private Function Payment(ByVal RateDecimal As Decimal, ByVal TimeDecimal As Decimal, _
  ByVal AmountDecimal As Decimal) As Decimal
    ' Calculate the monthly payment on an amortized loan.

    Dim RatePerMonthDecimal As Decimal

    RatePerMonthDecimal = RateDecimal / 12D

    ' Calculate and set the return value of the function.
    Payment = Convert.ToDecimal((AmountDecimal * RatePerMonthDecimal) _
      / ((1 - (1 / (1 + RatePerMonthDecimal) ^ (TimeDecimal * 12D)))))
End Function
```

Calling a Function with Multiple Parameters

To call this function from another procedure, use these statements:

```
RateDecimal = Decimal.Parse(RateTextBox.Text)
YearsDecimal = Decimal.Parse(YearsTextBox.Text)
PrincipalDecimal = Decimal.Parse(PrincipalTextBox.Text)
PaymentDecimal = Payment(RateDecimal, YearsDecimal, PrincipalDecimal)
```

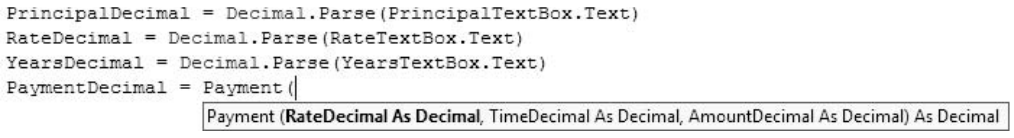
You can pass the value of the text boxes as well as format the result by combining functions:

```
PaymentLabel.Text = Payment(Decimal.Parse(RateTextBox.Text), _
  Decimal.Parse(YearsTextBox.Text), _
  Decimal.Parse(PrincipalTextBox.Text)).ToString("C")
```

When you call the function, the smart editor shows you the parameters of your function (Figure 5.20), just as it does for built-in functions (assuming that you have already entered the function procedure).

Figure 5.20

The Visual Studio IntelliSense feature pops up with the parameter list for your own newly written procedure.



Breaking Calculations into Smaller Units

A project with many calculations can be easier to understand and to write if you break the calculations into small units. Each unit should perform one program function or block of logic. In the following example that calculates bowling statistics, separate function procedures calculate the average, handicap, and series total, and find the high game.

```
'Project:       Chapter 5 Bowling Example
'Programmer:    Bradley/Millspaugh
'Date:          June 2008
'Folder:        Ch05Bowling
'Description:   This project calculates bowling statistics using
'               multiple function procedures.

Public Class BowlingForm

  Private Sub CalculateToolStripMenuItem_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles CalculateToolStripMenuItem.Click
      ' Calculate individual and summary info.
      Dim AverageDecimal, HandicapDecimal As Decimal
      Dim SeriesInteger, Game1Integer, Game2Integer, Game3Integer As Integer
      Dim HighGameString As String

      Try
          Game1Integer = Integer.Parse(Score1TextBox.Text)
          Game2Integer = Integer.Parse(Score2TextBox.Text)
          Game3Integer = Integer.Parse(Score3TextBox.Text)

          ' Perform all calculations.
          AverageDecimal = FindAverage(Game1Integer, Game2Integer, Game3Integer)
          SeriesInteger = FindSeries(Game1Integer, Game2Integer, Game3Integer)
          HighGameString = FindHighGame(Game1Integer, Game2Integer, Game3Integer)
          HandicapDecimal = FindHandicap(AverageDecimal)

          ' Format the output.
          AverageTextBox.Text = AverageDecimal.ToString("N1")
          HighGameTextBox.Text = HighGameString
          SeriesTextBox.Text = SeriesInteger.ToString()
          HandicapTextBox.Text = HandicapDecimal.ToString("N1")
      Catch
          MessageBox.Show("Please Enter three numeric scores", "Missing Data", _
            MessageBoxButtons.OK)
      End Try
  End Sub

  Private Sub ClearToolStripMenuItem_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles ClearToolStripMenuItem.Click
      ' Clear the data entry fields.

      With NameTextBox
          .Clear()
          .Focus()
      End With
      MaleRadioButton.Checked = False
      FemaleRadioButton.Checked = False
      Score1TextBox.Clear()
      Score2TextBox.Clear()
      Score3TextBox.Clear()
      SeriesTextBox.Clear()
      AverageTextBox.Clear()
      HighGameTextBox.Clear()
      HandicapTextBox.Clear()
  End Sub

  Private Sub ExitToolStripMenuItem_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles ExitToolStripMenuItem.Click
      ' Terminate the project.

      Me.Close()
  End Sub
```

```
  Private Function FindAverage(ByVal Score1Integer As Integer, _
    ByVal Score2Integer As Integer, ByVal Score3Integer As Integer) As Decimal
      ' Return the average of three games.

      Return (Score1Integer + Score2Integer + Score3Integer) / 3D
  End Function

  Private Function FindHandicap(ByVal AverageDecimal As Decimal) As Decimal
      ' Calculate the handicap.

      Return (200D - AverageDecimal) * 0.8D
  End Function

  Private Function FindSeries(ByVal Game1Integer As Integer, _
    ByVal Game2Integer As Integer, ByVal Game3Integer As Integer) As Integer
      ' Calculate the series total.

      Return Game1Integer + Game2Integer + Game3Integer
  End Function

  Private Function FindHighGame(ByVal Game1Integer As Integer, _
    ByVal Game2Integer As Integer, ByVal Game3Integer As Integer) As String
      ' Find the highest game in the series.

      If Game1Integer > Game2Integer And Game1Integer > Game3Integer Then
          Return "1"
      ElseIf Game2Integer > Game1Integer And Game2Integer > Game3Integer Then
          Return "2"
      ElseIf Game3Integer > Game1Integer And Game3Integer > Game2Integer Then
          Return "3"
      Else
          Return "Tie"
      End If
  End Function
End Class
```

Feedback 5.1

You need to write a procedure to calculate and return the average of three integer values.

1. Should you write a sub procedure or a function procedure?
2. Write the header line of the procedure.
3. Write the calculation.
4. How is the calculated average passed back to the calling procedure?

Basing a New Project on an Existing Project

In this chapter you will base a new project on an existing project but keep the previous project unchanged. To create a new project based on a previous one, you should copy the project folder. Then you can move it as necessary.

You can copy an entire Windows project folder from one location to another using My Computer. Make sure that the project is not open in Visual Studio and copy the entire folder.

- Make sure the project is not open (very important).
- Copy the folder to a new location using My Computer.
- Rename the new folder for the new project name, still using My Computer.

- Open the new project (the copy) in the Visual Studio IDE.
- In the IDE's Solution Explorer, rename the project. The best way to do this is to right-click on the name and choose the *Rename* command from the shortcut menu. To rename the solution, you must set the option to display the solution: *Tools / Options / Projects and Solutions / General / Always show solution.*
- Rename the forms, if desired. (If VS can't find the startup form, you must open the Project Designer and set the Startup Object. Select *Project / ProjectName Properties* or double-click on the *My Project* entry in the Solution Explorer.)
- Open the Project Designer and change the Assembly Name entry to match your new project name.

Warning: Do not try to copy a project that is open using the *Save As* command, attempting to place a copy in a new location. Visual Studio 2008 prevents you from saving anywhere but the original location; in some earlier versions of Visual Studio, doing so made the project unusable.

Your Hands-On Programming Example

Modify the hands-on programming example from Chapter 4 by replacing some of the buttons with menus. Write a function procedure to calculate the sales tax and allow the user to select the font and color of the summary text boxes.

The project for R 'n R—for Reading 'n Refreshment calculates the amount due for individual orders and maintains accumulated totals for a summary. Use a check box for takeout items, which are taxable (8 percent); all other orders are nontaxable. Include radio buttons for the five coffee selections: Cappuccino, Espresso, Latte, Iced Latte, and Iced Cappuccino. The prices for each will be assigned using these constants:

Cappuccino	2.00
Espresso	2.25
Latte	1.75
Iced (either)	2.50

Use a button for *Calculate Selection*, which will calculate and display the amount due for each item. A button for *Clear for Next Item* will clear the selections and amount for the single item. Additional text boxes in a separate group box will maintain the summary information for the current order to include subtotal, tax, and total.

The *New Order* menu item will clear the bill for the current customer and add to the totals for the summary. The menu item for *Summary* should display the total of all orders, the average sale amount per customer, and the number of customers in a message box.

The *Edit* menu contains options that duplicate the *Calculate* and *Clear* buttons. The *Font* and *Color* options change the properties of the subtotal, tax, and total text boxes.

The *About* selection on the *Help* menu will display a message box with information about the programmer.

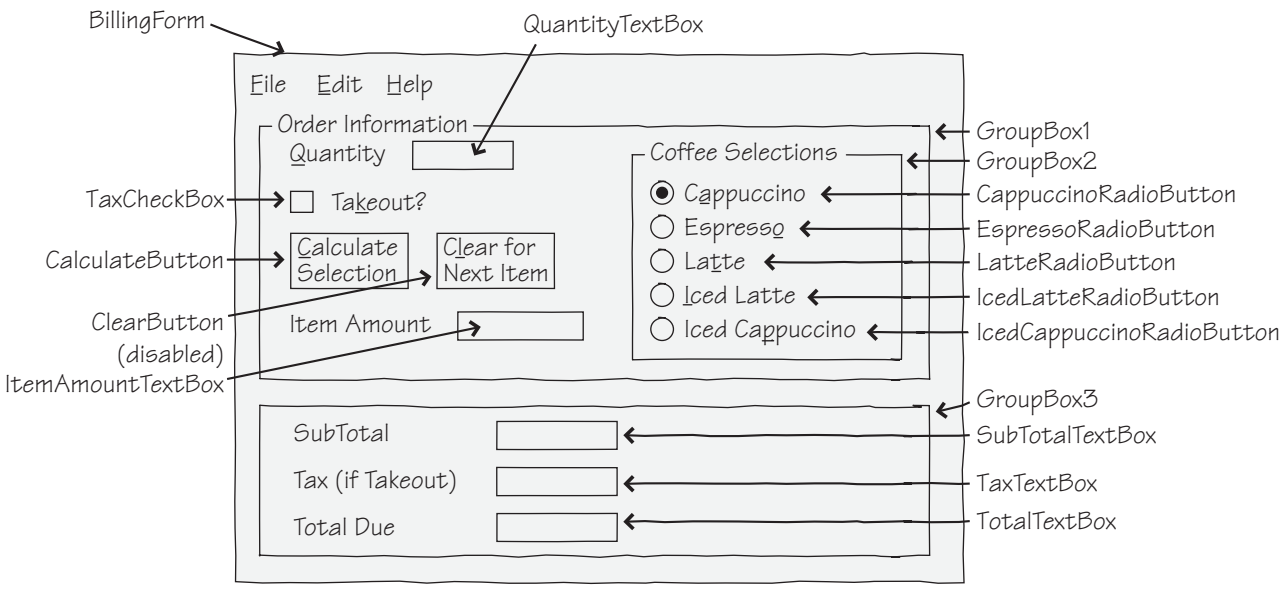
```
File              Edit                  Help
 New Order         Calculate Selection   About
 Summary           Clear Item
 ──────            ──────────
 Exit              Font...
                   Color...
```

Planning the Project

Sketch a form (Figure 5.21) that your users sign as meeting their needs.

Figure 5.21

A sketch of the form for the hands-on programming example.



Plan the Objects and Properties Plan the property settings for the form and each of the controls.

Object	Property	Setting
BillingForm	Name	BillingForm
	Text	R 'n R--for Reading 'n Refreshment
	AcceptButton	CalculateButton
	CancelButton	ClearButton
GroupBox1	Text	Order Information
GroupBox2	Text	Coffee Selections
GroupBox3	Text	(blank)
CappuccinoRadioButton	Name	CappuccinoRadioButton
	Text	C&appuccino
	Checked	True
EspressoRadioButton	Name	EspressoRadioButton
	Text	Espress&o
LatteRadioButton	Name	LatteRadioButton
	Text	La&tte

Object	Property	Setting
IcedLatteRadioButton	Name	IcedLatteRadioButton
	Text	&Iced Latte
IcedCappuccinoRadioButton	Name	IcedCappuccinoRadioButton
	Text	Iced Ca&ppuccino
Label1	Text	&Quantity
QuantityTextBox	Name	QuantityTextBox
	Text	(blank)
TaxCheckBox	Name	TaxCheckBox
	Text	Ta&keout?
Label2	Text	Item Amount
Label3	Text	SubTotal
Label4	Text	Tax (if Takeout)
Label5	Text	Total Due
ItemAmountTextBox	Name	ItemAmountTextBox
	TabStop	False
	ReadOnly	True
SubTotalTextBox	Name	SubTotalTextBox
	TabStop	False
	ReadOnly	True
TaxTextBox	Name	TaxTextBox
	TabStop	False
	ReadOnly	True
TotalTextBox	Name	TotalTextBox
	TabStop	False
	ReadOnly	True
CalculateButton	Name	CalculateButton
	Text	&Calculate Selection
ClearButton	Name	ClearButton
	Text	C&lear for Next Item
	Enabled	False
FileToolStripMenuItem	Text	&File
NewOrderToolStripMenuItem	Text	&New Order Property: Enabled; Setting: False
SummaryToolStripMenuItem	Text	&Summary
ExitToolStripMenuItem	Text	E&xit
EditToolStripMenuItem	Text	&Edit
CalculateSelectionToolStripMenuItem	Text	&Calculate Selection
ClearItemToolStripMenuItem	Text	Clear &Item
FontToolStripMenuItem	Text	&Font . . .
ColorToolStripMenuItem	Text	C&olor . . .
HelpToolStripMenuItem	Text	&Help
AboutToolStripMenuItem	Text	&About
ColorDialog1	Name	ColorDialog1
FontDialog1	Name	FontDialog1

Plan the Event Procedures You need to plan the actions for the buttons and the actions of the menu items, as well as the function for the sales tax.

Object	Procedure	Action
CalculateButton	Click	Validate for blank or nonnumeric amount. Find price of drink selection. Multiply price by quantity. Add amount to subtotal. Call tax function if needed. Calculate total = subtotal + tax. Format and display the values. Enable the Clear button and menu item. Disable the Takeout check box.
ClearButton	Click	Clear the coffee selections. Clear the quantity and the item price. Set the focus to the quantity.

NewOrderToolStripMenuItem	Click	Confirm clearing the current order.
		Clear the current order.
		If subtotal <> 0
		  Accumulate total sales and count.
		  Set subtotal and total due to 0.
		Enable Takeout check box.
		Disable the Clear button and menu item.
		Disable New Order menu item.

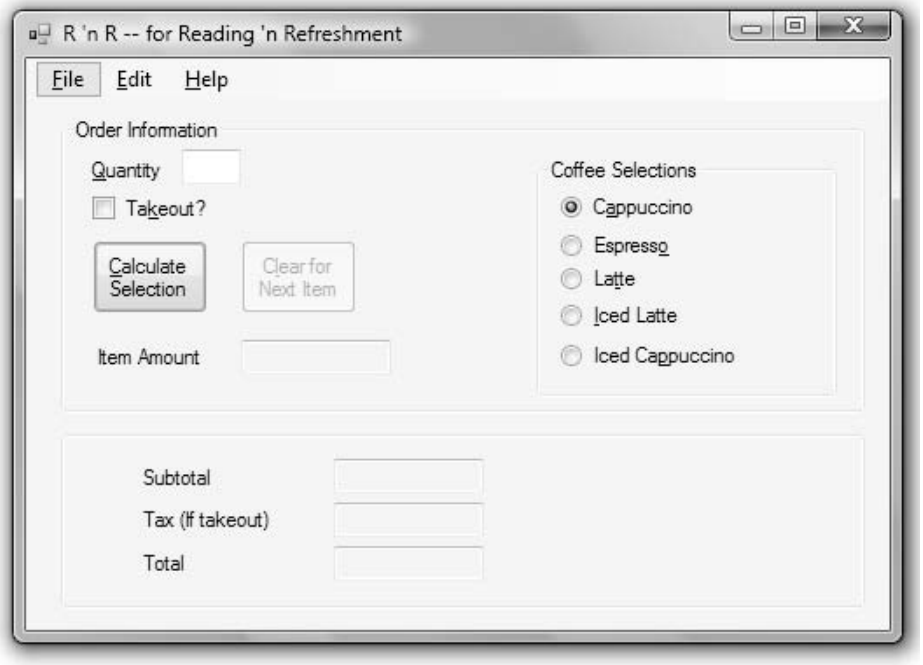
SummaryToolStripMenuItem	Click	If current order not added to totals
		  Call NewOrderToolStripMenuItem_Click.
		If the customer count > 0
		  Calculate the average.
		  Display the summary totals in a message box.

ExitToolStripMenuItem	Click	Terminate the project.
CalculateSelectionToolStripMenuItem	Click	Share the event procedure for CalculateButton.
ClearItemToolStripMenuItem	Click	Share the event procedure for ClearButton.
AboutToolStripMenuItem	Click	Display the About message box.
FontToolStripMenuItem	Click	Allow user to change fonts.
ColorToolStripMenuItem	Click	Allow user to change colors.
(Function procedure)	FindTax	Calculate the sales tax.

Write the Project Follow the sketch in Figure 5.21 to create the form. Figure 5.22 shows the completed form.

- If you are basing your project on the project from Chapter 4, first copy the project folder, as described in the section "Basing a New Project on an Existing Project."
- Set the properties of each object according to your plan. If you are modifying the project from Chapter 4, add the menus and the common dialog components and remove the extra buttons.
- Write the code. Working from the pseudocode, write each event procedure.
- When you complete the code, use a variety of data to thoroughly test the project.

Figure 5.22



The form for the hands-on programming example.

The Project Coding Solution

```
'Program Name   Ch05HandsOn
'Programmer:    Bradley/Millspaugh
'Date:          June 2008
'Description:   This project calculates the amount due
'               based on the customer selection
'               and accumulates summary data for the day.
'               Incorporates menus and common dialog boxes,
'               which allow the user to change the font and
'               color of text boxes.
'Folder:        Ch05HandsOn

Public Class BillingForm

  ' Declare module-level variables for summary information.
  Private SubtotalDecimal, TotalDecimal, GrandTotalDecimal As Decimal
  Private CustomerCountInteger As Integer

  ' Declare constants.
  Const TAX_RATE_Decimal As Decimal = 0.08D
  Const CAPPUCCINO_PRICE_Decimal As Decimal = 2D
  Const ESPRESSO_PRICE_Decimal As Decimal = 2.25D
  Const LATTE_PRICE_Decimal As Decimal = 1.75D
  Const ICED_PRICE_Decimal As Decimal = 2.5D
```

```
Private Sub CalculateButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) _
  Handles CalculateButton.Click, CalculateSelectionToolStripMenuItem.Click
    ' Calculate and display the current amounts and add to totals.
    Dim PriceDecimal, TaxDecimal, ItemAmountDecimal As Decimal
    Dim QuantityInteger As Integer

    ' Find the price.
    If CappuccinoRadioButton.Checked Then
        PriceDecimal = CAPPUCCINO_PRICE_Decimal
    ElseIf EspressoRadioButton.Checked Then
        PriceDecimal = ESPRESSO_PRICE_Decimal
    ElseIf LatteRadioButton.Checked Then
        PriceDecimal = LATTE_PRICE_Decimal
    ElseIf IcedCappuccinoRadioButton.Checked Or _
        IcedLatteRadioButton.Checked Then
      PriceDecimal = ICED_PRICE_Decimal
    End If

    ' Calculate the extended price and add to order total.
    Try
      QuantityInteger = Integer.Parse(QuantityTextBox.Text)
      ItemAmountDecimal = PriceDecimal * QuantityInteger
      SubtotalDecimal += ItemAmountDecimal
      If TaxCheckBox.Checked Then
          ' Call a function procedure.
          TaxDecimal = FindTax(SubtotalDecimal)
      Else
          TaxDecimal = 0
      End If
      TotalDecimal = SubtotalDecimal + TaxDecimal
      ItemAmountTextBox.Text = ItemAmountDecimal.ToString("C")
      SubTotalTextBox.Text = SubtotalDecimal.ToString("N")
      TaxTextBox.Text = TaxDecimal.ToString("N")
      TotalTextBox.Text = TotalDecimal.ToString("C")
      ' Allow change for new order only.
      TaxCheckBox.Enabled = False
      ' Allow Clear after an order is begun.
      ClearButton.Enabled = True
      ClearItemToolStripMenuItem.Enabled = True
      NewOrderToolStripMenuItem.Enabled = True
    Catch QuantityException As FormatException
      MessageBox.Show("Quantity must be numeric.", "Data entry error", _
        MessageBoxButtons.OK, MessageBoxIcon.Information)
      With QuantityTextBox
        .Focus()
        .SelectAll()
      End With
    End Try
End Sub

Private Function FindTax(ByVal AmountDecimal As Decimal) As Decimal
    ' Calculate the sales tax.

    Return AmountDecimal * TAX_RATE_Decimal
End Function
```

```
Private Sub ClearButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) _
  Handles ClearButton.Click, ClearItemToolStripMenuItem.Click
    ' Clear the appropriate controls.

    CappuccinoRadioButton.Checked = True
    ItemAmountTextBox.Clear()
    With QuantityTextBox
        .Clear()
        .Focus()
    End With
End Sub

Private Sub NewOrderToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles NewOrderToolStripMenuItem.Click
    ' Clear the current order and add to the totals.
    Dim ResponseDialogResult As DialogResult
    Dim MessageString As String

    ' Confirm clear of the current order.
    MessageString = "Clear the current order figures?"
    ResponseDialogResult = MessageBox.Show(MessageString, "Clear Order", _
      MessageBoxButtons.YesNo, MessageBoxIcon.Question, _
      MessageBoxDefaultButton.Button2)

    If ResponseDialogResult = System.Windows.Forms.DialogResult.Yes Then
      ' User said Yes; clear the screen fields.
      ClearButton_Click(sender, e)
      SubTotalTextBox.Text = ""
      TaxTextBox.Text = ""
      TotalTextBox.Text = ""

      ' Add to the totals only if not a new order/customer.
      If SubtotalDecimal <> 0 Then
          GrandTotalDecimal += TotalDecimal
          CustomerCountInteger += 1
          ' Reset totals for the next customer.
          SubtotalDecimal = 0
          TotalDecimal = 0
      End If

      ' Clear the appropriate display items and enable the check box.
      With TaxCheckBox
          .Enabled = True
          .Checked = False
      End With
      ClearButton.Enabled = False
      ClearItemToolStripMenuItem.Enabled = False
      NewOrderToolStripMenuItem.Enabled = False
    End If
End Sub

Private Sub SummaryToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles SummaryToolStripMenuItem.Click
    ' Calculate the average and display the totals.
    Dim AverageDecimal As Decimal
    Dim MessageString As String
```

```
    If TotalDecimal <> 0 Then
      ' Make sure the last order is counted.
      NewOrderToolStripMenuItem_Click(sender, e)
      ' Pass incoming arguments to the called procedure.
    End If

    If CustomerCountInteger > 0 Then
        ' Calculate the average.
        AverageDecimal = GrandTotalDecimal / CustomerCountInteger

        ' Concatenate the message string.
        MessageString = "Number of Orders: " _
          & CustomerCountInteger.ToString() _
          & Environment.NewLine & Environment.NewLine _
          & "Total Sales: " & GrandTotalDecimal.ToString("C") _
          & Environment.NewLine & Environment.NewLine _
          & "Average Sale: " & AverageDecimal.ToString("C")
        MessageBox.Show(MessageString, "Coffee Sales Summary", _
          MessageBoxButtons.OK, MessageBoxIcon.Information)
    Else
        MessageString = "No sales data to summarize."
        MessageBox.Show(MessageString, "Coffee Sales Summary", _
          MessageBoxButtons.OK, MessageBoxIcon.Information)
    End If
End Sub

Private Sub ExitToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles ExitToolStripMenuItem.Click
    ' Terminate the project.

    Me.Close()
End Sub

Private Sub AboutToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles AboutToolStripMenuItem.Click
    ' Display the About message box.
    Dim MessageString As String

    MessageString = "R 'n R Billing" & Environment.NewLine _
      & Environment.NewLine & "Programmed by Bradley and Millspaugh"
    MessageBox.Show(MessageString, "About R 'n R Billing", MessageBoxButtons.OK, _
      MessageBoxIcon.Information)
End Sub

Private Sub FontToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles FontToolStripMenuItem.Click
    ' Allow the user to select a new font for the summary totals.

    With FontDialog1
        .Font = SubTotalTextBox.Font
        .ShowDialog()
        SubTotalTextBox.Font = .Font
        TaxTextBox.Font = .Font
        TotalTextBox.Font = .Font
    End With
End Sub
```

```
  Private Sub ColorToolStripMenuItem_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles ColorToolStripMenuItem.Click
      ' Allow the user to select a new color for the summary totals.

      With ColorDialog1
          .Color = SubTotalTextBox.ForeColor
          .ShowDialog()
          SubTotalTextBox.ForeColor = .Color
          TaxTextBox.ForeColor = .Color
          TotalTextBox.ForeColor = .Color
      End With
  End Sub
End Class
```

Summary

1. The Visual Studio Menu Designer enables you to create menus by using MenuStrips, which contain ToolStrip menu items that can have keyboard access keys.
2. In the Menu Designer you can set and modify the order and level of menu items.
3. You can modify menu items in the MenuStrip's Items Collection Editor.
4. A menu item can have a second list of choices, which is called a submenu.
5. Menu items can be disabled by setting the Enabled property = False and can be made to appear with a check mark by setting the Checked property = True.
6. Menus should follow Windows standards, use standard keyboard shortcuts, and include ellipsis if further choices will be offered.
7. Each menu item has a Click event. The code to handle the actions of a menu item belongs in the item's Click event procedure.
8. Common dialog boxes allow Visual Basic programs to display the predefined Windows dialog boxes for *Color*, *Font*, *Open File*, *Save File* and *FolderBrowser*. These dialog boxes are part of the operating environment; therefore, it is an unnecessary duplication of effort to have each programmer create them again.
9. Context menus, or shortcut menus, are created using a ContextMenuStrip component and the Menu Designer. Context menus pop up when the user right-clicks.
10. The programmer can write reusable code in general procedures. These procedures may be sub procedures or function procedures and may be called from any other procedure in the form module.
11. Both sub procedures and function procedures can perform an action. However, function procedures return a value and sub procedures do not. The value returned by a function procedure has a data type.
12. Arguments can be passed `ByRef` or `ByVal` (the default). `ByRef` passes a reference to the actual data item; `ByVal` passes a copy of the data.
13. A function procedure must return a value, which can be accomplished using the `Return` statement or by setting the name of the function to the result.

Key Terms

`ByRef` *231*
`ByVal` *231*
`Call` (procedure call) *230*
checked *221*
Checked property *221*
common dialog *223*
context menu *226*
ContextMenuStrip component *226*
disabled *220*
Enabled property *220*
function procedure *229*
general procedure *229*
menu *214*
Menu Designer *214*
MenuStrip component *214*
method *229*
modal *224*
modeless *224*
return value *229*
separator bar *218*
shortcut menu *226*
`ShowDialog` method *223*
sub procedure *229*
submenu *218*

Review Questions

1. Explain the difference between a menu and a submenu.
2. How can the user know if a menu item contains a submenu?
3. What is a separator bar and how is it created?
4. Name at least three types of common dialog boxes.
5. What is a context menu? How would you attach a context menu to a control?
6. Why would you need procedures that are not attached to an event?
7. Code the necessary statements to produce a color dialog box and use it to change the background color of a label.
8. Explain the difference between a sub procedure and a function procedure.
9. What is a return value? How can it be used?
10. Explain the differences between `ByRef` and `ByVal`. When would each be used?

Programming Exercises

5.1 Modify Programming Exercise 4.6 (piecework pay) to replace buttons with menus and add a function procedure.

This project will input the number of pieces and calculate the pay for multiple employees. It also must display a summary of the total number of pieces, the number of workers, the total pay, and the average pay for all employees.

Menu: The menu bar must have these items:

```
File                Edit              Help
 Calculate Pay       Clear             About
 Summary
 Exit                _______
                     Font...
                     Color...
```

Piecework workers are paid by the piece. Workers who produce a greater quantity of output may be paid at a higher rate.

Use text boxes to obtain the name and the number of pieces completed. The *Calculate Pay* menu item calculates and displays the dollar amount earned. The *Summary* menu item displays the total number of pieces, the total pay, and the average pay per person in a message box. The *Clear* menu choice clears the name and the number of pieces for the current employee and resets the focus.

The *Color* and *Font* items should change the color and font of the information displayed in the Amount Earned control.

Use a message box to display the program name and your name for the *About* option on the *Help* menu.

Write a function procedure to find the pay rate and return a value to the proper event procedure.

Pieces Completed	Price Paid per Piece for All Pieces
1 to 199	.50
200 to 399	.55
400 to 599	.60
600 or more	.65

Note: For help in basing a new project on an existing project, see "Basing a New Project on an Existing Project" in this chapter.

5.2 Redo the checking account programming exercises from Chapter 4 (4.3, 4.4, and 4.5) using menus and sub procedures.

Menu:

```
File              Edit            Help
 Transaction       Clear           About
 Summary           ________
 Print             Font...
 _________         Color...
 Exit
```

Form: Use radio buttons to indicate the type of transaction—deposit, check, or service charge. Use a text box to allow the user to enter the amount of the transaction. Display the balance in a ReadOnly text box or a label.

Include validation that displays a message box if the amount of the transaction is a negative number. If there is not enough money to cover a check, display a message box with the message "Insufficient Funds." Do not pay the check, but deduct a service charge of $10.

Write function procedures for processing deposits, checks, and service charges. The deposit function adds the deposit to the balance; the check function subtracts the transaction amount from the balance; the service charge function subtracts the transaction amount from the balance. Each of the functions must return the updated balance.

The *Summary* menu item displays the total number of deposits and the dollar amount of deposits, the number of checks, and the dollar amount of the checks in a message box.

The *Clear* menu item clears the radio buttons and the amount and resets the focus.

The *Color* and *Font* menu items change the color and font of the balance.

Use a message box to display the program name and your name as the programmer for the *About* option on the *Help* menu.

Note: For help in basing a new project on an existing project, see "Basing a New Project on an Existing Project" in this chapter.

5.3 A salesperson earns a weekly base salary plus a commission when sales are at or above quota. Create a project that allows the user to input the weekly sales and the salesperson name, calculates the commission, and displays summary information.

Form: The form should have text boxes for the salesperson's name and his or her weekly sales.

Menu:

```
File              Edit              Help
  Pay               Clear             About
  Summary           ________
  Exit              Font...
                    Color...
```

Use constants to establish the base pay, the quota, and the commission rate.

The *Pay* menu item calculates and displays the commission and the total pay for that person. However, if there is no commission, do not display the commission amount (do not display a zero-commission amount).

Write a function procedure to calculate the commission. The function must compare sales to the quota. When the sales are equal to or greater than the quota, calculate the commission by multiplying sales by the commission rate.

Each salesperson receives the base pay plus the commission (if one has been earned). Format the dollar amounts to two decimal places; do not display a dollar sign.

The *Summary* menu item displays a message box that holds total sales, total commissions, and total pay for all salespersons. Display the numbers with two decimal places and dollar signs.

The *Clear* menu item clears the name, sales, and pay for the current employee and then resets the focus.

The *Color* and *Font* menu items should change the color and font of the information displayed in the total pay text box.

Use a message box to display the program name and your name as programmer for the *About* option on the *Help* menu.

Test Data: Quota = 1000; Commission rate = .15; and Base pay = $250.

Name	Sales
Sandy Smug	1,000.00
Sam Sadness	999.99
Joe Whiz	2,000.00

Totals should be

Sales	$3,999.99
Commissions	450.00
Pay	1,200.00

5.4 The local library has a summer reading program to encourage reading. The staff keeps a chart with readers' names and bonus points earned. Create a project using a menu and a function procedure that determines and returns the bonus points.
Menu:

```
File            Edit            Help
 Points          Clear           About
 Summary
 Exit            ________
                 Font...
                 Color...
```

Form: Use text boxes to obtain the reader's name and the number of books read. Use a ReadOnly text box or a label to display the number of bonus points.

The *Points* menu item should call a function procedure to calculate the points using this schedule: The first three books are worth 10 points each. The next three books are worth 15 points each. All books over six are worth 20 points each.

The *Summary* menu item displays the average number of books read for all readers that session.

The *Clear* menu item clears the name, the number of books read, and the bonus points and then resets the focus.

The *Color* and *Font* menu items change the color and font of the bonus points.

Use a message box to display the program name and your name as programmer for the *About* option on the *Help* menu.

5.5 Modify Programming Exercise 2.2 (the flag viewer) to use a menu instead of radio buttons, check boxes, and buttons. Include check marks next to the name of the currently selected country and next to the selected display options.
Menu:

```
File          Country              Display     Help
 Exit          United States        Title         About
               Canada               Country Name
               Japan                Programmer
               Mexico
```

Note: For help in basing a new project on an existing project, see "Basing a New Project on an Existing Project" in this chapter.

Case Studies

VB Mail Order

Modify the case study project from Chapter 4 to use menus and a function procedure. Refer to Chapter 4 for project specifications.

Write a function procedure to calculate and return the shipping and handling based on the weight for an entire order. (Do not calculate shipping and handling on individual items—wait until the order is complete.)

Apply the user's font and color changes to the Total Due, or another control of your choice.

Menu:

```
File                Edit                Help
 Update Summary      Add This Item       About
 Print               Clear
 ________            ________
 Exit                Font...
                     Color...
```

Note: For help in basing a new project on an existing project, see "Basing a New Project on an Existing Project" in this chapter.

VB Auto Center

Modify the case study project from Chapter 4 to use menus and a function procedure. Refer to Chapter 4 for project specifications.

Write a function procedure to calculate and return the sales tax.

Apply the user's font and color changes to the Amount Due, or other control of your choice.

Menu:

```
File            Edit                Help
 Exit            Calculate           About
                 Clear
                 ________
                 Font...
                 Color...
```

Consider adding keyboard shortcuts to the menu commands.

Note: For help in basing a new project on an existing project, see "Basing a New Project on an Existing Project" in this chapter.

Video Bonanza

Modify the case study project from Chapter 4 to use menus and a function procedure. Refer to Chapter 4 for project specifications.

Use a function procedure to calculate the rental fee based on the type of video.

The *Help* menu *About* option should display a message box with information about the program and the programmer. The *Color* option should change the background color of the form; the font changes can change the control of your choice.

Menu:

```
File          Edit                      Help
 Summary       Calculate                 About
 Print         Clear for Next Item
 _________     Order Complete
 Exit          ____________________
               Color...
               Font...
```

Optional extra: Set keyboard shortcuts for the menu commands.

Note: For help in basing a new project on an existing project, see "Basing a New Project on an Existing Project" in this chapter.

Very Very Boards

Modify your case study project from Chapter 4 to add a menu and a function procedure. Refer to Chapter 4 for the project specifications.

Write a function procedure to calculate and return the price of shirts; display the About box in a message box.

Allow the user to change the font size and font color of the label that displays the company slogan.

Include keyboard shortcuts for the menu commands.

Menu:

```
File       Sale               Display     Help
 Summary    Add to Order       Font...      About
 _______    Clear This Item    Color...
 Exit       Order Complete     _______
                               Slogan
                               Logo
```

The Slogan and Logo: Make up a slogan for the company, such as "We're Number One" or "The Best in Boards." The logo should be a graphic; you can use an icon, any graphic you have available, or a graphic you create yourself with a draw or paint program.

The *Slogan* and *Logo* menu choices must toggle and display a check mark when selected. For example, when the slogan is displayed, the *Slogan* menu command is checked. If the user selects the *Slogan* command again, hide the slogan and uncheck the menu command. The *Slogan* and *Logo* commands operate independently; that is, the user may select either, both, or neither item.

When the project begins, the slogan and logo must both be displayed and their menu commands appear checked.

Note: For help in basing a new project on an existing project, see "Basing a New Project on an Existing Project" in this chapter.

CHAPTER

6

Multiform Projects

at the completion of this chapter, you will be able to . . .

1. Include multiple forms in an application.
2. Use templates to create splash screens and About boxes.
3. Use the `Show`, `ShowDialog`, and `Hide` methods to display and hide forms.
4. Understand the various form events and select the best procedure for your code.
5. Declare variables with the correct scope and access level for multiform projects.

Using Multiple Forms

All the projects that you have created up to now have operated from a single form. It has probably occurred to you that the project could appear more professional if you could use different windows for different types of information. Consider the example in Chapter 5 in which summary information is displayed in a message box when the user presses the *Summary* button. You have very little control over the appearance of the message box. The summary information could be displayed in a much nicer format in a new window with identifying labels. Another window in Visual Basic is actually another form.

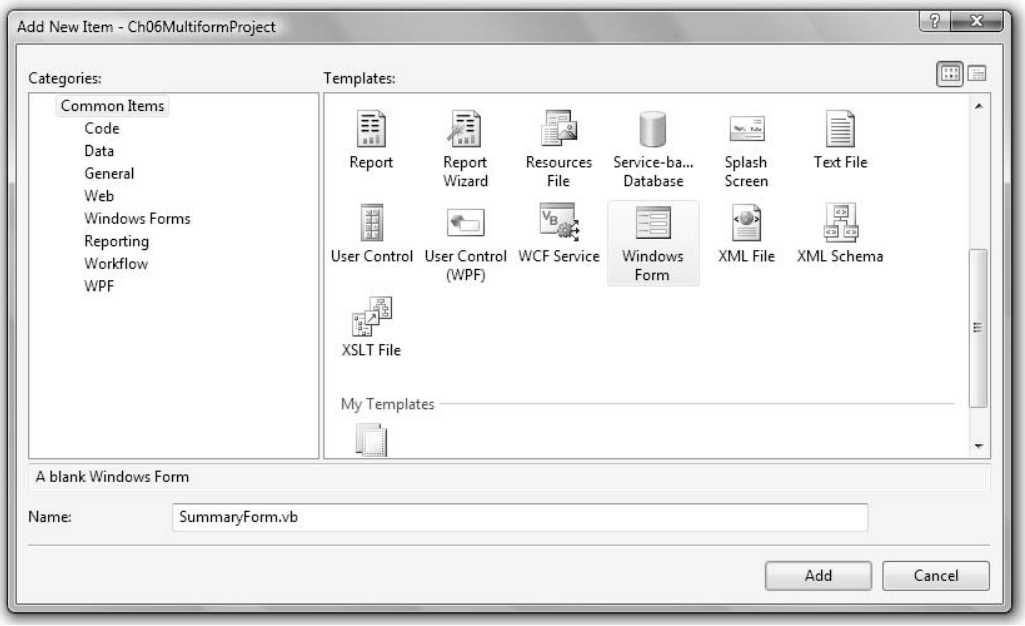
The first form a project displays is called the ***startup form***. You can add more forms to the project and display them as needed. A project can have as many forms as you wish.

Creating New Forms

To add a new form to a project, select *Add Windows Form* from the *Project* menu. The *Add New Item* dialog box appears (Figure 6.1), in which you can select from many installed templates. You will learn about some of the other form types later in the chapter. For now, choose *Windows Form* to add a regular new form.

Figure 6.1

Select the Windows Form template to add a new form to a project. Your dialog box may have more or fewer item templates, depending on the version of VB you are using.



Adding a New Form to a Project

You can add a new form to a project by following these steps:

STEP 1: Select *Add Windows Form* from the *Project* menu.

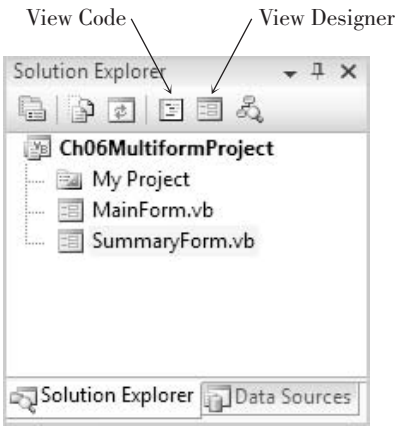
STEP 2: In the *Add New Item* dialog box select *Windows Form* from the template list.

STEP 3: Enter a name for the new form and click on *Add*.

The new form will display on the screen and be added to the Solution Explorer window (Figure 6.2).

Figure 6.2

After adding a new form, the Solution Explorer shows the filename of the new form.



While in design time, you can switch between forms in several ways. In the Solution Explorer window, you can select a form name and click the *View Designer* button or the *View Code* button. Double-clicking a form name opens the form in the designer. But the easiest way to switch between forms is to use the tabs at the top of the Document window that appear after the form has been displayed (Figure 6.3). If there isn't room to display tabs for all open documents, you can click the *Active Files* button to drop down a list and make a selection (Figure 6.4).

Figure 6.3

Click on the tabs at the top of the Document window to switch among the Form Designer and Editor windows.

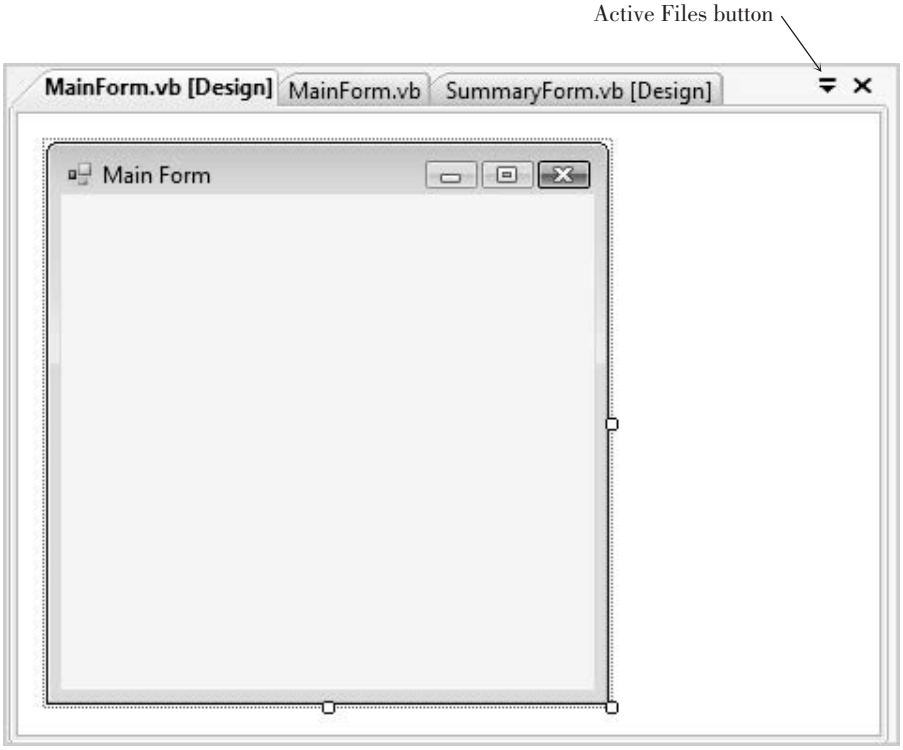
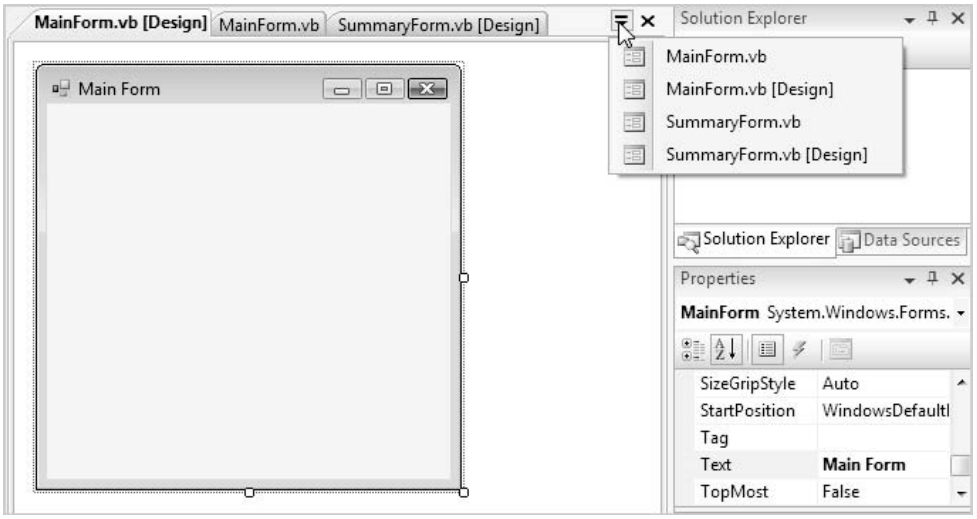


Figure 6.4

You can drop down the list of available windows and select a form to which to switch.



Each form is a separate file and a separate class. Later in this chapter you will learn to display and hide each of the forms in a project.

Adding and Removing Forms

The Solution Explorer window shows the files that are included in a project. You can add new files and remove files from a project.

Adding Existing Form Files to a Project

Forms may be used in more than one project. You might want to use a form that you created for one project in a new project.

Each form is saved as three separate files. All of the information for the form resides in the files, which includes the code procedures and the visual interface as well as all property settings for the controls.

To add an existing form to a project, use the *Add Existing Item* command on the *Project* menu and navigate to the form file to be added. You select only one filename: FormName.vb; all three files are automatically copied into the project folder.

You can add an existing form to a project by following these steps:

STEP 1: Select *Add Existing Item* from the *Project* menu.
STEP 2: In the *Add Existing Item* dialog box, locate the folder and file desired.
STEP 3: Click on *Add*.

Removing Forms from a Project

If you want to remove a file from a project, select its name in the Solution Explorer window. You can then either click the Delete key or right-click on the filename to display the context menu and choose *Delete*. You also can choose *Exclude from project* to remove the form from the project but not delete the files.

TIP

Use the Ctrl + F6 key combination to toggle between the *Form Designer Window* tab and the *Form Code* tab. Use Ctrl + Tab to cycle through all open files and IDE windows: while holding Ctrl, press Tab multiple times; when you reach the item you want, release the Ctrl key. ■

An About Box

One popular type of form in a project is an **About box**, such as the one you find in most Windows programs under *Help / About*. Usually an About box gives the name and version of the program as well as information about the programmer or company.

You can create your own About box by creating a new form and entering the information in labels. Of course, you may use any of the Windows controls on this new form, but About boxes typically hold labels and perhaps a picture box for a logo. Figure 6.5 shows a typical About box.

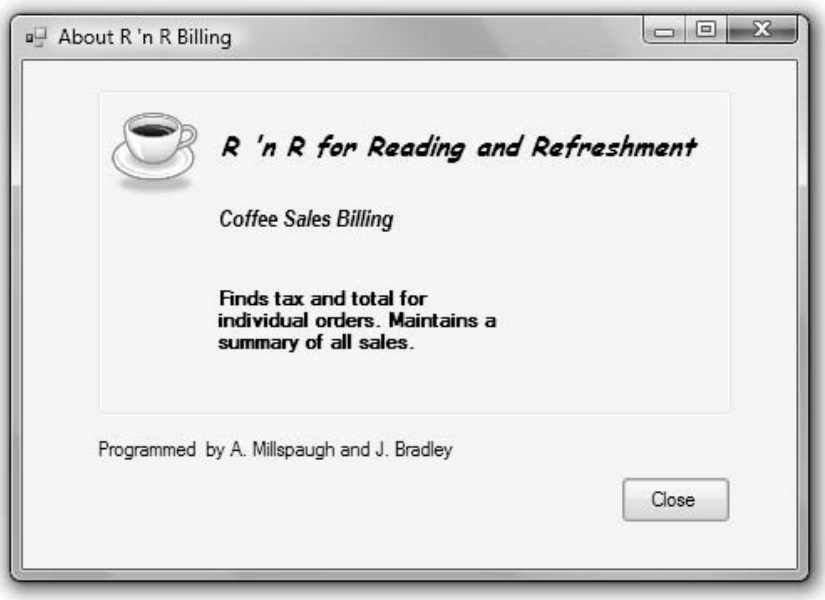


Figure 6.5

A typical About box that contains labels, a group box, a picture box, and a button.

Using the About Box Template

You also can use Visual Studio's About Box template to create a new About box. Choose *Add Windows Form* from the *Project* menu and select *About Box* (Figure 6.6). A new form named AboutBox1 is added to your project (Figure 6.7) with controls you can modify. You can change the captions and image by setting the properties as you would on any other form. Once you create the form in your project, it is yours and may be modified as you please.

Setting Assembly Information

Notice in Figure 6.7 that the About Box template form includes the product name, version, copyright, company name, and description. You can manually set the Text properties of the controls, but there's a better way that provides this information for the entire project. Open the Project Designer (Figure 6.8) from *Project / ProjectName Properties* or double-click *My Project* in the Solution

Figure 6.6

Select the About Box template to add a preformatted About Box form to a project.

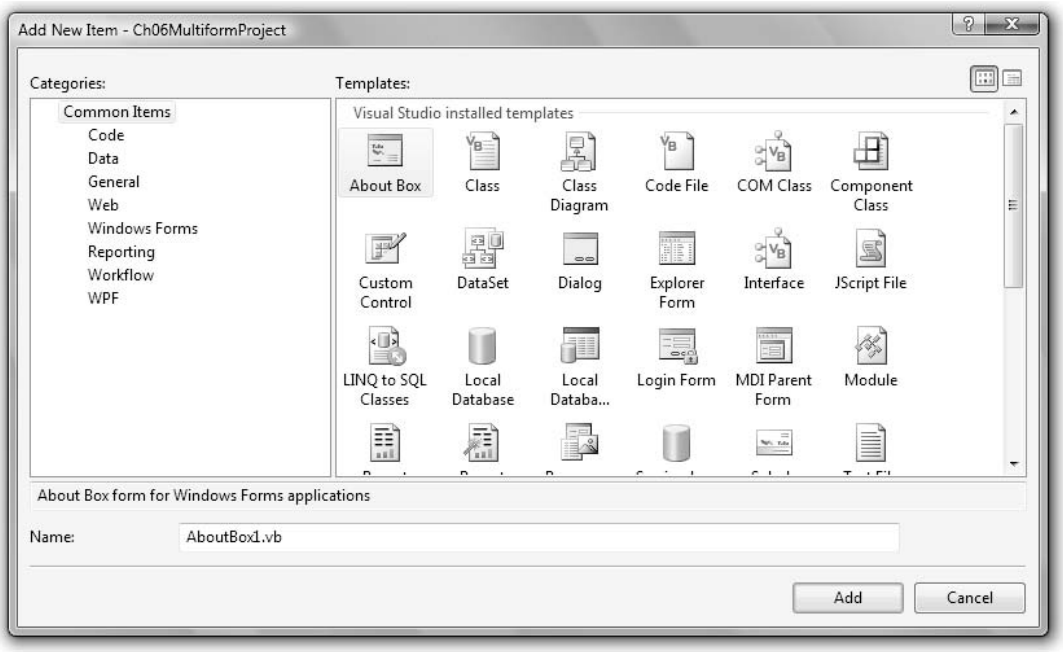
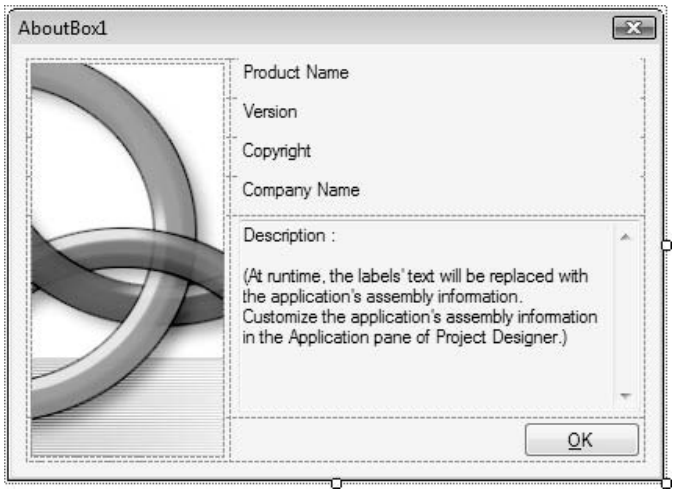


Figure 6.7

A new form created with the About Box template. You can customize the form by setting properties of the controls, adding controls, or removing controls.



Explorer. Click on the *Assembly Information* button and fill in the desired information in the *Assembly Information* dialog box (Figure 6.9).

Once the information is entered into the *Assembly Information*, you can retrieve it by using the My.Application object. The following code is automatically included in the AboutBox form's code:

```
Me.LabelProductName.Text = My.Application.Info.ProductName
Me.LabelVersion.Text = String.Format("Version {0}", _
  My.Application.Info.Version.ToString)
Me.LabelCopyright.Text = My.Application.Info.Copyright
Me.LabelCompanyName.Text = My.Application.Info.CompanyName
Me.TextBoxDescription.Text = My.Application.Info.Description
```

Typically you find much of this same information on the application's splash screen.

Figure 6.8

Open the Project Designer and click on the Assembly Information *button to display the project's assembly information.*

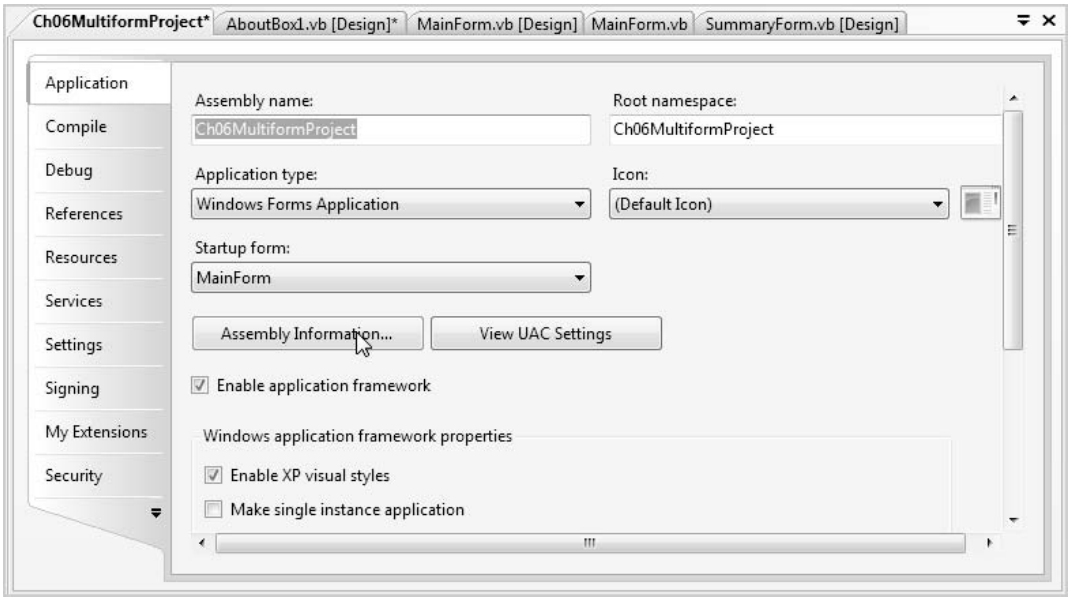
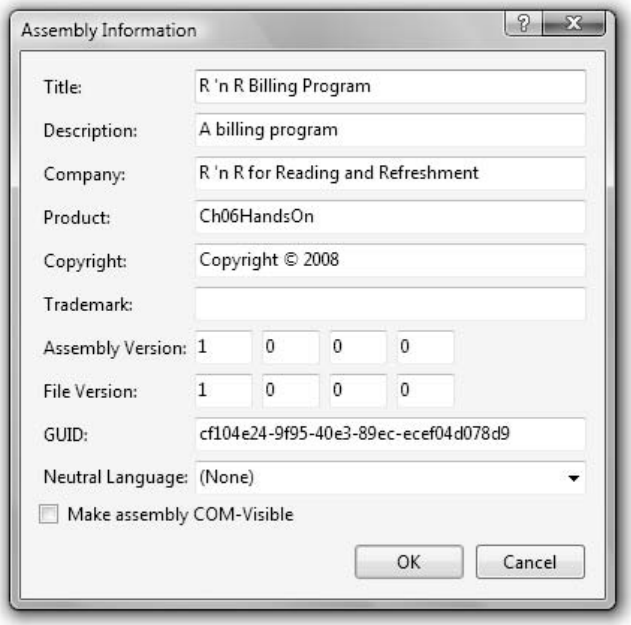


Figure 6.9

Enter or modify the project's information on the Assembly Information *dialog box.*



A Splash Screen

Perhaps you have noticed the logo or window that often appears while a program is loading, such as the one in Figure 6.10. This initial form is called a **splash screen**. Professional applications use splash screens to tell the user that the program is loading and starting. It can make a large application appear to load and run faster, since something appears on the screen while the rest of the application loads.

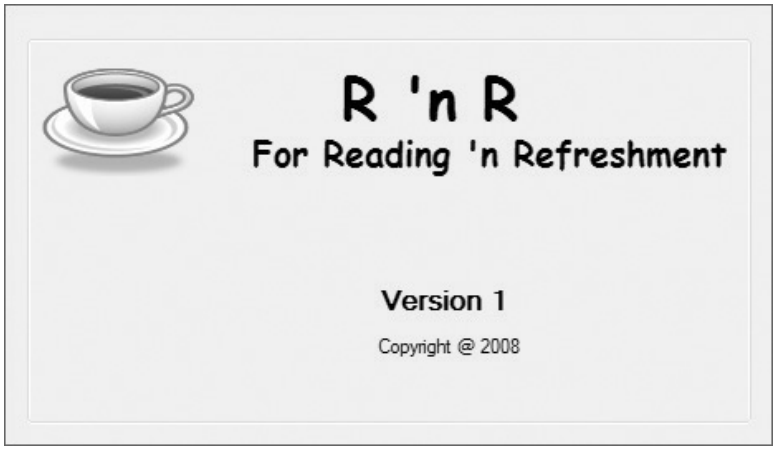


Figure 6.10

A custom splash screen created from a standard Windows form.

Using the Splash Screen Template

You can create your own splash screen or use the splash screen template included with Visual Studio (Figure 6.11). Select *Project / Add New Item* to display the *Add New Item* dialog box (refer to Figure 6.6). Choose *Splash Screen* to add

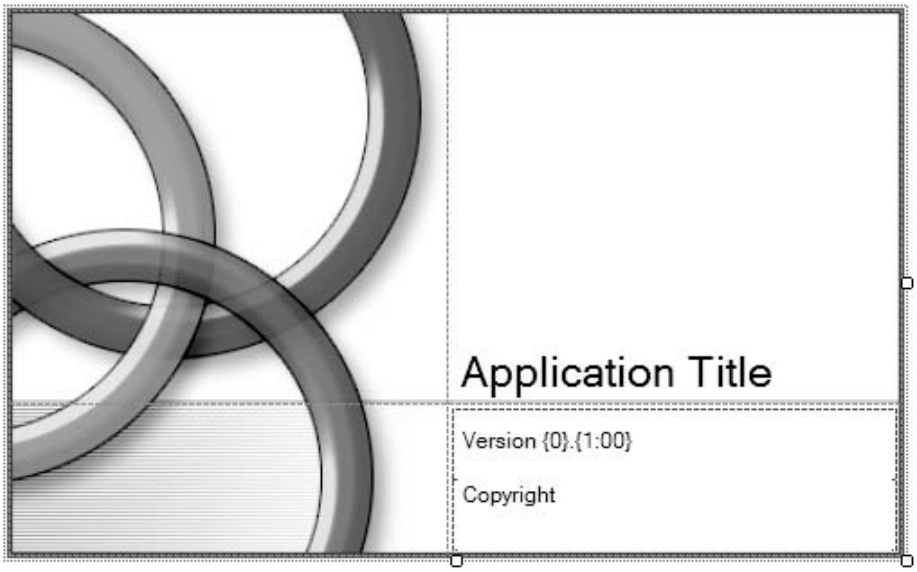


Figure 6.11

A splash form created using the Splash Screen template. You can customize the form as much as you wish.

the new form; then modify the form to fit your needs. You may want to make modifications to the labels and to the code.

The predefined code in the splash screen template may be more complicated than you need. It includes code to fill in the application title, version, and copyright information from the project's assembly information (refer to "Setting Assembly Information" in the preceding section for the About box). You can either set the assembly information or modify the labels to display the text that you want.

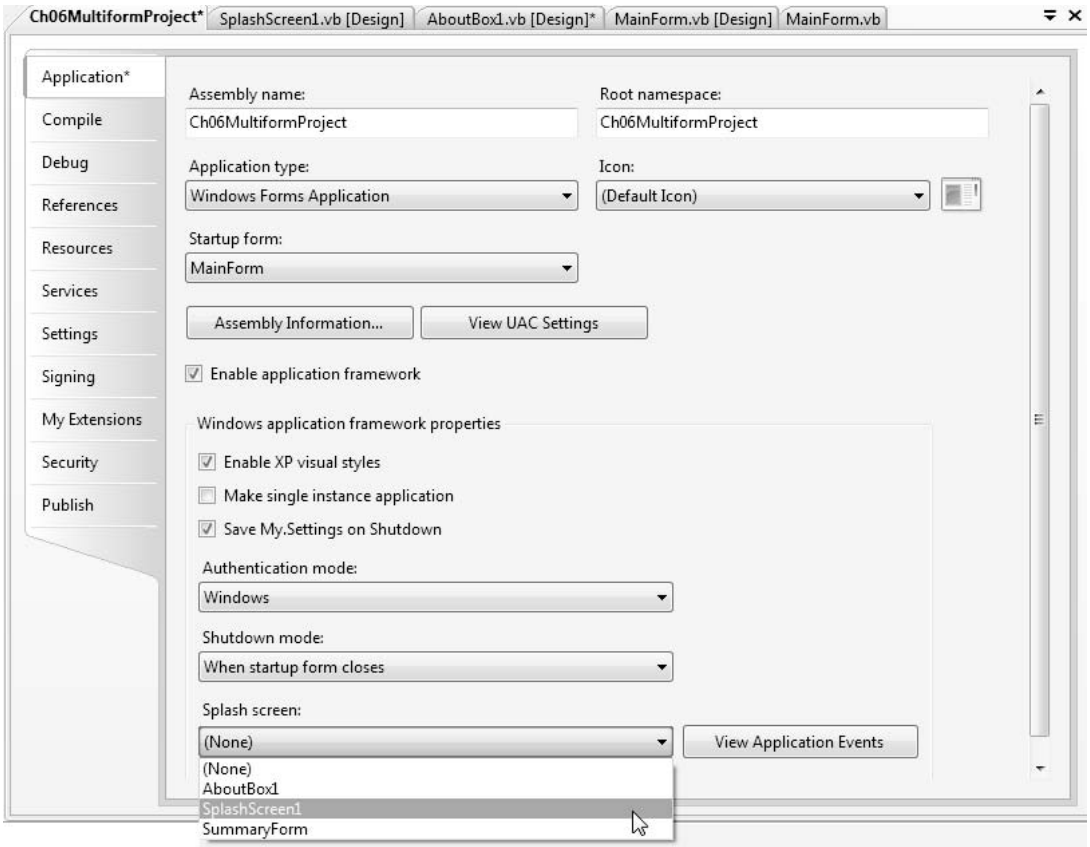
Making the Splash Form Display First

Whether you create your own splash screen or use the VB template, you must take one more step to make the splash screen appear before the startup form. Display the Project Designer either by selecting *ProjectName Properties* from the *Project* menu or by double-clicking the *My Project* item in the Solution Explorer. Set the *Splash screen* drop-down list to your splash screen (Figure 6.12). Do not change the setting for *Startup form* or *Shutdown mode*, which would require coding techniques that go beyond the scope of this chapter.

When you run the project, the splash screen should display while the startup form is loading and then disappear. For small applications like the ones you are writing, the startup form loads so quickly that it is nearly impossible to see the splash screen. Later in this chapter, in the section "Holding the Splash

Figure 6.12

Set the Splash screen drop-down list to your new form in the Project Designer.



Screen Display," you will see a technique to force the splash screen to display long enough to read its contents.

Other Template Forms

Take a look at the other templates in the *Add New Item* dialog. Some others that you might find of interest are the Login Form and the Explorer Form. Note that the templates vary depending on the version of Visual Studio. The Express Edition has the fewest templates.

Using the Methods and Events of Forms

In code, you can use several methods to show, hide, and close forms.

Showing a Form

You generally display a new form in response to a user clicking a button or a menu item. In the event procedure for the button or menu item, you can use either the `Show` method or the `ShowDialog` method to display the new form.

Modal versus Modeless Forms

The **`Show` method** displays a form as **modeless**, which means that both forms are open and the user can navigate from one form to the other. When you use the **`ShowDialog` method**, the new form displays as **modal**; the user must respond to the form in some way, usually by clicking a button. No other program code can execute until the user responds to and hides or closes the modal form. However, if you display a modeless form, the user may switch to another form in the project without responding to the form.

Note: Even with a modal form, the user can switch to another application within Windows.

The Show Method—General Form

General Form

```
FormName.Show()
```

The `Show` method displays the named form modelessly.

The Show Method—Example

Example

```
SummaryForm.Show()
```

The ShowDialog Method—General Form

General Form

```
FormName.ShowDialog()
```

Use the ShowDialog method when you want the user to notice, respond to, and close the form before proceeding with the application.

The ShowDialog Method—Example

Example

```
SummaryForm.ShowDialog()
```

You generally place this code in a menu item or a button's click event procedure:

```
Private Sub SummaryButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles SummaryButton.Click
    ' Show the summary form.

    SummaryForm.ShowDialog()
End Sub
```

VB automatically creates a form object for each of the form classes that you create. You can show, hide, and close forms without explicitly declaring a new object. This default form object is not actually instantiated until you access one of the form's objects (such as a text box) or a form method (such as the Show method). You also can declare and instantiate a new form object like this:

```
Dim NewSummaryForm as New SummaryForm
NewSummaryForm.ShowDialog()
```

Hiding or Closing a Form

You already know how to close the current form: Me.Close(). You also can use the Close method to close any other form: SummaryForm.Close().

The Close method behaves differently for a modeless form (using the Show method) compared to a modal form (using the ShowDialog method). For a modeless form, Close destroys the form instance and removes it from memory; for a modal form, the form is only hidden. A second ShowDialog method displays the same form instance, which can have data left from the previous time the form was displayed. In contrast, a second Show method creates a new instance, so no leftover data can appear.

You also can choose to use a form's **Hide method**, which sets the form's Visible property to False and keeps the form instance in memory.

The Hide Method—General Form

General Form

```
FormName.Hide()
```

Hiding conceals a form but keeps it in memory, ready to be redisplayed. Use the Hide method rather than Close when the user is likely to display the form again. A good example might be a form with instructions or Help text, which the user may display multiple times.

The Hide Method—Example

Example

```
SummaryForm.Hide()
```

Responding to Form Events

The two primary events for which you may need to write code are the *FormName*.Load and *FormName*.Activated. The first time a form is shown in an application, the form generates both the Load and Activated events. The Load event occurs when the form is loaded into memory; the Activated event occurs after the Load event, just as control is passed to the form. Each subsequent time the form is shown, the Activated event occurs, but the Load event does not. Therefore, if a form may be displayed multiple times, you may want to place initializing steps into the Activated event procedure rather than into the Load. Also, if you wish to set the focus in a particular place on the new form, place the `Focus` method in the FormName_Activated procedure.

The Sequence of Form Events

Although you don't need to write event procedures for all of these form events, it's helpful to know the order in which they occur:

Load	Occurs before the form is displayed for the first time. Happens only once for any one form unless the form is closed rather than hidden.
Activated	Occurs each time the form is shown. This event procedure is the correct location for initialization or `Focus`.
Paint	Occurs each time any portion of the form is redrawn, which happens each time a change is made or the form is moved or uncovered.
Deactivate	Occurs when the form is no longer the active form, such as when the user clicks on another window or the form is about to be hidden or closed.
FormClosing	Occurs as the form is about to close.
FormClosed	Occurs after the form is closed.

Writing Event Procedures for Selected Events

You are accustomed to double-clicking a control or form to open an event procedure for its default event. If you double-click a form, the default event is *FormName*.Load. To open an event procedure for the other events, you can use either of two easy techniques.

From the Code Editor

In the Editor, drop down the Class Name list and choose the entry that shows the events for the selected form (Figure 6.13). Then in the Method Name list (Figure 6.14), select the event for which you want to write a procedure. Any events that already have an event procedure written appear in bold in the list.

Notice in Figure 6.14 that there are *many* more events for forms than those covered in this chapter.

Figure 6.13

Select the (FormName Events) entry to see the list of possible events for which to write a procedure.

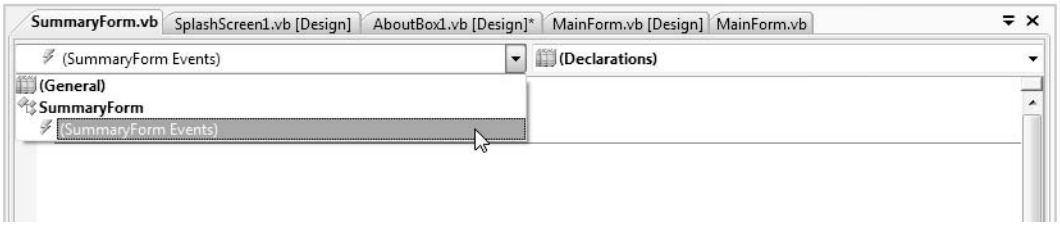
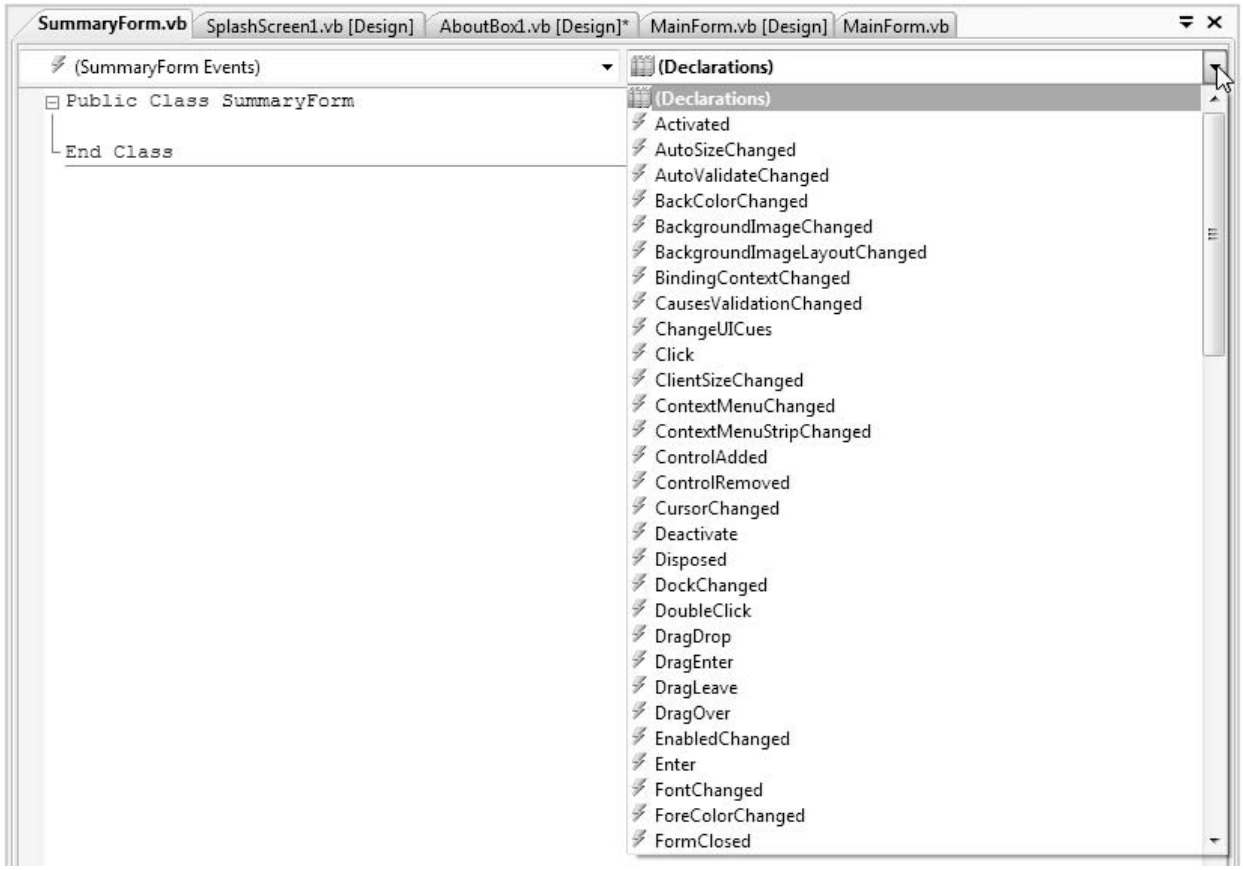


Figure 6.14

Select the event from the Method Name list to create an empty event procedure.



From the Properties Window in the Designer

You can select an event using the Properties window in the Form Designer. Click on the form to show its properties in the Properties window and click on the *Events* button (Figure 6.15) to display the available events (Figure 6.16). The default event appears selected, but you can double-click any other event to create its event procedure. You also can select a previously written procedure from the drop-down list for any event. When you want to switch the Properties window back to viewing properties, click on the *Properties* button.

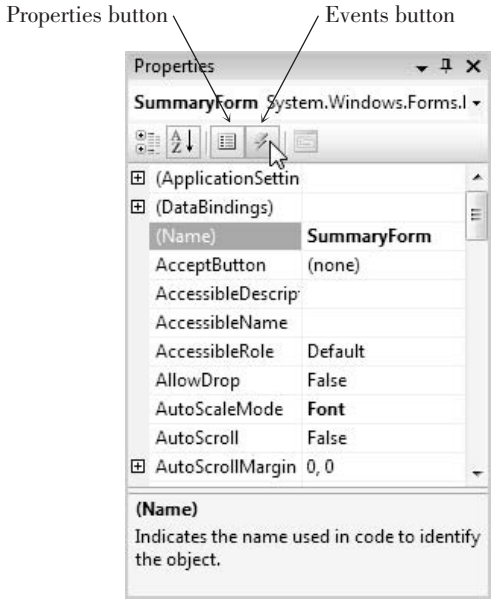


Figure 6.15

Click on the Events button in the Properties window to see the list of possible events for which to write a procedure.

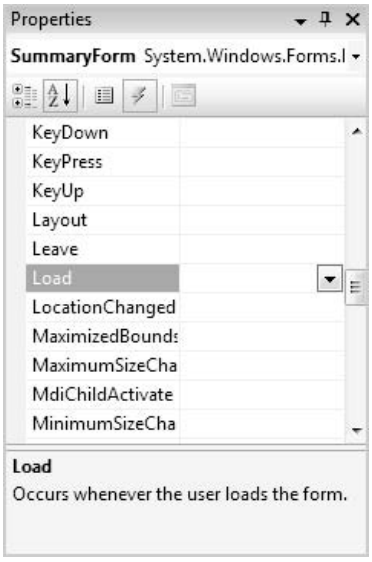


Figure 6.16

Double-click on the event to create an empty event procedure.

Holding the Splash Screen Display

As you learned earlier in this chapter, the splash screen should display only as long as it takes for the rest of the application to load. But our applications are so small that the splash screen disappears before the user can read it. You can write code to hold the splash screen longer, but it takes a technique called *threading*, which is not covered until the advanced text. You can just enter this code if you wish, even if you don't completely understand the statements.

First use one of the two techniques in the preceding section to create an event procedure for the FormClosing event. The FormClosing event occurs just before the form actually closes.

```
Private Sub SplashScreen1_FormClosing(ByVal sender As Object, _
  ByVal e As System.Windows.Forms.FormClosingEventArgs) Handles Me.FormClosing
    ' Hold the form on the screen approximately 5 seconds before closing.

    System.Threading.Thread.Sleep(5000)    ' Sleep 5000 milliseconds.
End Sub
```

Note: A VB program can have multiple threads, which allows for multiple processes to execute simultaneously. The `Sleep` method pauses the current thread (the one and only thread in all programs in this text). Threading and the BackgroundWorker class are covered in *Advanced Programming Using Visual Basic* by Bradley and Millspaugh and in MSDN.

Variables and Constants in Multiform Projects

When you have multiple forms in a project, the scope, access level, and lifetime of the variables and constants become a little more complicated. If you want module-level variables to be available in more than one form in a project, you must declare them as `Friend` or `Public`, not as `Private`.

Example

```
Friend GrandTotalDecimal As Decimal
```

Scope

Chapter 3 defined **scope** as the area of the program that can "see" and "use" the variable or constant. To expand the definition of scope for multiform projects: Scope is the set of statements that can access a variable or constant *without qualifying its name*. For example, if a variable is declared as `Friend` or `Public` in one form, another form can refer to that variable only by adding the form name (qualifying the name).

Example
In BillingForm:

```
Friend GrandTotalDecimal As Decimal
```

In SummaryForm:

```
GrandTotalTextBox.Text = BillingForm.GrandTotalDecimal.ToString("C")
```

Access Level

Access level specifies the permission required to make use of the variable or constant. For example, the hands-on project for Chapter 5 used module-level variables for the grand total and number of customers. Those variables were declared as **`Private`**, so they were available only to the one form. If you want to display the summary information on another form, which would look more professional, you must allow the summary form permission to use the variables. To make a variable available to other forms, you must use either `Public` or `Friend` in place of `Private`. Use **`Friend`** to allow other forms in your project to access the variable; use **`Public`** to allow all other programs to access the variables (generally considered a poor practice).

Note: The true access level of `Friend` is the entire *assembly*, rather than the entire project. An assembly can consist of multiple projects. In this text, all applications consist of a single project, so it makes sense to think of `Friend` access as projectwide.

By default, variables and constants are `Private`. You can use the following keywords to set the access level of module-level variables:

`Private`	Available only in the class (form) in which it is declared.
`Friend`	Available to all classes (forms) in the assembly (project).
`Public`	Available to all code in this project or any other.

Examples

```
Private RunningCountInteger As Integer  ' Accessible only by this form.
Friend TotalDecimal As Decimal  ' Accessible by all forms in this project.
Public DailyCountInteger As Integer  ' Accessible by any code in any project.
```

You can use the access-level keywords only for module-level variables. Local and block-level variables are declared inside a procedure and are always private.

Lifetime

Lifetime is the period of time that a variable or constant remains in existence. Recall from Chapter 3 that local and block variables exist only as long as that procedure executes and are re-created for each execution of the procedure. Module and namespace variables exist as long as the application runs.

Static Variables

Another statement you can use to declare local and block-level variables is the **`Static`** statement. Static variables retain their value for the life of the project, rather than being reinitialized for each call to the procedure. If you need to retain the value in a variable for multiple calls to a procedure, such as a running count, declare it as `Static`. However, if you need to use the variable in multiple procedures, declare it at the module level. (Using a static local variable is better than using a module-level variable because it is always best to keep the scope of a variable as narrow as possible.)

The Static Statement—General Form

General Form

```
Static Identifier As DataType
```

The format of the `Static` statement is the same as the format of the `Dim` statement. However, `Static` statements can appear only inside procedures; `Static` statements never appear at the module level.

The Static Statement—Examples

Examples

```
Static PersonCountInteger As Integer
Static ReportTotalDecimal As Decimal
```

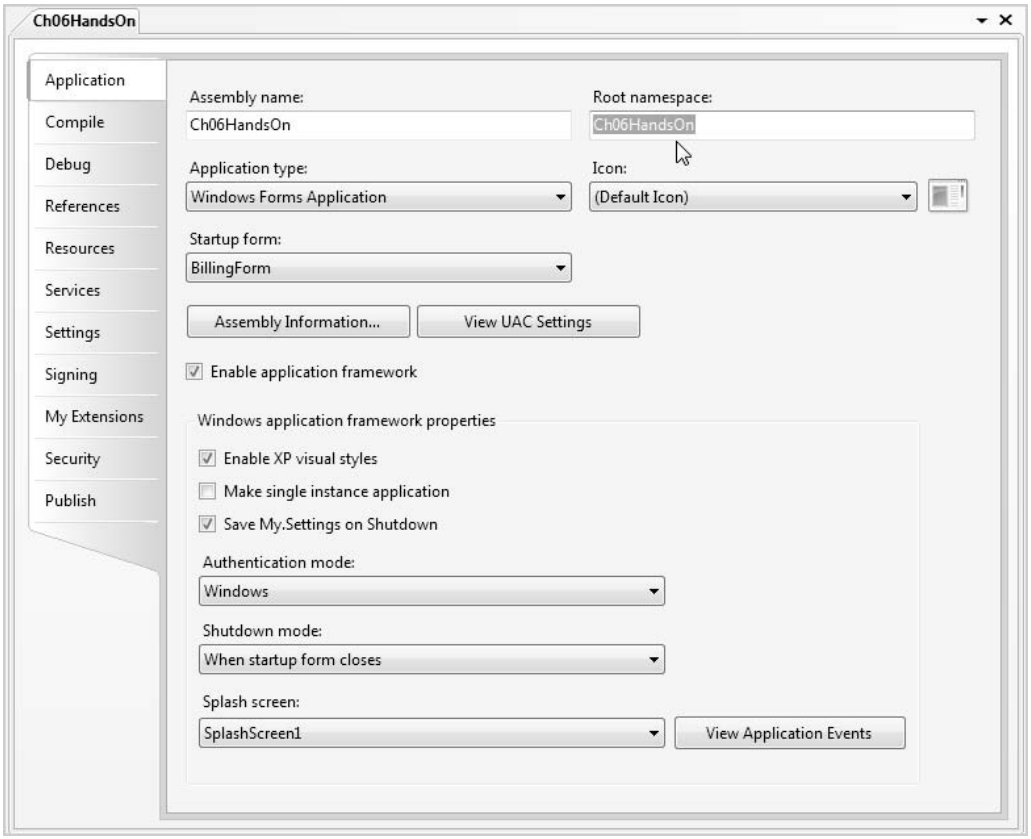
You never use access-level qualifiers on static variables since all static variables are local.

Namespaces

A VB project is automatically assigned to a **namespace**, which defaults to the name of the project. You can view and modify the project's namespace, called the *root namespace*, in the Project Designer (Figure 6.17).

Figure 6.17

Change the project's root namespace in the Project Designer.



Declaration Summary for Variables and Constants

Keyword	Location of Declaration Statement	Lifetime	Accessibility
`Dim`	Module level (outside of any procedure). *Note*: The default for `Dim` is the same as for `Private`. The `Private` keyword is preferred over `Dim`.	As long as the form is loaded.	All procedures in the class (form).
`Dim`	Inside a procedure but not inside a block such as `If / End If` or `Try / End Try`.	One execution of the procedure.	Local to that procedure.
`Dim`	Inside a block of code such as `If / End If` or `Try / End Try`.	One execution of the procedure.	Only the code within the block.
`Private`	Module level.	As long as the form is loaded.	All procedures in the class (form).
`Friend`	Module level.	As long as any form in the project is loaded.	Any code in the project. To refer to it in any other form, must qualify with form name: *`FormName.VariableName`*.
`Public`	Module level.	As long as any form in the project is loaded.	Any code in any program. However, any references from outside the form must be qualified.
`Const`	Module level (outside of any procedure).	As long as the form is loaded.	Any code in the form. (`Const` is `Private` by default.)
`Const`	Inside a procedure.	As long as the form is loaded.	Any code in the procedure. (Behaves like a read-only static variable.)
`Const`	Inside a block.	As long as the form is loaded.	Any code in the block. (Behaves like a read-only static variable.)
`Friend Const`	Module level.	As long as the form is loaded.	Any code in the project, but any references from outside the form must be qualified.
`Static`	Inside a procedure	As long as the form is loaded.	Local to that procedure.

Guidelines for Declaring Variables and Constants

When you declare variables and constants, select the location of the declaration carefully. These general guidelines will help you decide where to place declarations:

1. Place all local declarations (`Dim`, `Static`) at the top of a procedure. Although VB will accept declarations placed further down in the code, such placement is considered a poor practice. Your code will be easier to read, debug, modify, and maintain if you follow this guideline.
2. Use named constants for any value that doesn't change during program execution. It is far more clear to use named constants such as MAXIMUM_RATE_Decimal and COMPANY_NAME_String than to

place the values into your code; and if in the future the values must be modified, having a constant name (at the top of your code) makes the task much easier.

3. Keep the scope of variables and constants as narrow as possible. Don't declare them all to be module level for convenience. There are books full of horror stories about strange program bugs popping up because the value of a variable was changed in an unknown location.
4. Consider making variables local if possible.
5. If you need to keep the value of a variable for multiple executions of a procedure, but don't need the variable in any other procedure, make it `Static`.
6. If you need to use a variable both in a procedure and also in a second procedure called by the first procedure, declare the variable as local and pass it as an argument. (Refer to "Passing Arguments to Procedures" in Chapter 5.)
7. If you need to use a variable in multiple procedures, such as to add to the variable in one procedure and to display it in another, use `Private` module-level variables.
8. Finally, if you need to use the value of a variable in more than one form, declare it as `Friend`.

Feedback 6.1

For each of these situations, write the declaration statement and tell where it should appear. Assume the project will have multiple forms.

1. The number of calories in a gram of fat (nine) to use in the calculations of a procedure.
2. The name of the person with the highest score, which will be determined in one procedure and displayed in a label on a different form. (The value must be retained for multiple executions of the procedure.)
3. The name of the company ("Bab's Bowling Service"), which will appear in several forms.
4. A total dollar amount to be calculated in one procedure of a form, added to a grand total in a procedure of a second form, and formatted and displayed in a third form.
5. A count of the number of persons entered using a single form. The count will be used to help calculate an average in a second form.
6. The formatted version of a dollar total, which will be displayed in a text box in the next statement.

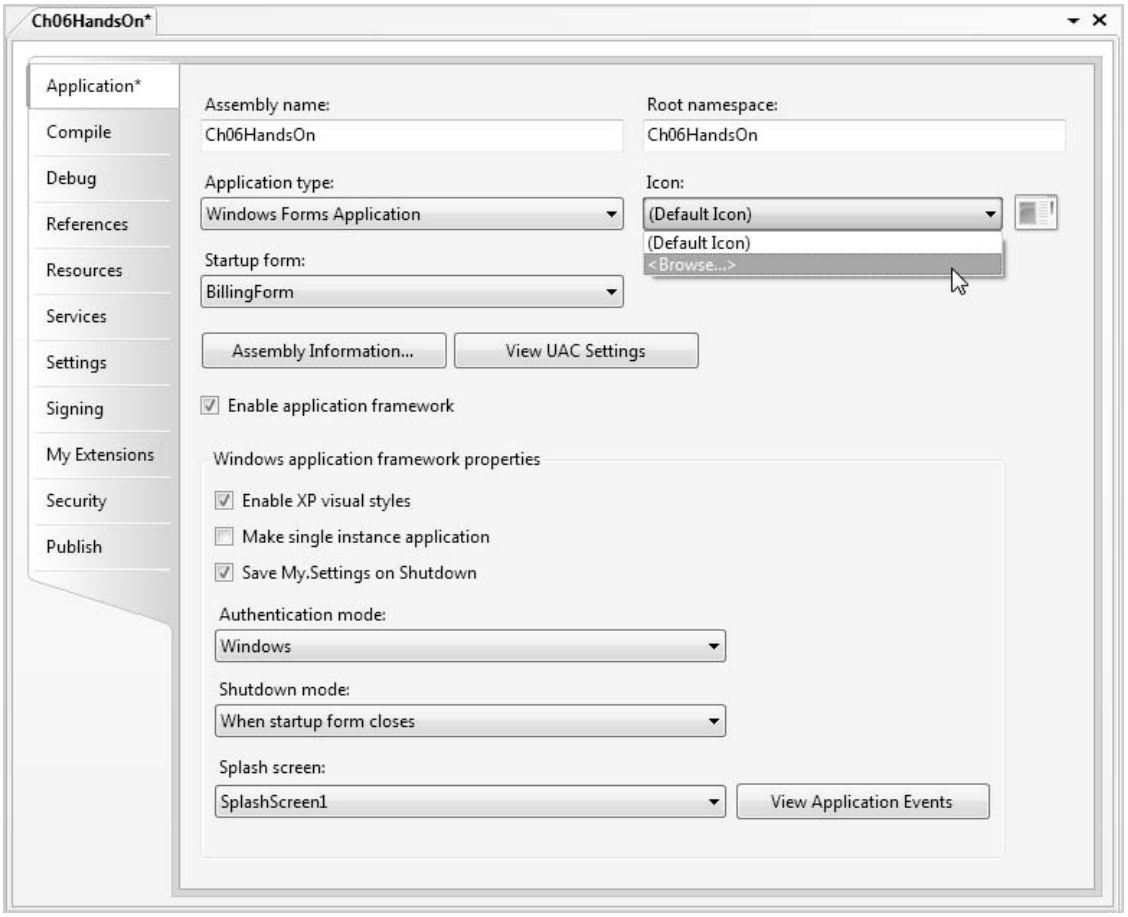
Running Your Program Outside the IDE

Every time that you create and run an application, the executable file is placed in the project's bin\Debug folder. You can move that .exe file to another computer, place the file on the system desktop, or use it as a shortcut just like any other application on your system. If you copy the executable file to another system, you must make sure that the computer has the Microsoft .NET Framework. It is possible to download the framework for free from the Microsoft Web site.

You also may want to change the icon for your program. The default icon is a standard window image. To change the icon to something more interesting, open the Project Designer. On the *Application* tab, drop down the list for Icon (Figure 6.18) and browse to find another file with an .ico extension. Many icon files are in the Professional version of Visual Studio and in various folders in Windows; a few are on the text StudentData CD. You must recompile (build) the project again after setting the icon.

Figure 6.18

Select a different icon for your project in the Project Designer.



Your Hands-On Programming Example

Modify the hands-on project from Chapter 5 to include multiple forms. This version of the project requires four forms: BillingForm, AboutForm, SplashForm, and SummaryForm.

Note: Follow the instructions in Chapter 5, "Basing a New Project on an Existing Project," or Appendix C, "Copy and Move a Project," to begin this hands-on example.

- BillingForm: Use the BillingForm form from Chapter 5 with a few modifications to display output on new forms rather than in message boxes.

- SummaryForm: Create a form with the appropriate labels and text boxes for the summary information.
- AboutForm: Replace the MessageBox for the *Help / About* menu item from Chapter 5 with a new form using the About Box template.
- SplashForm: Create a splash screen using the Splash Screen template.

Reviewing the Project Requirements from Chapter 5 For the BillingForm, the user enters the number of items, selects the coffee type from radio buttons, and selects the check box for taxable items. The price for each coffee is calculated according to these prices:

Cappuccino	2.00
Espresso	2.25
Latte	1.75
Iced (either)	2.50

The *Calculate Selection* button calculates and displays the amount due for each item, adds the current item to the order, and calculates and displays the order information in text boxes. The *Clear for Next Item* button clears the selections and amount for the single item.

The *New Order* menu item clears the bill for the current customer and adds to the totals for the summary. The *Summary* menu item shows the summary form that displays the total of all orders, the average sale amount per customer, and the number of customers.

The *Edit* menu contains options that duplicate the *Calculate* and *Clear* buttons. The *Font* and *Color* options change the contents of the subtotal, tax, and total text boxes.

The *About* selection on the *Help* menu displays the About box, which contains information about the program.

```
File                Edit                          Help
 New Order           Calculate Selection           About
 Summary             Clear Item
 Exit                _____
                     Font...
                     Color...
```

Planning the Project

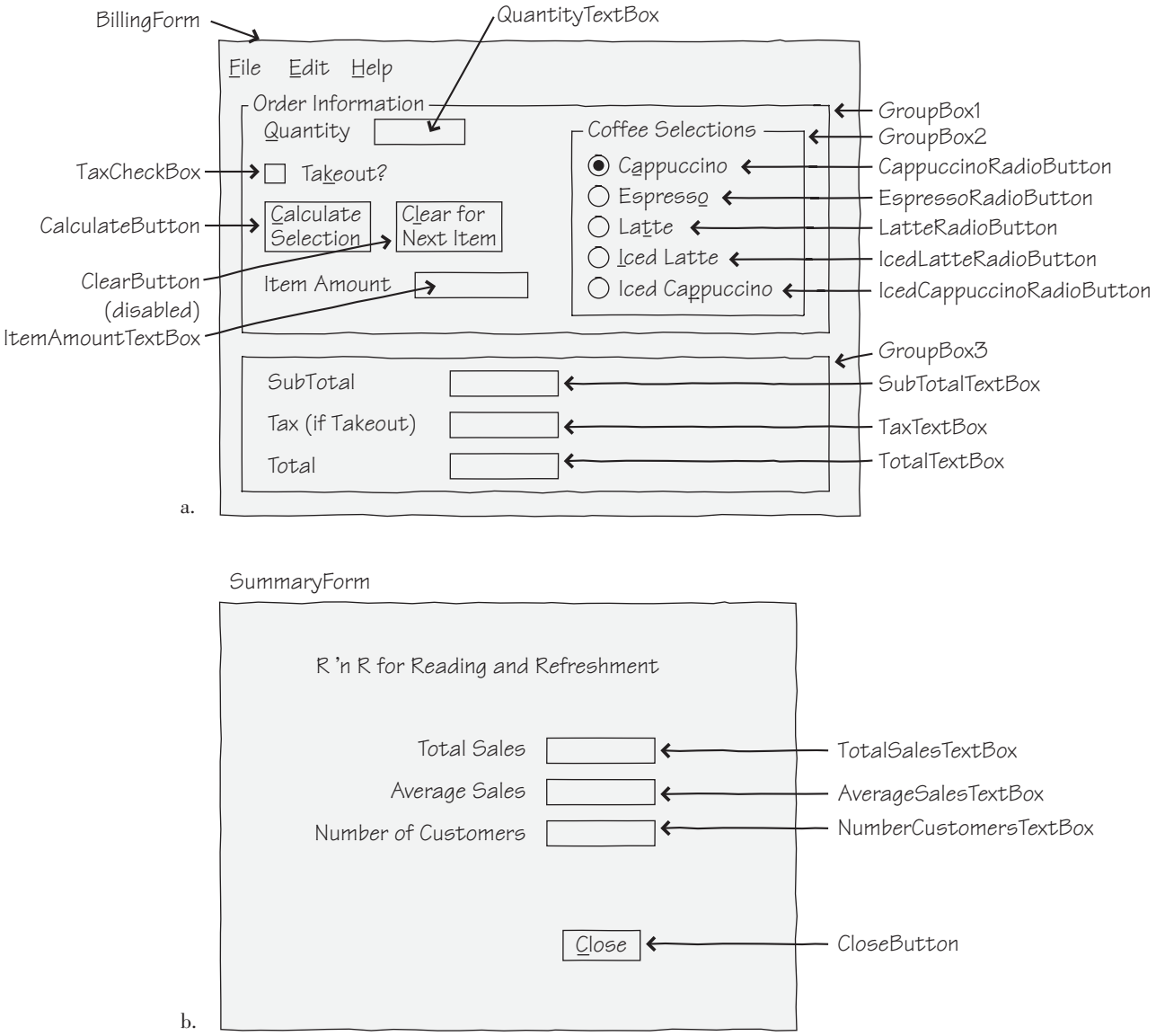
Sketch the four forms (Figure 6.19). The users approve and sign off the forms as meeting their needs.

Plan the Objects and Properties for the Billing Form See the hands-on exercise for Chapter 5 for the objects and properties of BillingForm, which are unchanged for this project.

Plan the Procedures for the Billing Form Most of the procedures for BillingForm are unchanged from the project in Chapter 5. You must change the accessibility of the variables that must be displayed on the summary form; you

Figure 6.19

The planning sketches of the forms for the hands-on programming example. a. the billing form; b. the summary form; c. the splash form; and d. the About box.



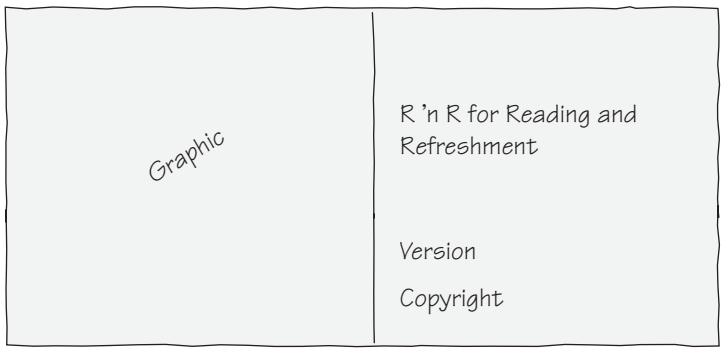
also must change the variable used for the average (AverageDecimal) to a module-level `Friend` variable.

Object	Procedure	Actions
SummaryToolStripMenuItem	Click	If current order not added to totals Call NewOrderToolStripMenuItem_Click. Calculate the average (in a `Friend` variable). Display the summary form.
AboutToolStripMenuItem	Click	Display the About Box form.

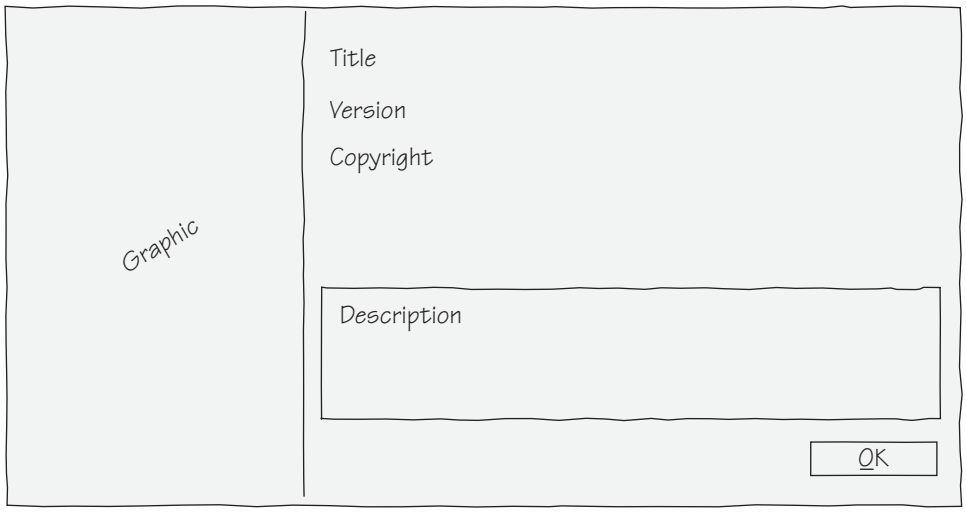
Figure 6.19

(continued)

c.



d.



Plan the Objects and Properties for the Summary Form

Object	Property	Setting
SummaryForm	Name	SummaryForm
	Text	R 'n R Billing Summary
	AcceptButton	CloseButton
Label1	Name	Label1
	Text	Total Sales
TotalSalesTextBox	Name	TotalSalesTextBox
	ReadOnly	True
Label2	Name	Label2
	Text	Average Sales
AverageSalesTextBox	Name	AverageSalesTextBox
	ReadOnly	True
Label3	Name	Label3
	Text	Number of Customers
NumberCustomersTextBox	Name	NumberCustomersTextBox
	ReadOnly	True
CloseButton	Name	CloseButton
	Text	&Close

Plan the Procedures for the Summary Form

Object	Procedure	Actions
SummaryForm	Activated	Assign values from billing form to text boxes
CloseButton	Click	Close this form

Plan the Objects and Properties for the Splash Screen Use the Splash Screen template and consider changing the graphic. Fill in the *Assembly Information* in the Project Designer so that the screen fields are filled when the form displays.

Plan the Procedures for the Splash Screen If you use the Splash Screen template, you don't need to write any code for the form except to hold the form on the screen long enough to read it.

Object	Procedure	Actions
SplashScreen	FormClosing	Sleep for a few seconds

Plan the Objects and Properties for the About Box Use the About Box template and consider changing the graphic. Fill in the *Assembly Information* in the Project Designer so that the screen fields are filled when the form displays.

Plan the Procedures for the About Box If you use the About Box template, you don't need to write any code for the form.

Plan the Project Properties Changes

Splash Screen Set to the name of your splash screen form in the Project Designer.

Assembly Information Fill in fields to display in the splash screen and the About box.

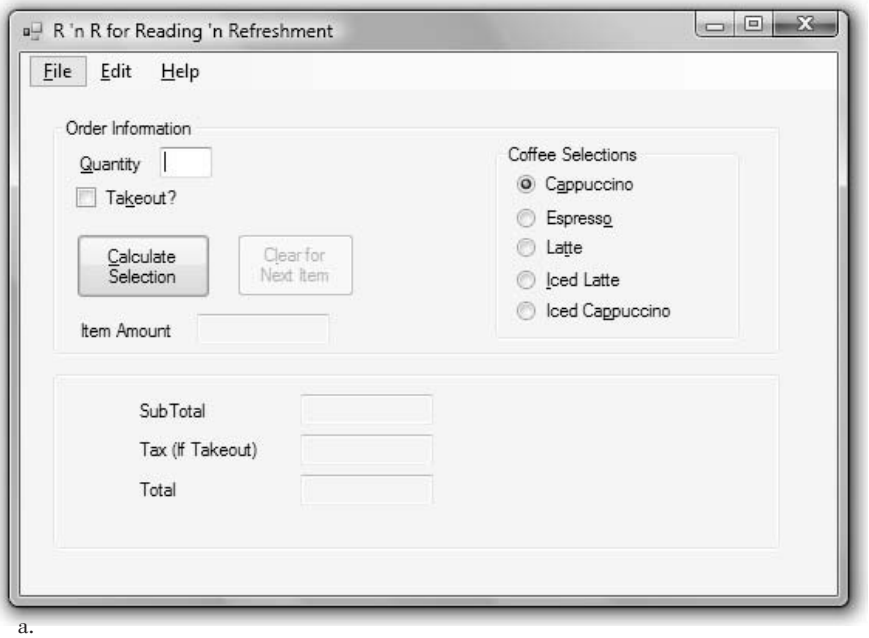
Write the Project Follow the instructions in Chapter 5, "Basing a New Project on an Existing Project," or Appendix C, "Copy and Move a Project," to base this project on Ch05HandsOn. If you have not written Ch05HandsOn, do so first before beginning this project.

Follow the sketches in Figure 6.19 to create the forms. Use the Splash Screen and About Box templates. Figure 6.20 shows the completed forms.

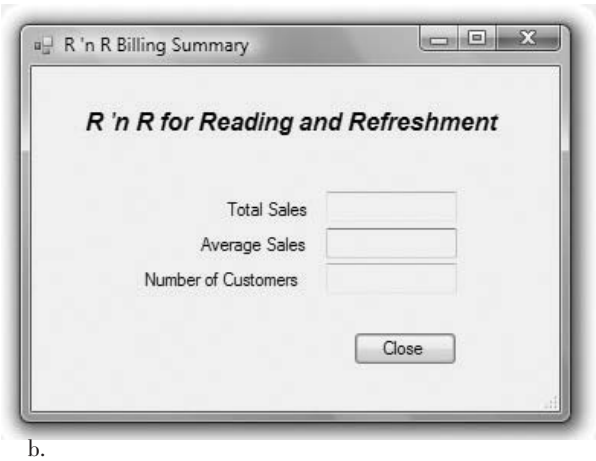
- Set the properties of each of the objects according to your plan.
- Write the code. Working from the pseudocode, write each procedure.
- Make sure to change the module-level variables needed for the summary form to `Friend` access level. Move the declaration of AverageDecimal from the local level to the module level.
- When you complete the code, use a variety of data to thoroughly test the project.

Figure 6.20

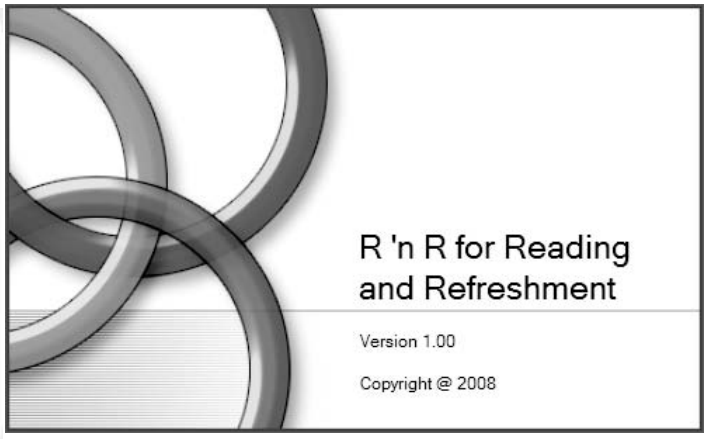
The completed forms for the hands-on programming example. a. the billing form; b. the summary form; c. the splash screen; and d. the About box.



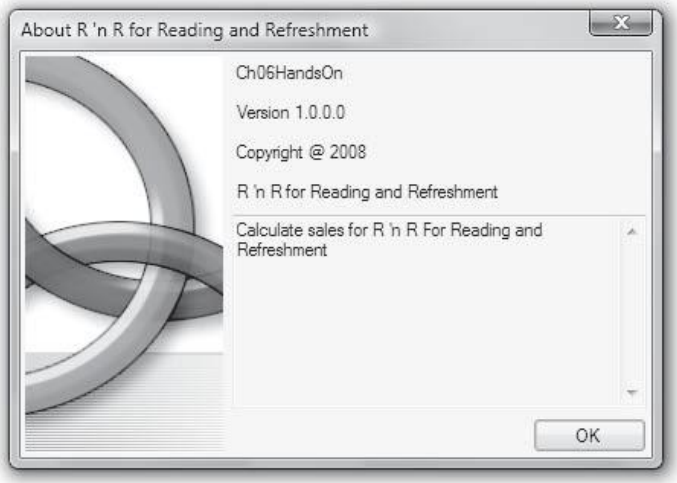
a.



b.



c.



d.

The Project Coding Solution

BillingForm

```
'Program Name:    Ch06HandsOn
'Programmer:      Bradley/Millspaugh
'Date:            June 2008
'Description:     This project calculates the amount due
'                 based on the customer selection
'                 and accumulates summary data for the day.
'                 Incorporates menus and common dialog boxes,
'                 which allow the user to change the font and
'                 color of controls.
'                 This version of the project includes a splash form,
'                 a summary form, and an About box form.
'Folder:          Ch06HandsOn
'Form:            BillingForm

Public Class BillingForm
    ' Declare projectwide variables.
    Friend GrandTotalDecimal, AverageDecimal As Decimal
    Friend CustomerCountInteger As Integer

    ' Declare module-level variables.
    Private SubTotalDecimal, TotalDecimal As Decimal

    ' Declare constants.
    Const TAX_RATE_Decimal As Decimal = 0.08D
    Const CAPPUCCINO_PRICE_Decimal As Decimal = 2D
    Const ESPRESSO_PRICE_Decimal As Decimal = 2.25D
    Const LATTE_PRICE_Decimal As Decimal = 1.75D
    Const ICED_PRICE_Decimal As Decimal = 2.5D

    Private Sub CalculateButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles CalculateButton.Click, _
      CalculateSelectionToolStripMenuItem.Click
        ' Calculate and display the current amounts and add to totals.
        Dim PriceDecimal, TaxDecimal, ItemAmountDecimal As Decimal
        Dim QuantityInteger As Integer

        ' Find the price.
        If CappuccinoRadioButton.Checked Then
            PriceDecimal = CAPPUCCINO_PRICE_Decimal
        ElseIf EspressoRadioButton.Checked Then
            PriceDecimal = ESPRESSO_PRICE_Decimal
        ElseIf LatteRadioButton.Checked Then
            PriceDecimal = LATTE_PRICE_Decimal
        ElseIf IcedCappuccinoRadioButton.Checked Or _
          IcedLatteRadioButton.Checked Then
            PriceDecimal = ICED_PRICE_Decimal
        End If

        ' Calculate the extended price and add to order total.
        Try
            QuantityInteger = Integer.Parse(QuantityTextBox.Text)
            ItemAmountDecimal = PriceDecimal * QuantityInteger
            SubTotalDecimal += ItemAmountDecimal
            If TaxCheckBox.Checked Then
                ' Call a function procedure.
                TaxDecimal = FindTax(SubTotalDecimal)
```

```
            Else
                TaxDecimal = 0
            End If
            TotalDecimal = SubTotalDecimal + TaxDecimal
            ItemAmountTextBox.Text = ItemAmountDecimal.ToString("C")
            SubTotalTextBox.Text = SubTotalDecimal.ToString("N")
            TaxTextBox.Text = TaxDecimal.ToString("N")
            TotalTextBox.Text = TotalDecimal.ToString("C")
            ' Allow change for new order only.
            TaxCheckBox.Enabled = False
            ' Allow Clear after an order is begun.
            ClearButton.Enabled = True
            ClearItemToolStripMenuItem.Enabled = True
            NewOrderToolStripMenuItem.Enabled = True
        Catch QuantityException As FormatException
            MessageBox.Show("Quantity must be numeric.", "Data entry error", _
              MessageBoxButtons.OK, MessageBoxIcon.Information)
            With QuantityTextBox
                .Focus()
                .SelectAll()
            End With
        End Try
    End Sub

    Private Function FindTax(ByVal AmountDecimal As Decimal) As Decimal
        ' Calculate the sales tax.

        Return AmountDecimal * TAX_RATE_Decimal
    End Function

    Private Sub ClearButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ClearButton.Click, _
      ClearItemToolStripMenuItem.Click
        ' Clear the appropriate controls.

        CappuccinoRadioButton.Checked = True
        ItemAmountTextBox.Clear()
        With QuantityTextBox
            .Clear()
            .Focus()
        End With
    End Sub

    Private Sub NewOrderToolStripMenuItem_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles NewOrderToolStripMenuItem.Click
        ' Clear the current order and add to the totals.
        Dim ResponseDialogResult As DialogResult
        Dim MessageString As String

        ' Confirm clear of the current order.
        MessageString = "Clear the current order figures?"
        ResponseDialogResult = MessageBox.Show(MessageString, "Clear Order", _
          MessageBoxButtons.YesNo, MessageBoxIcon.Question, _
          MessageBoxDefaultButton.Button2)

        If ResponseDialogResult = DialogResult.Yes Then
            ' User said Yes; clear the screen fields.
            ClearButton_Click(sender, e)
            SubTotalTextBox.Text = ""
            TaxTextBox.Text = ""
            TotalTextBox.Text = ""
```

```
        ' Add to the totals only if not a new order/customer.
        If SubTotalDecimal <> 0 Then
            GrandTotalDecimal += TotalDecimal
            CustomerCountInteger += 1
            ' Reset totals for the next customer.
            SubTotalDecimal = 0
            TotalDecimal = 0
        End If

        ' Clear the appropriate display items and enable the check box.
        With TaxCheckBox
            .Enabled = True
            .Checked = False
        End With
        ClearButton.Enabled = False
        ClearItemToolStripMenuItem.Enabled = False
        NewOrderToolStripMenuItem.Enabled = False
    End If
End Sub

Private Sub SummaryToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles SummaryToolStripMenuItem.Click
    ' Calculate the average and display the totals.
    Dim MessageString As String

    If TotalDecimal <> 0 Then
        ' Make sure the last order is counted.
        NewOrderToolStripMenuItem_Click(sender, e)
        ' Pass incoming arguments to the called procedure.
    End If

    If CustomerCountInteger > 0 Then
        ' Calculate the average.
        AverageDecimal = GrandTotalDecimal / CustomerCountInteger
        SummaryForm.ShowDialog()
    Else
        MessageString = "No sales data to summarize."
        MessageBox.Show(MessageString, "Coffee Sales Summary", MessageBoxButtons.OK, _
          MessageBoxIcon.Information)
    End If
End Sub

Private Sub ExitToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles ExitToolStripMenuItem.Click
    ' Terminate the project.

    Me.Close()
End Sub

Private Sub AboutToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles AboutToolStripMenuItem.Click
    ' Display the About Box form.

    AboutBox1.ShowDialog()
End Sub

Private Sub FontToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles FontToolStripMenuItem.Click
    ' Allow the user to select a new font for the summary totals.

    With FontDialog1
        .Font = Me.SubTotalTextBox.Font
        .ShowDialog()
```

```
            SubTotalTextBox.Font = .Font
            TaxTextBox.Font = .Font
            TotalTextBox.Font = .Font
        End With
    End Sub

    Private Sub ColorToolStripMenuItem_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ColorToolStripMenuItem.Click
        ' Allow the user to select a new color for the summary totals.

        With ColorDialog1
            .Color = SubTotalTextBox.ForeColor
            .ShowDialog()
            SubTotalTextBox.ForeColor = .Color
            TaxTextBox.ForeColor = .Color
            TotalTextBox.ForeColor = .Color
        End With
    End Sub
End Class
```

SummaryForm

```
'Program Name:   Ch06HandsOn
'Programmer:     Bradley/Millspaugh
'Date:           June 2008
'Description:    This project calculates the amount due
'                based on the customer selection
'                and accumulates summary data for the day.
'                Incorporates menus and common dialog boxes,
'                which allow the user to change the font and
'                color of controls.
'                This form displays the summary totals.
'Folder:         Ch06HandsOn
'Form:           SummaryForm

Public Class SummaryForm

   Private Sub SummaryForm_Activated(ByVal sender As System.Object, _
     ByVal e As System.EventArgs) Handles MyBase.Activated
       ' Get the data.

       TotalSalesTextBox.Text = BillingForm.GrandTotalDecimal.ToString("C")
       AverageSalesTextBox.Text = BillingForm.AverageDecimal.ToString("C")
       NumberCustomersTextBox.Text = BillingForm.CustomerCountInteger.ToString()
   End Sub

   Private Sub CloseButton_Click(ByVal sender As System.Object, _
     ByVal e As System.EventArgs) Handles CloseButton.Click
       ' Close this summary form.

       Me.Hide()
   End Sub
End Class
```

SplashScreen

Note: Nearly all of the code is generated by the template. Add one event procedure to hold the splash screen long enough to read it.

```
Private Sub SplashScreen1_FormClosing(ByVal sender As Object, _
  ByVal e As System.Windows.Forms.FormClosingEventArgs) Handles Me.FormClosing
    ' Hold the form on the screen approximately 5 seconds before closing.

    System.Threading.Thread.Sleep(5000)
End Sub
```

AboutBox

Note: All of the About Box code is generated by the template.

Summary

1. Projects may need more than one form; there is virtually no limit to the number of forms that can be used within a single project.
2. Forms used for one project can be added to another project. Forms also can be removed from a project.
3. An About box, which typically contains information about the version of an application and the programmer and copyrights, may be created by adding a new form. VB has an About Box template form that you can use to create an About box.
4. A splash screen may be displayed while a program loads. VB provides a Splash Screen template that you can use to create a new splash screen form.
5. Both the Splash Screen and About Box templates automatically insert information that you can enter in the *Assembly Information* dialog box.
6. The `Show` (modeless) and `ShowDialog` (modal) methods are used to display a form on the screen.
7. A form displayed as modal requires a response from the user; it must be closed or unloaded before any execution continues. When a form is displayed as modeless, the user can switch to another form without closing the form.
8. The `Form.Hide` method hides the form but keeps it loaded in memory; the `Form.Close` method removes a modeless form from memory; the `Form.Close` method for a modal form actually hides the form rather than closing it.
9. The `Form.Load` event occurs once for each loaded form; the `Form.Activated` event can occur multiple times—each time the form is shown.
10. The form's `FormClosing` event occurs just before the form closes. You can write event procedures for any of the form's events.
11. Variables that are visible to all forms in a project are declared using the keyword `Friend`. The `Private` keyword sets the access level to the current form, and the `Public` keyword makes the variable available to all classes in all programs.
12. To refer to a `Friend` variable in a different form, use the form name, a period, and the variable name.
13. Variables declared with the keyword `Static` retain their values for multiple calls to the procedure in which they are declared. Static variables are local or block-level.
14. Each project has a default namespace, called the *root namespace*. You can change the root namespace for a VB project in the Project Designer, which you display either by double-clicking *My Project* in the Solution Explorer or selecting *Project / ProjectName Properties*.
15. You can run a project outside the VS IDE by moving and running the .exe file. The target machine must have the correct version of the .NET Framework installed.

Key Terms

access level *268*
About box *257*
`Friend` *268*
`Hide` method *263*
modal *262*
modeless *262*
namespace *269*
`Private` *268*
`Public` *268*
scope *267*
`Show` method *262*
`ShowDialog` method *262*
splash screen *260*
startup form *254*
`Static` *268*

Review Questions

1. List some of the items generally found in an About box.
2. What is the purpose of a splash screen?
3. What is the term used for the first form to display in a project?
4. How can you choose a different form as the startup form after the project has been created?
5. Explain how to include an existing form in a new project.
6. What is the *assembly information*? How can you change the information? How can you use the information?
7. Explain the difference between *modal* and *modeless*.
8. How does the `Show` method differ from the `ShowDialog` method?
9. Explain when the form's Load event and Activated event occur. In which event procedure should you place code to initialize screen fields? Is the answer always the same?
10. Explain the differences between `Public`, `Private`, and `Friend` access levels.
11. What is a static variable? When would it be useful?
12. How can you run a compiled VB program outside the Visual Studio IDE?

Programming Exercises

Note: For help in basing a new project on an existing project, see "Copy and Move a Project" in Appendix C.

6.1 Modify Programming Exercise 5.5 (the flag viewer) to include a splash screen and an About box.
Menus

```
File          Country              Display              Help
 Exit          United States        Title                About
               Canada               Country Name
               Japan                Programmer
               Mexico
```

6.2 Create a project that will produce a summary of the amounts due for Pat's Auto Repair Shop. Display a splash screen first; then display the main form, which has only the menus. If you wish, you can add a graphic to the form.

Main Form Menus

```
File        Process                Help
 Exit        Job Information        About
```

Job Information

The *Job Information* menu item will display the Job Information form.

Job Information Form The Job Information form must have text boxes for the user to enter the job number, customer name, amount charged for parts, and the hours of labor. Include labels and text boxes for Parts, Labor, Subtotal, Sales Tax, and Total.

Include buttons for *Calculate*, *Clear*, and *OK*.

The *Calculate* button finds the charges and displays them in controls. The tax rate and the hourly labor charge should be set up as named constants so that they can be easily modified if either changes. Current charges are $50 per hour for labor and 8 percent (.08) for the sales tax rate. Sales tax is charged only on parts, not on labor.

The *Clear* button clears the text boxes and resets the focus in the first text box.

The *OK* button closes the Job Information form and displays the main form.

6.3 Modify Programming Exercise 6.2 so that summary information is maintained for the total dollar amount for parts, labor, sales tax, and total for all customers.

Add a *Summary* menu item under the *Process* menu with a separator bar between the two menu items. When the user selects the *Summary* menu item, display the summary information in a Summary form. The Summary form should have an *OK* button that closes the Summary form and returns the user to the main form.

6.4 A battle is raging over the comparative taste of Prune Punch and Apple Ade. Each taste tester rates the two drinks on a scale of 1 to 10 (10 being best). The proof of the superiority of one over the other will be the average score for the two drinks.

Display a splash screen and then the main form. The main form has only the menus; you can add a graphic if you wish.

Main Form Menus

```
File              Help
 New Tester        About
 Summary

 ___________
 Exit
```

New Tester Menu Item

The *New Tester* menu item displays a form that inputs the test results for each drink. The form contains an *OK* button and a *Close* button.

When the user clicks the *OK* button, add the score for each type of drink to the drink's total, clear the text boxes, and reset the focus. Leave the form on the screen in case the next tester is ready to enter scores. If either score is blank when the *OK* button is pressed, display a message in a message box and reset the focus to the box for the missing data.

The *Close* button returns to the main form without performing any calculation.

Summary Menu Item
The *Summary* item displays a form that contains the current results of the taste test. It should display the winner, the total number of taste testers, and the average rating for each drink. The form contains an *OK* button that returns to the main form. (The user will be able to display the summary at any time and as often as desired.)

About Box
The About box should display information about the program and the programmer. Include an *OK* button that returns the user to the main form.

6.5 Modify Programming Exercise 5.1 (piecework pay) to add a Splash form, an About box, and a Summary form. Add a slogan and a logo that the user can hide or display from menu choices on the main form.

Splash Form
The Splash form must appear when the project begins execution. It should display the project name, programmer name, and at least one graphic.

About Box
The About box should have the program name, version number, and programmer name, as well as a graphic and an *OK* button. It must be displayed as modal.

Summary Form
The Summary form should display the summary information. Note that in Chapter 5 the summary information was displayed in a message box. You must remove the message box and display the summary information only on the Summary form.

Slogan and Logo
Make up a slogan for the company, such as "We're Number One" or "We Do Chicken Right." For the logo, you can use an icon or any graphic you have available, or create one yourself with a draw or paint program.

The *Slogan* and *Logo* menu choices must toggle and display a check mark when selected. For example, when the slogan is displayed, the *Slogan* menu item is checked. If the user selects the *Slogan* command again, hide the slogan and uncheck the menu item. The *Slogan* and *Logo* commands operate independently; that is, the user may select either, both, or neither item.

When the project begins, the slogan and logo must both be displayed on the main form and their menu items appear checked.

Case Studies

VB Mail Order

Modify the VB Mail Order project from Chapter 5 to include a splash screen, an About box, and a summary form. Include an image on both the Splash form and the About box.

VB Auto Center

Create a project that uses four forms. Add the form from the Chapter 5 VB Auto case study and create a main form, a splash screen, and an About box.

Main Form: The main form should display a large label with the words: "Valley Boulevard Auto Center - Meeting all your vehicle's needs" and appropriate image(s).

Main Form Menus

```
File            Edit          Help
 Input Sale      Color...      About
 Exit            Font...
```

The *Color* and *Font* items should allow the user to change the large label on the form.

The *Input Sale* item should display the form from Chapter 5.

Video Bonanza

Modify the Video Bonanza project from Chapter 5 to separate the project into multiple forms. Include a summary form, a splash screen, and an About box.

Very Very Boards

Modify the Very Very Boards project from Chapter 5 to separate the project into multiple forms. Include a summary form, a splash screen, and an About box.

CHAPTER

7

Lists, Loops, and Printing

at the completion of this chapter, you will be able to . . .

1. Create and use list boxes and combo boxes.
2. Differentiate among the available types of combo boxes.
3. Enter items into list boxes using the Items collection in the Properties window.
4. Add and remove items in a list at run time.
5. Determine which item in a list is selected.
6. Use the Items.Count property to determine the number of items in a list.
7. Display a selected item from a list.
8. Use `Do/Loops` and `For/Next` statements to iterate through a loop.
9. Terminate a loop with the `Exit` statement.
10. Skip to the next iteration of a loop by using the `Continue` statement.
11. Send information to the printer or the Print Preview window using the PrintDocument class.

Often you will want to offer the user a list of items from which to choose. You can use the Windows ListBox and ComboBox controls to display lists on a form. You may choose to add items to a list during design time, during run time, or perhaps a combination of both. Several styles of list boxes are available; the style you use is determined by design and space considerations as well as by whether you will allow users to add items to the list.

List Boxes and Combo Boxes

Both list boxes and combo boxes allow you to have a list of items from which the user can make a selection. Figure 7.1 shows the toolbox tools for creating the controls; Figure 7.2 shows several types of list boxes and combo boxes, including **simple list boxes**, **simple combo boxes**, **drop-down combo boxes**, and **drop-down lists**. The list boxes on the left of the form in Figure 7.2 are all created with the list box tool; the boxes on the right of the form are created with the combo box tool. Notice the three distinct styles of combo boxes.

ListBox controls and **ComboBox controls** have most of the same properties and operate in a similar fashion. One exception is that a combo box control has a DropDownStyle property, which determines whether or not the list box also has a text box for user entry and whether or not the list will drop down (refer to Figure 7.2).

Both list boxes and combo boxes have a great feature. If the box is too small to display all the items in the list at one time, VB automatically adds a scroll bar. You do not have to be concerned with the location of the scroll box in the scroll bar; the scrolling is handled automatically.

When you add a list control to a form, choose the style according to the space you have available and how you want the box to operate. Do you want the user to select from an existing list? If so, use a simple list box or a drop-down list (ComboBox DropDownStyle = DropDownList). Do you want the user to be able to type a new entry if necessary? In this case, use one of the two styles with

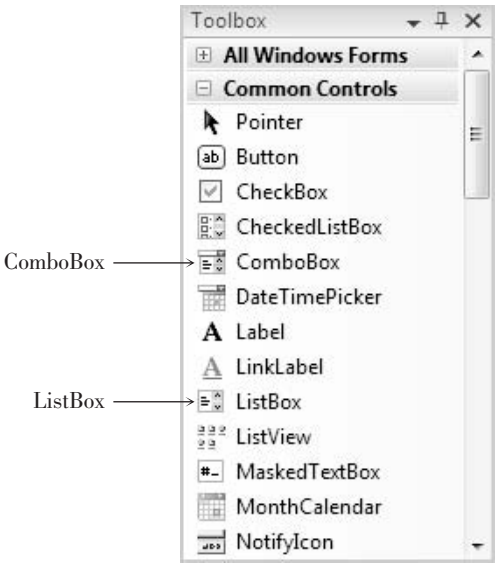
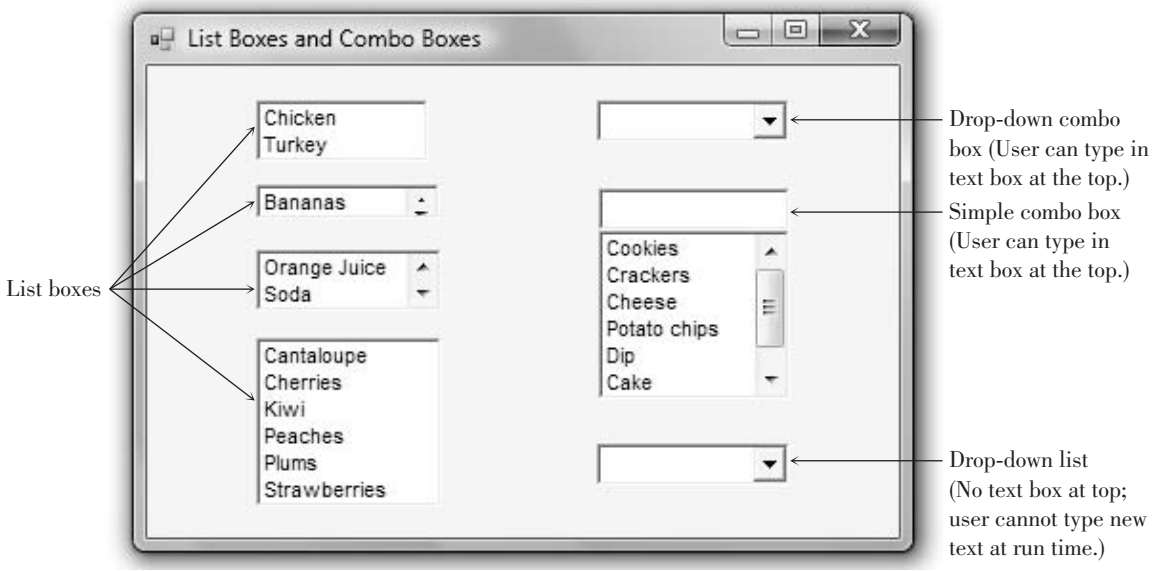


Figure 7.1

Use the ListBox tool and ComboBox tool to create list boxes and combo boxes on your forms.

Figure 7.2

Various styles of list boxes and combo boxes.



an added text box: the drop-down combo box (DropDownStyle = DropDown) or the simple combo box (DropDownStyle = Simple).

At design time, the behavior of list boxes and combo boxes differs. For list boxes, Visual Basic displays the Name property in the control; for combo boxes, the Text property displays, which is blank by default. Don't spend any time trying to make a list box appear empty during design time; the box will appear empty at run time. Combo boxes have a Text property, which you can set at design time if you wish. List boxes also have a Text property, but you can access it only at run time.

The Items Collection

The list of items that displays in a list box or combo box is a **collection**. VB collections are objects that have properties and methods to allow you to add items, remove items, refer to individual elements, count the items, and clear the collection. In the sections that follow, you will learn to maintain and refer to the Items collection.

You can refer to the items in a collection by an index, which is zero based. For example, if a collection holds 10 items, the indexes to refer to the items range from 0 to 9. To refer to the first item in the Items collection, use Items(0).

Filling a List

You can use several methods to fill the Items collection of a list box and combo box. If you know the list contents at design time and the list never changes, you can define the Items collection in the Properties window. If you must add items to the list during program execution, you will use the `Items.Add` or `Items.Insert` method in an event procedure. In Chapter 11 you will learn to

fill a list from a data file on disk. This technique allows the list contents to vary from one run to the next.

Using the Properties Window

The **Items property**, which is a collection, holds the list of items for a list box or combo box. To define the Items collection at design time, select the control and scroll the Properties window to the Items property (Figure 7.3). Click on the ellipses button to open the String Collection Editor (Figure 7.4) and type your list items, ending each line with the Enter key. Click *OK* when finished. You can open the editor again to modify the list, if you wish.

Figure 7.3

Select the Items property of a list box to enter the list items.

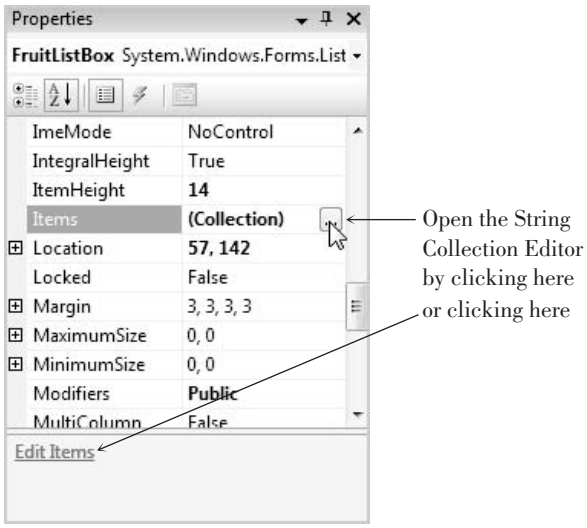
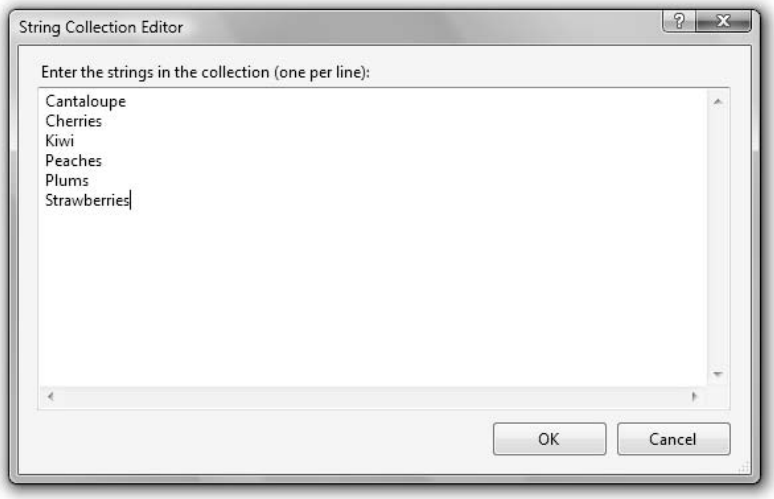


Figure 7.4

In the String Collection Editor that opens, type each list item and press Enter to go to the next line.



Using the Items.Add Method

To add an item to a list at run time, use the **`Items.Add` method**. You can choose to add a variable, a constant, the contents of the text box at the top of a combo box, or the Text property of another control.

The Items.Add Method—General Form

General Form

```
Object.Items.Add(ItemValue)
```

ItemValue is the string value to add to the list. If the value is a string literal, enclose it in quotation marks.

The new item generally goes at the end of the list. However, you can alter the placement by setting the control's **Sorted property** to True. Then the new item will be placed alphabetically in the list.

The Items.Add Method—Examples

Examples

```
SchoolsListBox.Items.Add("Harvard")
SchoolsListBox.Items.Add("Stanford")
SchoolsListBox.Items.Add(SchoolsTextBox.Text)
MajorsComboBox.Items.Add(MajorsComboBox.Text)
MajorsComboBox.Items.Add(MajorString)
```

When the user types a new value in the text box portion of a combo box, that item is not automatically added to the list. If you want to add the newly entered text to the list, use the `Items.Add` method:

```
CoffeeComboBox.Items.Add(CoffeeComboBox.Text)
```

or the preferable form:

```
With CoffeeComboBox
   .Items.Add(.Text)
End With
```

You also can add the contents of a text box to a list box.

```
SchoolsListBox.Items.Add(SchoolTextBox.Text)
```

Using the Items.Insert Method

You can choose the location for a new item added to the list. In the **`Items.Insert` method**, you specify the index position for the new item.

The Items.Insert Method—General Form

General Form

```
Object.Items.Insert(IndexPosition, ItemValue)
```

The index position is zero based. To insert a new item in the first position, use index position = 0.

The Items.Insert Method—Examples

Examples

```
SchoolsListBox.Items.Insert(0, "Harvard")
MajorsComboBox.Items.Insert(1, MajorsComboBox.Text)
```

If you choose the index position of an item using the `Insert` method, do not set the list control's Sorted property to True. A sorted list is always sorted into alphabetic order, regardless of any other order that you request.

The SelectedIndex Property

When a project is running and the user selects (highlights) an item from the list, the index number of that item is stored in the **SelectedIndex property** of the list box. Recall that the index of the first item in the list is 0. If no list item is selected, the SelectedIndex property is set to negative 1 (–1).

You can use the SelectedIndex property to select an item in the list or deselect all items in code.

Examples

```
' Select the fourth item in list.
CoffeeTypesListBox.SelectedIndex = 3

' Deselect all items in list.
CoffeeTypesListBox.SelectedIndex = –1
```

The Items.Count Property

You can use the Count property of the Items collection to determine the number of items in the list. We will use the **Items.Count property** later in this chapter to process each element in the list. Items.Count is also handy when you need to display the count at some point in your project.

Remember: Items.Count is always one more than the highest possible SelectedIndex, since the indexes begin with 0. For example, if there are five items in a list, Items.Count is 5 and the highest index is 4 (Figure 7.5).

Figure 7.5

For a list of five items, the indexes range from 0 to 4.

Items.SelectedIndex	Items.Count = 5
(0)	Harvard
(1)	Stanford
(2)	University of California
(3)	Miami University
(4)	University of New York

Examples

```
TotalItemsInteger = ItemsListBox.Items.Count
MessageBox.Show("The number of items in the list is " & _
  ItemsListBox.Items.Count.ToString())
```

Referencing the Items Collection

If you need to display one item from a list, you can refer to one element of the Items collection. The Items collection of a list box or combo box holds the text of all list elements. You specify which element you want by including an index.

This technique can be useful if you need to display a list item in a label or on another form. Later in this chapter we will use the Items property to send the contents of the list box to the printer.

Using the Items Collection—General Form

General Form

```
Object.Items(IndexPosition) [ = Value]
```

The index of the first list element is 0, so the highest index is Items.Count – 1.

Note: If you use an *IndexPosition* less than 0 or greater than Items.Count – 1, an exception will be thrown.

You can retrieve the value of a list element or set an element to a new value.

Using the Items Collection—Examples

Examples

```
SchoolsListBox.Items(5) = "University of California"
MajorLabel.Text = MajorsComboBox.Items(IndexInteger)
SelectedMajorLabel.Text = MajorsComboBox.Items(MajorsComboBox.SelectedIndex)
SelectedMajorLabel.Text = MajorsComboBox.Text
```

To refer to the currently selected element of a list, you must combine the Items property and the SelectedIndex property:

```
SelectedFlavorString = FlavorListBox.Items(FlavorListBox.SelectedIndex).ToString()
```

You also can retrieve the selected list item by referring to the Text property of the control:

```
SelectedMajorLabel.Text = MajorsComboBox.Text
```

Note: If you assign a value to a particular item, you replace the previous contents of that position. For example,

```
SchoolsListBox.Items(0) = "My School"
```

places "My School" into the first position, replacing whatever was there already. It does not insert the item into the list or increase the value in Items.Count.

Removing an Item from a List

You can remove individual items from a list either by specifying the index of the item or the text of the item. Use the **`Items.RemoveAt` method** to remove an item by index and the **`Items.Remove` method** to remove by specifying the text.

The Items.RemoveAt Method—General Form

General Form

```
Object.Items.RemoveAt(IndexPosition)
```

The index is required; it specifies which element to remove. The index of the first list element is 0, and the index of the last element is Items.Count – 1. If you specify an invalid index, the system throws an IndexOutOfRange exception.

The Items.RemoveAt Method—Examples

Examples

```
' Remove the first name from the list.
NamesListBox.Items.RemoveAt(0)
' Remove the item in position IndexInteger.
SchoolsComboBox.Items.RemoveAt(IndexInteger)
' Remove the currently selected item.
CoffeeComboBox.Items.RemoveAt(CoffeeComboBox.SelectedIndex)
```

The Items.Remove Method—General Form

General Form

```
Object.Items.Remove(TextString)
```

The `Items.Remove` method looks for the specified string in the Items collection. If the string is found, it is removed; however, if it is not found, no exception is generated.

The Items.Remove Method—Examples

Examples

```
' Remove the specified item.
NamesListBox.Items.Remove("My School")
' Remove the matching item.
SchoolsComboBox.Items.Remove(SchoolTextBox.Text)
' Remove the currently selected item.
CoffeeComboBox.Items.Remove(CoffeeComboBox.Text)
```

When you remove the currently selected item using either the `RemoveAt` or `Remove` method, make your code more efficient and easier to read by using the `With` statement.

```
With CoffeeComboBox
   If .SelectedIndex <> –1 Then
      .Items.RemoveAt(.SelectedIndex)     ' Remove by Index.
      '.Items.Remove(.Text)               ' Alternate – remove by Text.
   Else
      MessageBox.Show("First select the coffee to remove.", "No Selection Made", _
        MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
   End If
End With
```

Clearing a List

In addition to removing individual items at run time, you also can clear all items from a list. Use the **`Items.Clear` method** to empty a combo box or list box.

The Items.Clear Method—General Form

General Form

```
Object.Items.Clear()
```

The Clear Method—Examples

Examples

```
SchoolsListBox.Items.Clear()
MajorsComboBox.Items.Clear()
```

```
' Confirm clearing the majors list.
Dim ResponseDialogResult As DialogResult

ResponseDialogResult = MessageBox.Show("Clear the majors list?", "Clear Majors List", _
  MessageBoxButtons.YesNo, MessageBoxIcon.Question)

If ResponseDialogResult = DialogResult.Yes Then
    MajorsComboBox.Items.Clear()
End If
```

List Box and Combo Box Events

Later in the chapter we will perform actions in event procedures for events of list boxes and combo boxes. Some useful events are the SelectedIndexChanged, TextChanged, Enter, and Leave.

Note: Although we haven't used these events up until this point, many other controls have similar events. For example, you can code event procedures for the Enter, Leave, and TextChanged events of text boxes.

The TextChanged Event

As the user types text into the text box portion of a combo box, the TextChanged event occurs. Each keystroke generates another TextChanged event.

The Enter Event

When a control receives the focus, an Enter event occurs. As the user tabs from control to control, an Enter event fires for each control. Later you will learn to make any existing text appear selected when the user tabs to a text box or the text portion of a combo box.

The Leave Event

You can also write code for the Leave event of a control. When the user tabs from one control to another, the Leave event is triggered as the control loses focus, before the Enter event of the next control. Programmers often use Leave event procedures to validate input data.

TIP

To write a procedure for an event that isn't the default event, you cannot just double-click the control. Instead, in the Properties window, click the *Events* button, and then double-click the event name. The Editor will create the procedure header for you. ■

Feedback 7.1

Describe the purpose of each of the following methods or properties for a list box or combo box control.

1. Sorted
2. SelectedIndex
3. Items
4. DropDownStyle
5. Items.Count
6. `Items.Add`
7. `Items.Insert`
8. `Items.Clear`
9. `Items.RemoveAt`
10. `Items.Remove`

Do/Loops

Until now, there has been no way to repeat the same steps in a procedure without calling them a second time. The computer is capable of repeating a group of instructions many times without calling the procedure for each new set of data. The process of repeating a series of instructions is called *looping*. The group of repeated instructions is called a ***loop***. An **iteration** is a single execution of the statement(s) in the loop. In this section, you will learn about the `Do/Loop`. Later in this chapter, you will learn about another type of loop—a `For/Next` loop.

A **`Do/Loop`** terminates based on a condition that you specify. Execution of a `Do/Loop` continues *while* the condition is True or *until* the condition is True. You can choose to place the condition at the top or the bottom of the loop.

Align the **`Do`** and **`Loop` statements** with each other and indent the lines of code to be repeated in between.

The Do and Loop Statements—General Form

General Form

```
Do {While | Until} Condition
  ' Statements in loop.

Loop

or

Do
  ' Statements in loop.

Loop {While | Until} Condition
```

The first form of the `Do/Loop` tests for completion at the top of the loop. With this type of loop, also called a ***pretest*** or ***entry test***, the statements inside the loop may never be executed if the terminating condition is True the first time it is tested.

Example

```
TotalInteger = 0
Do Until TotalInteger = 0
    ' These statements in loop will never execute.
Loop
```

Because TotalInteger is 0 the first time the condition is tested, the condition is True and the statements inside the loop will not execute. Control will pass to the statement following the `Loop` statement.

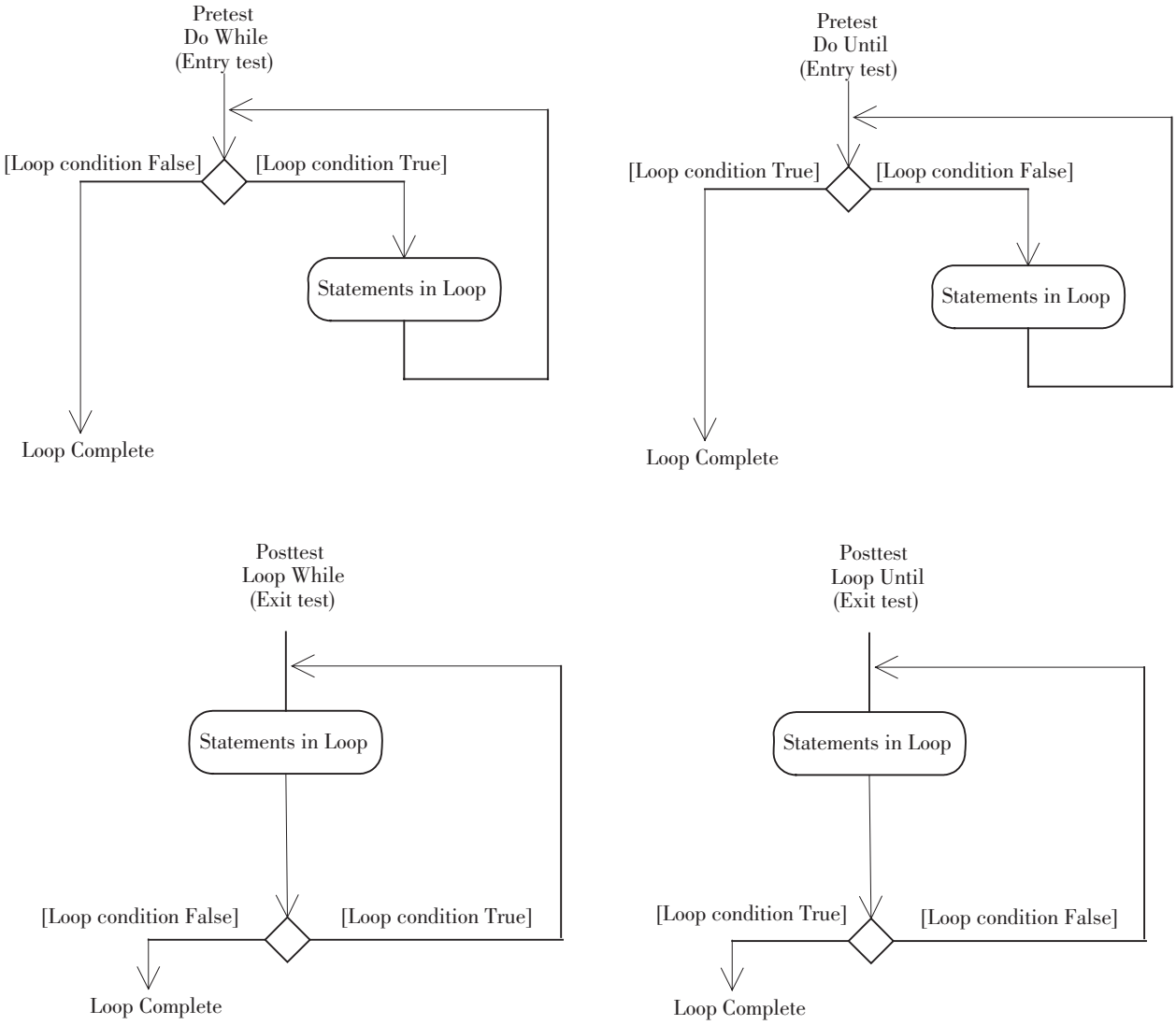
The second form of the `Do/Loop` tests for completion at the bottom of the loop, which means that the statements inside the loop will *always* be executed at least once. This form of loop is sometimes called a ***posttest*** or ***exit test***. Changing the example to a posttest, you can see the difference.

```
TotalInteger = 0
Do
   ' Statements in Loop will execute at least once.

Loop Until TotalInteger = 0
```

In this case the statements inside the loop will be executed at least once. Assuming the value for TotalInteger does not change inside the loop, the condition (TotalInteger = 0) will be True the first time it is tested and control will pass to the first statement following the `Loop` statement. Figure 7.6 shows UML action diagrams of pretest and posttest loops, using both `While` and `Until`.

Figure 7.6

UML action diagrams of pretest and posttest loops.



The Do and Loop Statements—Examples

Examples

```
Do Until ItemIndexInteger = ItemsListBox.Items.Count – 1
  ' Statements in loop.

Loop

Do While AmountDecimal >= 10D And AmountDecimal <= 20D
  ' Statements in loop.

Loop

Do
  ' Statements in loop.
Loop Until TotalInteger < 0
```

The Boolean Data Type Revisited

In Chapter 2 you learned to set and test True and False Boolean values. You will find Boolean variables very useful when setting and testing conditions for a loop. You can set a Boolean variable to True when a specific circumstance occurs and then write a loop condition to continue until the variable is True.

An example of using a Boolean variable is when you want to search through a list for a specific value. The item may or may not be found, and you want to quit looking when a match is found.

Using a Boolean variable is usually a three-step process. First you must dimension a variable and set its initial value (or use the default VB setting of False). Then, when a particular situation occurs, you set the variable to True. A loop condition can then check for True.

```
Dim ItemFoundBoolean as Boolean = False

Do Until ItemFoundBoolean    ' Checks for True.
  ' ...
```

A Boolean variable is always in one of two states: True or False. Many programmers refer to Boolean variables as *switches* or *flags*. Switches have two states—on or off; flags are considered either up or down.

Using a Do/Loop with a List Box

This small example combines a Boolean variable with a `Do/Loop`. Inside the loop, each element of the list is compared to NewItemTextBox.Text for a match. The loop will terminate when a match is found or when all elements have been tested. Follow through the logic to see what happens when there is a match, when there isn't a match, when the match occurs on the first list element, and when the match occurs on the last list element.

```
Private Sub FindButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles FindButton.Click
    ' Look for a match between text box and list items.
    Dim ItemFoundBoolean As Boolean = False
    Dim ItemIndexInteger As Integer = 0
```

```
    Do Until ItemFoundBoolean Or ItemIndexInteger = ItemsListBox.Items.Count
      If NewItemTextBox.Text = ItemsListBox.Items(ItemIndexInteger).ToString() Then
        ItemFoundBoolean = True  'A match was found.
      Else
        ItemIndexInteger += 1
      End If
    Loop

    If ItemFoundBoolean Then
      MessageBox.Show("Item is in the list.", "Item match", _
        MessageBoxButtons.OK, MessageBoxIcon.Information)
    Else
      MessageBox.Show("Item is not in the list.", "No item match", _
        MessageBoxButtons.OK, MessageBoxIcon.Information)
    End If
End Sub
```

Feedback 7.2

Explain the purpose of each line of the following code:

```
ItemFoundBoolean = False
ItemIndexInteger = 0
Do Until ItemFoundBoolean Or ItemIndexInteger = ItemsListBox.Items.Count
    If NewItemTextBox.Text = ItemsListBox.Items(ItemIndexInteger).ToString() Then
       ItemFoundBoolean = True
    Else
       ItemIndexInteger += 1
    End If
Loop
```

For/Next Loops

When you want to repeat the statements in a loop a specific number of times, the **`For/Next` loop** is ideal. The `For/Next` loop uses the **`For`** and **`Next` statements** and a counter variable, called the ***loop index***. The loop index is tested to determine the number of times the statements inside the loop will execute.

```
Dim LoopIndexInteger as Integer
Dim MaximumInteger as Integer
MaximumInteger = SchoolsListBox.Items.Count – 1

For LoopIndexInteger = 0 To MaximumInteger
    ' The statements inside of the loop are indented
    ' and referred to as the body of the loop.
Next LoopIndexInteger
```

When the `For` statement is reached during program execution, several things occur. The loop index, LoopIndexInteger, is established as the loop counter and is initialized to 0 (the initial value). The final value for the loop index is set to the value of MaximumInteger, which was assigned the value of SchoolsListBox.Items.Count – 1 in the previous statement.

Execution is now "controlled by" the `For` statement. After the value of LoopIndexInteger is set, it is tested to see whether LoopIndexInteger is *greater than* MaximumInteger. If not, the statements in the body of the loop are executed. The `Next` statement causes the LoopIndexInteger to be incremented by 1. Then control passes back to the `For` statement. Is the value of LoopIndexInteger greater than MaximumInteger? If not, the loop is again executed. When the test is made and the loop index *is* greater than the final value, control passes to the statement immediately following the `Next`.

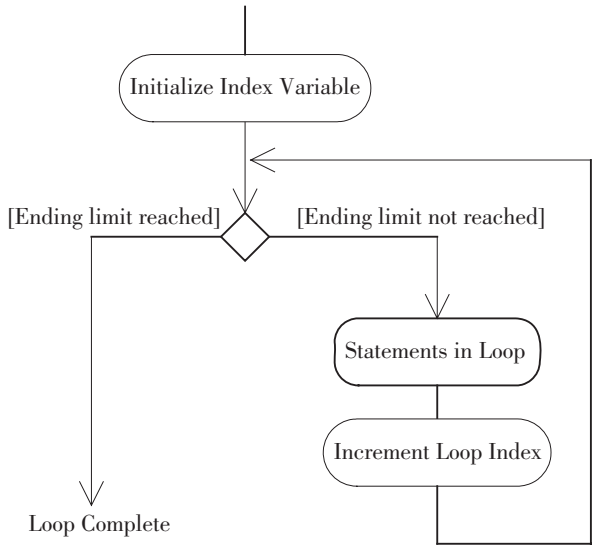
A counter-controlled loop generally has three elements (see Figure 7.7 for a UML action diagram of loop logic).

1. Initialize the counter.
2. Increment the counter.
3. Test the counter to determine when it is time to terminate the loop.

A `For/Next` loop handles all three steps for you.

Figure 7.7

A UML action diagram of the logic of a `For/Next` *loop.*



The For and Next Statements—General Form

General Form

```
For LoopIndex [As Datatype] = InitialValue To TestValue [Step Increment]
    '
    ' Statements in loop.
    '
Next [LoopIndex]
```

LoopIndex must be a numeric variable; InitialValue and TestValue may be constants, variables, numeric property values, or numeric expressions. The optional word `Step` may be included, along with the value to be added to the loop index for each iteration of the loop. When the `Step` is omitted, the increment is assumed to be 1.

The optional `As Datatype` entry allows you to declare the index variable as part of the `For` statement. This technique creates a block-level variable that is available only inside the `For/Next` loop. Declaring and using a block-level variable for the loop index is the preferred approach.

The For and Next Statements—Examples

Examples

```
For IndexInteger As Integer = 2 To 100 Step 2
For CountInteger As Integer = StartInteger To EndInteger Step IncrementInteger
For CountInteger = 0 To CoffeeComboBoxType.Items.Count – 1
For NumberInteger = (NumberCorrectInteger – 5) To TotalPossibleInteger
For RateDecimal As Decimal = 0.05D To 0.25D Step 0.05D
For CountDownInteger As Integer = 10 To 0 Step –1
```

Each `For` statement has a corresponding `Next` statement, which must follow the `For`. All statements between the `For` and `Next` statements are considered to be the body of the loop and will be executed the specified number of times.

The first `For` statement example will count from 2 to 100 by 2. The statements in the body of the loop will be executed 50 times: first with IndexInteger = 2, next with IndexInteger = 4, next with IndexInteger = 6, and so forth.

When the comparison is done, the program checks for *greater than* the test value—not equal to. When IndexInteger = 100 in the preceding example, the body of the loop will execute one more time. Then, at the `Next` statement, IndexInteger will be incremented to 102, the test will be made, and control will pass to the statement following the `Next`.

TIP

Use a `For/Next` loop when you know the number of iterations needed for the loop. Use a `Do/Loop` when the loop should end based on a condition. ■

Negative Increment or Counting Backward

You can use a negative number for the `Step` increment to decrease the loop index rather than increase it. When the `Step` is negative, VB tests for *less than* the test value instead of greater than.

```
' Count Backwards.
For CountInteger As Integer = 10 To 1 Step –1
   ' Statements in body of loop.
Next CountInteger
```

Conditions Satisfied before Entry

At times the final value will be reached before entry into the loop. In that case, the statements in the body of the loop will not be executed at all.

```
' An unexecutable loop.
FinalInteger = 5
For IndexInteger As Integer = 6 to FinalInteger
   ' The execution will never reach here.
Next IndexInteger
```

Altering the Values of the Loop Control Variables

Once a `For` loop has been entered, the values for InitialValue, TestValue, and Increment have already been set. Changing the value of these control variables within the loop will have no effect on the number of iterations of the loop. Many texts admonish against changing the values within the loop. However, Visual Basic just ignores you if you try.

```
' Bad Example – Changing the Control Variable.
FinalInteger = 10
IncreaseInteger = 2
For IndexInteger As Integer = 1 to FinalInteger Step IncreaseInteger
    FinalInteger = 25
    IncreaseInteger = 5
Next IndexInteger
```

If you tried this example and displayed the values of IndexInteger, you would find that the final value remains 10 and the increment value is 2.

The value that you *can* change within the loop is the loop index. However, this practice is considered poor programming.

```
' Poor Programming.
For IndexInteger = 1 To 10 Step 1
  IndexInteger += 5
Next IndexInteger
```

Endless Loops

Changing the value of a loop index variable is not only considered a poor practice but also may lead to an endless loop. Your code could get into a loop that is impossible to exit. Consider the following example; when will the loop end?

```
' More Poor Programming.
For IndexInteger = 1 To 10 Step 1
    IndexInteger = 1
Next IndexInteger
```

Exiting Loops

In the previous example of an endless loop, you will have to break the program execution manually. You can click on your form's close box or use the Visual Basic menu bar or toolbar to stop the program. If you can't see the menu bar or toolbar, you can usually move or resize your application's form to bring it into view. If you prefer, press Ctrl + Break to enter break time; you may want to step program execution to see what is causing the problem.

Usually loops should proceed to normal completion. However, on occasion you may need to terminate a loop before the loop index reaches its final value. Visual Basic provides `Exit For` and `Exit Do` statements for this situation. Generally, the `Exit` statement is part of an `If` statement.

The Exit Statement—General Form

General Form

```
Exit For
Exit Do
```

The `Exit For` and `Exit Do` transfer control to the statement following the loop termination—the `Next` or `Loop` statement at the bottom of the loop structure.

The Exit Statement—Examples

Examples

```
For IndexInteger As Integer = 1 To MaxInteger
    If IndexInteger > 1000 Then
        Exit For
    End If
    ' Statements in loop.
Next IndexInteger

Do Until ItemIndexInteger = ItemsListBox.Items.Count
    If NewItemTextBox.Text = _
      ItemsListBox.Items(ItemIndexInteger).ToString() Then
        ItemFoundBoolean = True
        Exit Do
    Else
        ItemIndexInteger += 1
    End If
Loop
```

Skipping to the Next Iteration of a Loop

At times you may be finished in the current iteration of a loop and want to skip to the next. The `Continue` statement transfers control to the last statement in the loop and retests the loop exit condition. This effectively skips to the next iteration of the loop. Generally, the `Continue` statement is part of an `If` statement.

The Continue Statement—General Form

General Form

```
Continue For
Continue Do
```

The Continue Statement—Examples

Examples

```
For LoopInteger As Integer = 0 To NameListBox.Items.Count – 1
    If NameListBox.Items(LoopInteger).ToString() = String.Empty Then
       Continue For
    End If
    ' Code to do something with the name found.
    Debug.WriteLine("Name = " & NameListBox.Items(LoopInteger).ToString())
Next

LoopInteger = –1
Do Until LoopInteger = NameListBox.Items.Count – 1
    LoopInteger += 1
    If NameListBox.Items(LoopInteger).ToString() = String.Empty Then
       Continue Do
    End If
    ' Code to do something with the name found.
    Debug.WriteLine("Name = " & NameListBox.Items(LoopInteger).ToString())
Loop
```

Note: The two above examples do the same thing, but you'll notice that the `For` loop has less code. Because the number of iterations is known (Items.Count), the `For` statement is the preferred solution.

Feedback 7.3

1. Identify the statements that are correctly formed and those that have errors. For those with errors, state what is wrong and how to correct it.
   (a)
   ```
   For IndexDecimal = 3.5D To 6.0D, Step 0.5D
   Next IndexDecimal
   ```
   (b)
   ```
   For IndexInteger = BeginInteger To EndInteger Step IncrementInteger
   Next EndInteger
   ```
   (c)
   ```
   For 4 = 1 To 10 Step 2
   Next For
   ```
   (d)
   ```
   For IndexInteger = 100 To 0 Step –25
   Next IndexInteger
   ```
   (e)
   ```
   For IndexInteger = 0 To –10 Step –1
   Next IndexInteger
   ```
   (f)
   ```
   For IndexInteger = 10 To 1
   Next IndexInteger
   ```
2. How many times will the body of the loop be executed for each of these examples? What will be the value of the loop index after normal completion of the loop?
   (a) `For CountInteger = 1 To 3`
   (b) `For CountInteger = 2 To 11 Step 3`
   (c) `For CountInteger = 10 To 1 Step –1`
   (d) `For CounterDecimal = 3.0D To 6.0D Step 0.5D`
   (e) `For CountInteger = 5 To 1`

Making Entries Appear Selected

You can use several techniques to make the text in a text box or list appear selected.

Selecting the Entry in a Text Box

When the user tabs into a text box that already has an entry, how do you want the text to appear? Should the insertion point appear at either the left or right end of the text? Or should the entire entry appear selected? You also can apply this question to a text box that fails validation: Shouldn't the entire entry be selected? The most user-friendly approach is to select the text, which you can do with the `SelectAll` method of the text box. A good location to do this is in the text box's Enter event procedure, which occurs when the control receives the focus.

```
Private Sub NameTextBox_Enter(ByVal sender As Object, _
  ByVal e As System.EventArgs) Handles NameTextBox.Enter
    ' Select any existing text.

    NameTextBox.SelectAll()
End Sub
```

Selecting an Entry in a List Box

You can make a single item in a list box appear selected by setting the SelectedIndex property.

```
CoffeeListBox.SelectedIndex = IndexInteger
```

When a list box has a very large number of entries, you can help users by selecting the matching entry as they type in a text box. This method is similar to the way the Help Topics list in Visual Basic works. For example, when you type *p*, the list quickly scrolls and displays words beginning with *p*. Then if you next type *r*, the list scrolls down to the words that begin with *pr* and the first such word is selected. If you type *i* next, the first word beginning with *pri* is selected. The following example implements this feature. See if you can tell what each statement does.

Notice that this is coded in the TextChanged event procedure for the control into which the user is typing; the event occurs once for every keystroke entered.

```
Private Sub CoffeeTextBox_TextChanged(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles CoffeeTextBox.TextChanged

    ' Locate first matching occurrence in the list.

    Dim IndexInteger As Integer = 0
    Dim FoundBoolean As Boolean = False
    Dim ListCompareString As String
    Dim TextCompareString As String

    Do While Not FoundBoolean And IndexInteger < CoffeeListBox.Items.Count
        ListCompareString = CoffeeListBox.Items(IndexInteger).ToString().ToUpper()
        TextCompareString = CoffeeTextBox.Text.ToUpper()
        If ListCompareString.StartsWith(TextCompareString) Then
            CoffeeListBox.SelectedIndex = IndexInteger
            FoundBoolean = True
        Else
            IndexInteger += 1
        End If
    Loop
End Sub
```

Sending Information to the Printer

So far, your program output has been on the screen or a print of a form. You can use the VB PrintDocument and PrintPreviewDialog components to produce more customized output for the printer and also to preview the output on the screen. These components appear in the *Printing* tab of the toolbox.

Visual Basic was designed to run under Windows, which is a highly interactive environment. It is extremely easy to create forms for interactive programs, but it is not easy at all to print formatted output on the printer. Most professional programmers using Visual Basic use a separate utility program to format printer reports. Several companies sell utilities that do a nice job of designing and printing reports. The VB Professional Edition and Enterprise Edition include Crystal Reports for creating reports from database files.

The PrintDocument Component

You set up output for the printer using the methods and events of the **PrintDocument component**. Add a PrintDocument component to a form; the component appears in the component tray below the form (Figure 7.8).

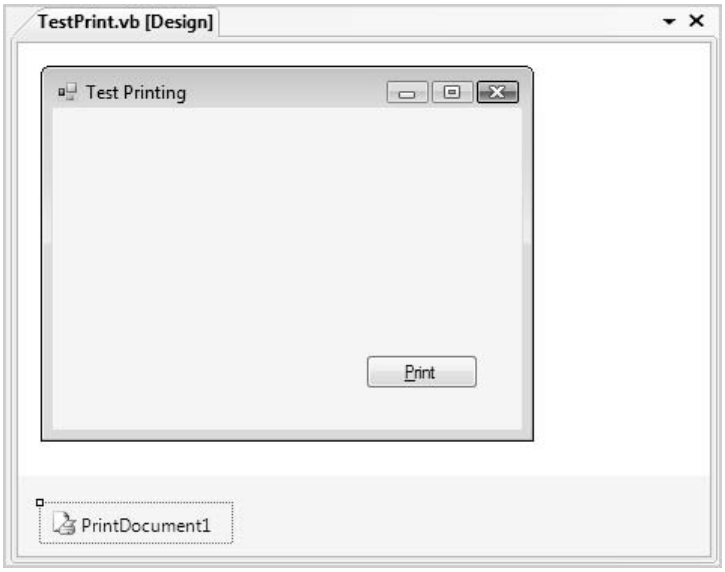


Figure 7.8

Add a PrintDocument component to your application. The component appears in the form's component tray.

Initiating a Print Operation

To initiate printing output, you execute the **`Print` method** of the PrintDocument component. This code belongs in the Click event procedure for the Print button or menu item that the user selects to begin printing.

```
Private Sub PrintButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles PrintButton.Click
      ' Print output on the printer.

      PrintDocument1.Print()   ' Start the print process.
End Sub
```

Setting Up the Print Output

The code that you write to set up the printed page belongs in the PrintDocument's **PrintPage event procedure**. The PrintPage event is fired once for each page to be printed. This technique is referred to as a ***callback*** and is different from anything we have done so far. In a callback, the object notifies the program that it needs to do something or that a situation exists that the program needs to handle. The object notifies the program of the situation by firing an event.

The PrintDocument object is activated when you issue its `Print` method (usually from a menu option or a button click). It then sets up the graphics page that corresponds to your printer and fires a PrintPage event for each page to print. It also fires events for BeginPrint and EndPrint, for which you can write code if you wish.

```
Private Sub PrintDocument1_PrintPage(ByVal sender As System.Object, _
  ByVal e As System.Drawing.Printing.PrintPageEventArgs) _
  Handles PrintDocument1.PrintPage
      ' Set up actual output to print.

End Sub
```

Notice the argument: `e As System.Drawing.Printing.PrintPage-EventArgs`. We will use some of the properties and methods of the PrintPage-EventArgs argument for such things as determining the page margins and sending a string of text to the page.

The Graphics Page

You set up a graphics page in memory, and then the page is sent to the printer. The graphics page can contain strings of text as well as graphic elements.

You must specify the exact location on the graphics page for each element that you want to print. You can specify the upper-left corner of any element by giving its X and Y coordinates, or by using a Point structure or a Rectangle structure. We will stick with the X and Y coordinates in these examples (Figure 7.9).

You can use multiple PrintDocument objects if you have more than one type of output or report. Each PrintDocument has its own PrintPage event. Code the graphics commands to precisely print the page in each document's PrintPage event procedure.

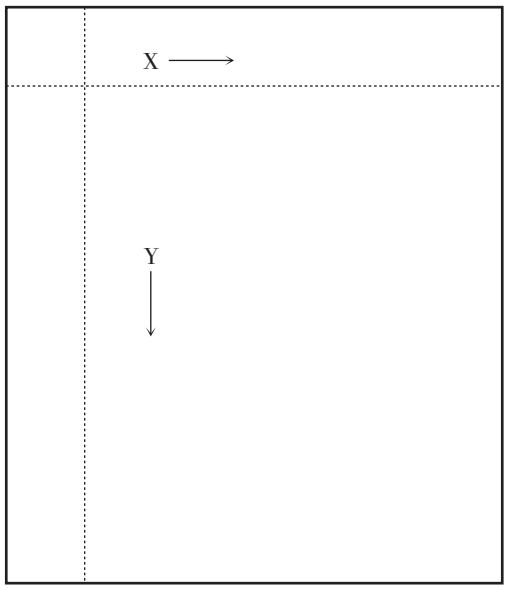


Figure 7.9

The X coordinate is the horizontal distance across a line from the left edge of the page; the Y coordinate is the vertical distance from the top of the page. The measurements are in pixels.

Using the DrawString Method

You use the **`DrawString` method** to send a line of text to the graphics page. The `DrawString` method belongs to the Graphics object of the PrintPage-EventArgs argument. Refer back to the procedure header for the PrintPage event in "Setting Up the Print Output."

The DrawString Method—General Form

The `DrawString` method is overloaded, which means that there are several forms for calling the method. The form presented here is the least complicated and requires that page coordinates be given in X and Y format.

General Form

```
DrawString(StringToPrint, Font, Brush, Xcoordinate, Ycoordinate)
```

You supply the arguments of the `DrawString` method: what to print, what font and color to print it in, and where to print it.

The DrawString Method—Examples

Examples

```
e.Graphics.DrawString(PrintLineString, PrintFont, Brushes.Black, _
  HorizontalPrintLocationSingle, VerticalPrintLocationSingle)
e.Graphics.DrawString("My text string", MyFont, Brushes.Black, 100.0, 100.0)
e.Graphics.DrawString(NameTextBox.Text, New Font("Arial", 10), Brushes.Red, _
  LeftMarginSingle, CurrentLineSingle)
```

Before you execute the `DrawString` method, you should set up the font that you want to use and the X and Y coordinates.

Getting Started with Printing—Step-by-Step

This simple project introduces you to printing by creating a document that sends your name to the printer.

Create the Project

STEP 1: Create a project called Ch07Printing.
STEP 2: Add a button and a PrintDocument component to the form.
STEP 3: Name the button PrintButton with appropriate text.

Set Up the Page to Print

STEP 1: Double-click on *PrintDocument1* in the component tray. The PrintPage event handler appears.
STEP 2: Write the code.

```
' Information to print.

e.Graphics.DrawString("Your Name", New Font("Arial", 36), _
  Brushes.Black, 100, 100)
```

Write Code for the Print Button

STEP 1: Go to the Click event procedure for the PrintButton and add the code to call the `Print` method of the print document.

Note: You also can print to the Print Preview window; see Page 311.

```
Private Sub PrintButton_Click(ByVal sender As Object, _
  ByVal e As System. EventArgs) Handles PrintButton.Click
    ' Call the Print method of the PrintDocument component.
    PrintDocument1.Print()
End Sub
```

Run the Program

STEP 1: Run the program and click on the *Print* button. A page should print on the printer.

STEP 2: Stop execution and change the font and location for the text. If you have a color printer, try changing the color for the brushes.

STEP 3: Run the program again.

Setting the X and Y Coordinates

For each line that you want to print, you must specify the X and Y coordinates. It is helpful to set up some variables for setting these values, which should be declared as Single data type.

```
Dim HorizontalPrintLocationSingle As Single
Dim VerticalPrintLocationSingle As Single
```

The PrintPageEventArgs argument has several useful properties (Figure 7.10), such as MarginBounds, PageBounds, and PageSettings. You can use these properties to determine the present settings. For example, you may want to set the X coordinate to the current left margin and the Y coordinate to the top margin.

```
HorizontalPrintLocationSingle = e.MarginBounds.Left
VerticalPrintLocationSingle = e.MarginBounds.Top
```

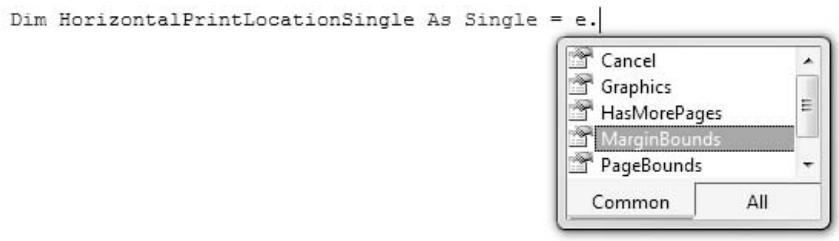


Figure 7.10

Use the properties of the PrintPageEventArgs argument to determine the current margin settings.

Printing Multiple Lines

To send multiple lines to the print page, you must increment the Y coordinate. You can add the height of a line to the previous Y coordinate to calculate the next line's Y coordinate. Use `PrintFont.GetHeight()` to retrieve the height of the line.

```
' Declarations at the top of the procedure.
Dim PrintFont As New Font("Arial", 12)
Dim LineHeightSingle As Single = PrintFont.GetHeight + 2 ' Add two pixels for spacing.
Dim HorizontalPrintLocationSingle As Single = e.MarginBounds.Left
Dim VerticalPrintLocationSingle As Single = e.MarginBounds.Top
Dim PrintLineString As String = "This is a test line to print."

' Print a line.
e.Graphics.DrawString(PrintLineString, PrintFont, Brushes.Black, _
  HorizontalPrintLocationSingle, VerticalPrintLocationSingle)

' Increment the Y position for the next line.
VerticalPrintLocationSingle += LineHeightSingle
```

Printing Summary

Although the steps for printing may sound confusing at first, you can follow these easy steps for nearly all printing tasks. Place the code for these actions in the PrintPage event procedure for the PrintDocument component:

1. At the top of the procedure, define the font(s), line height, and X and Y coordinates.
2. Set up the line to print.
3. Print the line.
4. Increment the Y coordinate if another line will be printed.
5. Place 2, 3, and 4 inside a loop if there are multiple lines to print.

Printing the Contents of a List Box

You can combine the techniques for printing, a loop, and the list box properties to send the contents of a list box to the printer. You know how many iterations to make, using the Items.Count property. The Items collection allows you to print out the actual values from the list.

```
' Print out all items in the CoffeeComboBox list.
For ListIndexInteger As Integer = 0 To CoffeeComboBox.Items.Count – 1
  ' Set up a line.
  PrintLineString = CoffeeComboBox.Items(ListIndexInteger).ToString()
  ' Send the line to the graphics page object.
  e.Graphics.DrawString(PrintLineString, PrintFont, Brushes.Black, _
    HorizontalPrintLocationSingle, VerticalPrintLocationSingle)
  ' Increment the Y position for the next line.
  VerticalPrintLocationSingle += LineHeightSingle
Next ListIndexInteger
```

Printing the Selected Item from a List

When an item is selected in a list box or a combo box, the Text property holds the selected item. You can use the Text property to print the selected item.

```
' Set up the line to print the selected list item.
PrintLineString = "Coffee: " & CoffeeComboBox.Text & _
    "     Syrup: " & SyrupListBox.Text
' Send the line to the graphics page object.
e.Graphics.DrawString(PrintLineString, PrintFont, Brushes.Black, _
  HorizontalPrintLocationSingle, VerticalPrintLocationSingle)
```

Aligning Decimal Columns

When the output to the printer includes numeric data, the alignment of the decimal points is important. Alignment can be tricky with proportional fonts, where the width of each character varies. The best approach is to format each number as you want it to print and then measure the length of the formatted string. This technique requires a couple more elements: You need an object declared as a SizeF structure, which has a Width property, and you need to use the `MeasureString` method of the Graphics class. Both the SizeF structure and the `MeasureString`

method work with pixels, which is what you want. It's the same unit of measure as used for the X and Y coordinates of the `DrawString` method.

The following example prints a left-aligned literal at position 200 on the line and right-aligns a formatted number at position 500. (Assume that all variables are properly declared.)

```
' SizeF structure for font size info.
Dim FontSizeF As New SizeF()

' Set X for left-aligned column.
HorizontalPrintLocationSingle = 200
' Set ending position for right-aligned column.
ColumnEndSingle = 500

' Format the number.
FormattedOutputString = AmountDecimal.ToString("C")

' Calculate the X position of the amount.

' Measure string in this font.
FontSizeF = e.Graphics.MeasureString(FormattedOutputString, PrintFont)
' Subtract width of string from the column position.
ColumnXSingle = ColumnEndSingle - FontSizeF.Width

' Set up the line - each element separately.
e.Graphics.DrawString("The Amount = ", PrintFont, Brushes.Black, _
  HorizontalPrintLocationSingle, VerticalPrintLocationSingle)
e.Graphics.DrawString(FormattedOutputString, PrintFont, Brushes.Black, _
  ColumnXSingle, VerticalPrintLocationSingle)
' Increment Y coordinate for next line.
VerticalPrintLocationSingle += LineHeightSingle
```

Displaying a Print Preview

A really great feature of the .NET printing model is **print preview**. You can view the printer's output on the screen and then choose to print or cancel. This is especially helpful for testing and debugging a program, so that you don't have to keep sending pages to the printer and wasting paper.

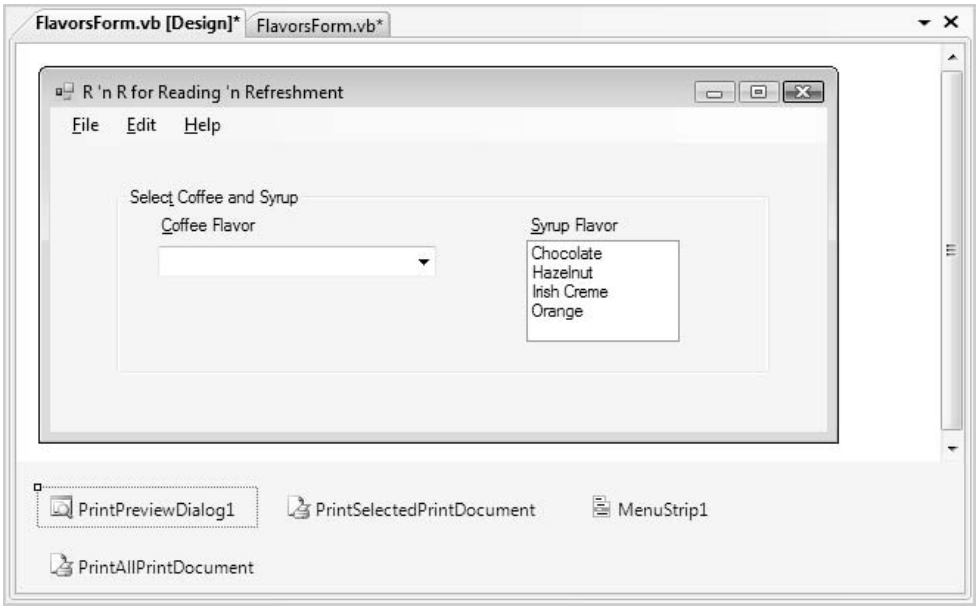
The **PrintPreviewDialog component** is the key to print preview. You add the control to your form's component tray; the default name is PrintPreviewDialog1 (Figure 7.11). Since you can use the same dialog for all print previews, you do not need to rename the component.

You write two lines of code in the event procedure for the button or menu item where the user selects the print preview option. The PrintPreviewDialog component uses the same PrintDocument component that you declared for printer output. You assign the PrintDocument to the Document property of the PrintPreviewDialog and execute the `ShowDialog` method. The same PrintPage event procedure executes as for the PrintDocument.

```
Private Sub PreviewAllToolStripMenuItem_Click(ByVal sender As Object, _
  ByVal e As System.EventArgs) Handles PreviewAllToolStripMenuItem.Click
      ' Begin the process for print preview of all items.

      PrintPreviewDialog1.Document = PrintAllPrintDocument
      PrintPreviewDialog1.ShowDialog()
End Sub
```

Figure 7.11

Add a PrintPreviewDialog component to your form's component tray.



Adding a PrintPreview Dialog to the Print Project—Step-by-Step

This exercise adds a *Print Preview* dialog box to the step-by-step example created earlier in this chapter.

Open the Project

STEP 1: Open Ch07Printing.
STEP 2: Add a PrintPreviewDialog component to the form.
STEP 3: Add a new button labeled "Print Preview".

Write the Code

STEP 1: Write the code for the *Print Preview* button.

```
Private Sub PrintPreviewButton_Click(ByVal sender As Object, _
  ByVal e As System.EventArgs) Handles PrintPreviewButton.Click
    ' Assign the PrintDialog1 document to the preview.

    PrintPreviewDialog1.Document = PrintDocument1
    ' Show the dialog.
    PrintPreviewDialog1.ShowDialog()
End Sub
```

Test the Program

STEP 1: Run the program. This time your output should appear in a *Print Preview* dialog box rather than on the printer.

The Using Block

When you are using system resources such as fonts, you can access the resources inside of a **Using block**. Any variables that are declared in a Using block are only accessible within that block, as with any other block-level variable. The advantage of declaring a variable inside a Using block is that system resources are released as soon as the block terminates.

```
Using HeadingFont as New Font("Arial", 14, FontStyle.Bold)
   e.Graphics.DrawString("Flavors", HeadingFont, Brushes.Black, HorizontalPrintLocationSingle, _
     VerticalPrintLocationSingle)
End Using
```

Printing Multiple Pages

You can easily print multiple pages, both to the printer and to the *Print Preview* dialog box. Recall that the PrintDocument's PrintPage event fires once for each page. You indicate that you have more pages to print by setting the HasMorePages property of the PrintPageEventArgs argument to True.

The following example prints four pages full of the same line, just to illustrate multiple-page output. Normally you will have a certain amount of data to print and stop when you run out.

```
Private Sub ReportPrintDocument_PrintPage(ByVal sender As Object, _
  ByVal e As System.Drawing.Printing.PrintPageEventArgs) _
  Handles ReportPrintDocument.PrintPage

    ' Print multipage output.
    Dim PrintFont As New Font("Arial", 12)
    Dim LineHeightSingle As Single = PrintFont.GetHeight + 2
    Dim VerticalPrintLocationSingle As Single = e.MarginBounds.Top
    Dim PrintLineString As String = "This is a test."

    ' Set the left margin.
    HorizontalPrintLocationSingle = 100

    ' Count pages for multiple-page output.
    ' Initialize the page number at 1.
    Static PageCountInteger As Integer = 1

    ' Print the page number.
    e.Graphics.DrawString("Page " & PageCountInteger.ToString(), PrintFont, _
      Brushes.Black, 600, VerticalPrintLocationSingle)
    VerticalPrintLocationSingle += LineHeightSingle * 2

    ' Print a page full of the same line.
    Do
        ' Print a line.
        e.Graphics.DrawString(PrintLineString, PrintFont, Brushes.Black, _
          HorizontalPrintLocationSingle, VerticalPrintLocationSingle)
        ' Double space.
        VerticalPrintLocationSingle += LineHeightSingle * 2

        ' Stop at the bottom margin.
    Loop Until VerticalPrintLocationSingle >= e.MarginBounds.Bottom

    ' Increment the page number.
    PageCountInteger += 1
```

```
    ' Indicate whether there are more pages to print.
    If PageCountInteger <= 4 Then       ' Print only 4 pages.
        e.HasMorePages = True
    Else
        e.HasMorePages = False
        ' Reset the page counter for the next report.
        PageCountInteger = 1
    End If
End Sub
```

Declaring the Page Counter as Static

As you learned in Chapter 6, static local variables keep their values from one execution of the procedure to the next. When you print multiple pages, you must keep track of the current page number, but you don't need that value in any procedure but the PrintPage procedure. This is the perfect time to use a static local variable.

```
' Count pages for multiple-page output.
' Initialize the page number at 1.
Static PageCountInteger As Integer = 1
```

Feedback 7.4

What is the purpose of each of these elements? Where and how is each used?

1. The PrintDocument component.
2. The `Print` method.
3. The PrintPage event.
4. The `DrawString` method.
5. `System.Drawing.Printing.PrintPageEventArgs`.
6. `MarginBounds.Left`.
7. The PrintPreviewDialog component.

Your Hands-On Programming Example

Create a project for R 'n R—for Reading 'n Refreshment that contains a drop-down combo box of the coffee flavors and a list box of the syrup flavors. Adjust the size of the boxes as needed when you test the project. The controls should have labels above them with the words *Coffee* and *Syrup*. Enter the initial values for the syrup flavors and coffee flavors in the Properties window. Set the Sorted property of both lists to True. The user will be able to add more coffee flavors to the list at run time by typing in the top portion of the combo box and selecting a menu item.

Coffee Flavors	Syrup Flavors
Espresso Roast	(None)
Jamaica Blue Mountain	Chocolate
Kona Blend	Hazelnut
Chocolate Almond	Irish Cream
Vanilla Nut	Orange

Include one menu item to print all the flavors and another to print only a selected item from each list. Then include submenus for each of the print options to allow the user to send the output to the printer or the Print Preview window. These print commands belong on the *File* menu, along with the *Exit* command. Use a separator bar between the *Print*s and the *Exit*.

Include an *Edit* menu with items to *Add coffee flavor*, *Remove coffee flavor*, *Clear coffee list*, and *Display coffee count*.

Add an About form to your project, and add a *Help* menu with an *About* command.

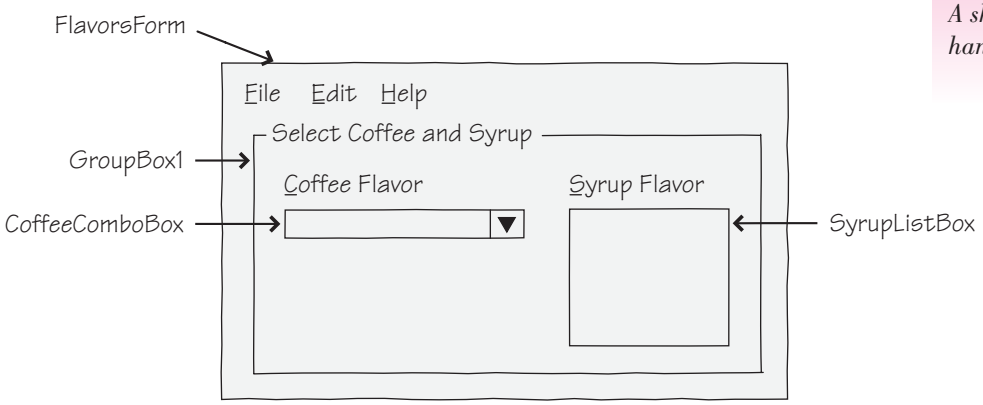
After you have completed the project, try using different styles for the combo box and rerun the project. As an added challenge, modify the *Add coffee flavor* routine so that no duplicates are allowed.

Planning the Project

Sketch a form (Figure 7.12), which your users sign off as meeting their needs.

Figure 7.12

A sketch of the form for the hands-on project.



Plan the Objects and Properties

Object	Property	Setting
FlavorsForm	Name	FlavorsForm
	Text	R 'n R for Reading 'n Refreshment
GroupBox1	Text	Select Coffee and Syrup
Label1	Text	&Coffee Flavor
Label2	Text	&Syrup Flavor
CoffeeComboBox	Name	CoffeeComboBox
	DropDownStyle	DropDown
	Items	Chocolate Almond
		Espresso Roast
		Jamaica Blue Mountain
		Kona Blend
		Vanilla Nut
	Sorted	True

Object	Property	Setting
SyrupListBox	Name	SyrupListBox
	Items	(None) Chocolate Hazelnut Irish Creme Orange
	Sorted	True
FileToolStripMenuItem	Text	&File
PrintSelectedFlavorsToolStripMenuItem	Text	Print &Selected Flavors
PrintAllFlavorsToolStripMenuItem	Text	Print &All Flavors
PrintAllToolStripMenuItem	Text	&Print All
PreviewAllToolStripMenuItem	Text	Pre&view All
PrintSelectedToolStripMenuItem	Text	&Print Selected
PreviewSelectedToolStripMenuItem	Text	Pre&view Selected
ExitToolStripMenuItem	Text	E&xit
EditToolStripMenuItem	Text	&Edit
AddCoffeeFlavorToolStripMenuItem	Text	&Add Coffee Flavor
RemoveCoffeeFlavorToolStripMenuItem	Text	&Remove Coffee Flavor
ClearCoffeeListToolStripMenuItem	Text	&Clear Coffee List
DisplayCoffeeCountToolStripMenuItem	Text	Count Coffee &List
HelpToolStripMenuItem	Text	&Help
AboutToolStripMenuItem	Text	&About
PrintAllPrintDocument	Name	PrintAllPrintDocument
PrintSelectedPrintDocument	Name	PrintSelectedPrintDocument
PrintPreviewDialog1	Name	PrintPreviewDialog1

Plan the Event Procedures

Main Form

Procedure	Actions

PreviewSelectedToolStripMenuItem_Click	If both coffee and syrup selected
	  Set Boolean variable for selected item.
	  Set the print preview document.
	  Show the print preview dialog.
	Else
	  Display error message.

Main Form

Procedure	Actions

PrintSelectedToolStripMenuItem_Click	If both coffee and syrup selected
	  Set Boolean variable for selected item.
	  Start the print operation.
	Else
	  Display error message.

PreviewAllToolStripMenuItem_Click	Set the print preview document. Show the print preview dialog.
PrintAllToolStripMenuItem_Click	Start the print operation.
PrintAllPrintDocument_PrintPage	Use a loop to send all flavor names to the printer.

PrintSelectedPrintDocument_PrintPage	If item is selected
	  Send selected item to the printer.
	Else
	  Display error message.

ExitToolStripMenuItem_Click	Terminate the project.

AddCoffeeFlavorToolStripMenuItem_Click	If a selection is made
	If duplicate item
	  Display "Duplicate" message.
	Else
	  Add item to the list.
	  Clear the list's Text Property.

RemoveCoffeeFlavorToolStripMenuItem_Click	If coffee flavor selected then
	  Remove selected item.
	Else
	  Display error message.

ClearCoffeeListToolStripMenuItem_Click	Display a message box to confirm the clear. If user clicks Yes Clear the coffee list.
DisplayCoffeeCountToolStripMenuItem_Click	Display list count in message box.
AboutToolStripMenuItem_Click	Display the About box.

About Form

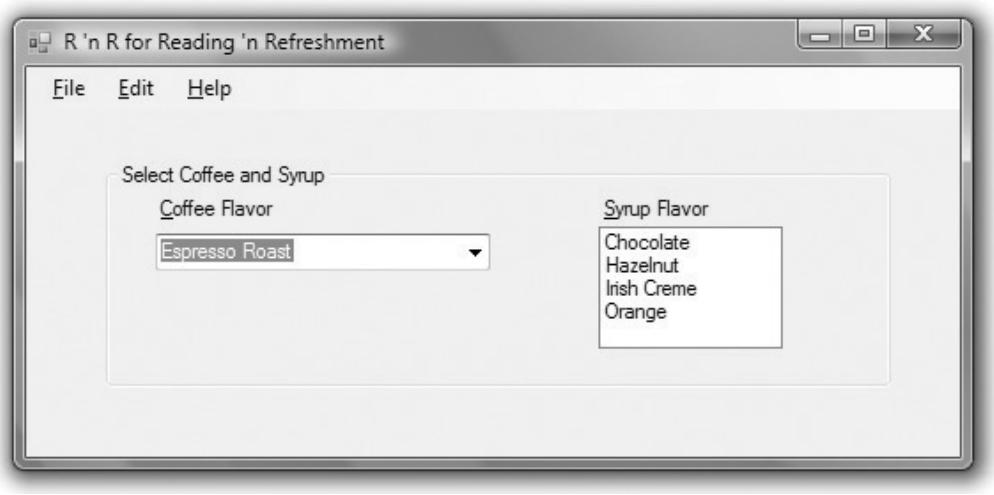
Procedure	Actions
OkButton_Click	Close the About box.

Write the Project Follow the sketch in Figure 7.12 to create the form. Figure 7.13 shows the completed form.

- Set the properties of each object as you have planned.
- Write the code. Working from the pseudocode, write each event procedure.
- When you complete the code, use a variety of data to thoroughly test the project.

Figure 7.13

The main form for the hands-on project.



The Project Coding Solution

Main Form

```
'Project:       Ch07HandsOn
'Programmer:    Bradley/Millspaugh
'Date:          June 2008
'Description:   Maintain a list of coffee flavors; print the selected flavor
'               of coffee and syrup or print a list of all of the coffee flavors.
'Folder:        Ch07HandsOn

Public Class FlavorsForm

    Private Sub ExitToolStripMenuItem_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ExitToolStripMenuItem.Click
        ' End the program.

        Me.Close()
    End Sub

    Private Sub AddCoffeeFlavorToolStripMenuItem_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles AddCoffeeFlavorToolStripMenuItem.Click
        ' Add a new coffee flavor to the coffee list.

        With CoffeeComboBox
            ' Test for blank input.
            If .Text <> "" Then
                ' Make sure item is not already on the list.
                Dim ItemFoundBoolean As Boolean
                Dim ItemIndexInteger As Integer
                Do Until ItemFoundBoolean Or ItemIndexInteger = .Items.Count
                    If .Text = .Items(ItemIndexInteger).ToString() Then
                        ItemFoundBoolean = True
                        Exit Do
                    Else
                        ItemIndexInteger += 1
                    End If
                Loop
                If ItemFoundBoolean Then
                    MessageBox.Show("Duplicate item.", "Add Failed", _
                      MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
```

```
                Else
                    ' If it's not in the list, add it.
                    .Items.Add(.Text)
                    .Text = ""
                End If
            Else
                MessageBox.Show("Enter a coffee flavor to add", _
                  "Missing Data", MessageBoxButtons.OK, _
                MessageBoxIcon.Exclamation)
            End If
            .Focus()
        End With
    End Sub

    Private Sub PrintAllToolStripMenuItem_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles PrintAllToolStripMenuItem.Click
        ' Begin the print process to print all items.

        PrintAllPrintDocument.Print()
    End Sub

    Private Sub PreviewAllToolStripMenuItem_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles PreviewAllToolStripMenuItem.Click
        ' Begin the process for print preview of all items.

        PrintPreviewDialog1.Document = PrintAllPrintDocument
        PrintPreviewDialog1.ShowDialog()
    End Sub

    Private Sub PrintSelectedToolStripMenuItem1_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles PrintSelectedToolStripMenuItem1.Click
        ' Begin the print process to print the selected item.

        If SyrupListBox.SelectedIndex = -1 Then
            ' Select (None) if nothing selected.
            SyrupListBox.SelectedIndex = 0
        End If
        If CoffeeComboBox.SelectedIndex <> -1 Then
            ' Items selected.
            PrintSelectedPrintDocument.Print()
        Else
            ' No item selected.
            MessageBox.Show("Select a flavor from the coffee list", _
              "Print Selection", MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
        End If
    End Sub

    Private Sub PreviewSelectedToolStripMenuItem1_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles PreviewSelectedToolStripMenuItem1.Click
      ' Begin the process for print preview of the selected item.

        If SyrupListBox.SelectedIndex = -1 Then
            ' Select (None) if nothing selected.
            SyrupListBox.SelectedIndex = 0
        End If
        If CoffeeComboBox.SelectedIndex <> -1 Then
            ' Item selected.
            PrintPreviewDialog1.Document = PrintSelectedPrintDocument
            PrintPreviewDialog1.ShowDialog()
        Else
            ' No item selected.
            MessageBox.Show("Select a flavor from the coffee list.", "Print Selection", _
              MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
        End If
    End Sub
```

```
Private Sub PrintAllPrintDocument_PrintPage(ByVal sender As Object, _
  ByVal e As System.Drawing.Printing.PrintPageEventArgs) _
  Handles PrintAllPrintDocument.PrintPage
    ' Handle printing and print previews when printing all.

    Dim PrintFont As New Font("Arial", 12)
    Dim LineHeightSingle As Single = PrintFont.GetHeight + 2
    Dim HorizontalPrintLocationSingle As Single = e.MarginBounds.Left
    Dim VerticalPrintLocationSingle As Single = e.MarginBounds.Top
    Dim PrintLineString As String

    ' Print the heading.
    Using HeadingFont As New Font("Arial", 14, FontStyle.Bold)
       e.Graphics.DrawString("Flavors", HeadingFont, _
         Brushes.Black, HorizontalPrintLocationSingle, _
         VerticalPrintLocationSingle)
    End Using

    ' Loop through the entire list.
    For ListIndexInteger As Integer = 0 To CoffeeComboBox.Items.Count - 1
       ' Increment the Y position for the next line.
       VerticalPrintLocationSingle += LineHeightSingle

       ' Set up a line.
       PrintLineString = CoffeeComboBox.Items(ListIndexInteger).ToString()
       ' Send the line to the graphics page object.
       e.Graphics.DrawString(PrintLineString, PrintFont, _
         Brushes.Black, HorizontalPrintLocationSingle, VerticalPrintLocationSingle)

    Next ListIndexInteger
End Sub

Private Sub PrintSelectedPrintDocument_PrintPage(ByVal sender As System.Object, _
  ByVal e As System.Drawing.Printing.PrintPageEventArgs) _
  Handles PrintSelectedPrintDocument.PrintPage
    ' Handle printing and print previews when printing selected items.

    Dim PrintFont As New Font("Arial", 12)
    Dim HeadingFont As New Font("Arial", 14, FontStyle.Bold)
    Dim LineHeightSingle As Single = PrintFont.GetHeight + 2
    Dim HorizontalPrintLocationSingle As Single = e.MarginBounds.Left
    Dim VerticalPrintLocationSingle As Single = e.MarginBounds.Top
    Dim PrintLineString As String

    ' Set up and display heading lines.
    PrintLineString = "Print Selected Item"
    e.Graphics.DrawString(PrintLineString, HeadingFont, _
      Brushes.Black, HorizontalPrintLocationSingle, VerticalPrintLocationSingle)
    PrintLineString = "by Programmer Name"
    VerticalPrintLocationSingle += LineHeightSingle
    e.Graphics.DrawString(PrintLineString, HeadingFont, _
      Brushes.Black, HorizontalPrintLocationSingle, VerticalPrintLocationSingle)

    ' Leave a blank line between the heading and detail line.
    VerticalPrintLocationSingle += LineHeightSingle * 2
    ' Set up the selected line.
    PrintLineString = "Coffee: " & CoffeeComboBox.Text & _
      "     Syrup: " & SyrupListBox.Text
    ' Send the line to the graphics page object.
    e.Graphics.DrawString(PrintLineString, PrintFont, _
      Brushes.Black, HorizontalPrintLocationSingle, VerticalPrintLocationSingle)
End Sub

Private Sub ClearCoffeeListToolStripMenuItem_Click(ByVal sender As Object, _
  ByVal e As System.EventArgs) Handles ClearCoffeeListToolStripMenuItem.Click
    ' Clear the coffee list.
    Dim ResponseDialogResult As DialogResult
```

```
        ResponseDialogResult = MessageBox.Show("Clear the coffee flavor list?", _
          "Clear coffee list", MessageBoxButtons.YesNo, MessageBoxIcon.Question)
        If ResponseDialogResult = DialogResult.Yes Then
            CoffeeComboBox.Items.Clear()
        End If
    End Sub

    Private Sub RemoveCoffeeFlavorToolStripMenuItem_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles RemoveCoffeeFlavorToolStripMenuItem.Click
        ' Remove the selected coffee from list.

        With CoffeeComboBox
            If .SelectedIndex <> -1 Then
               .Items.RemoveAt(.SelectedIndex)
            Else
               MessageBox.Show("First select the coffee to remove", _
                 "No selection made", MessageBoxButtons.OK, _
                 MessageBoxIcon.Exclamation)
            End If
          End With
    End Sub

    Private Sub DisplayCoffeeCountToolStripMenuItem_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) _
      Handles DisplayCoffeeCountToolStripMenuItem.Click
        ' Display a count of the coffee list.
        Dim MessageString As String

        MessageString = "The number of coffee types is " & _
          CoffeeComboBox.Items.Count & "."
        MessageBox.Show(MessageString,"R 'n R Coffee Type Count", _
          MessageBoxButtons.OK, MessageBoxIcon.Information)
    End Sub

    Private Sub AboutToolStripMenuItem_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles AboutToolStripMenuItem.Click
        ' Display the About form.

        AboutForm.ShowDialog()
    End Sub
End Class
```

About Form

```
'Class:         AboutForm
'Programmer:    Bradley/Millspaugh
'Date:          June 2008
'Description:   Display information about the program
'               and the programmer.
'Folder:        Ch07HandsOn

Public Class AboutForm

    Private Sub OkButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles OkButton.Click
        ' Close the form.

        Me.Close()
    End Sub
End Class
```

Summary

1. List boxes and combo boxes hold lists of values. The three styles of combo boxes are simple combo boxes, drop-down combo boxes, and drop-down lists.
2. The size of a list box or combo box is determined at design time. If all of the items will not fit into the box, VB automatically adds scroll bars.
3. The values for the items in a list are stored in the Items property, which is a collection. The items can be entered in the Items property in the Properties window. At run time, items are added to lists using the `Items.Add` or `Items.Insert` method.
4. The SelectedIndex property can be used to select an item in the list or to determine which item is selected.
5. The Items.Count property holds the number of elements in the list.
6. The Items collection holds all elements of the list. The individual elements can be referenced by using an index.
7. The `Items.Remove` and `Items.RemoveAt` methods remove one element from a list.
8. The `Items.Clear` method may be used to clear all of the contents of a list box's Items collection at once.
9. Code can be written for several events of list boxes and combo boxes. Combo boxes have a TextChanged event; both combo boxes and list boxes have Enter and Leave events.
10. A loop allows a statement or series of statements to be repeated. `Do/Loops` continue to execute the statements in the loop until a condition is met. Each pass through a loop is called an *iteration*.
11. `Do/Loops` can have the condition test at the top or the bottom of the loop and can use a `While` or `Until` to test the condition.
12. A `Do/Loop` can be used to locate a selected item in a combo box.
13. A loop index controls `For/Next` loops; the index is initialized to an initial value. After each iteration, the loop index is incremented by the `Step` value (the increment), which defaults to 1. The loop is terminated when the loop index is greater than the ending value.
14. The PrintDocument and PrintPreviewDialog components can be used to send program output to the printer or the screen.
15. The `Print` method of the PrintDialog control begins a print operation. The control's PrintPage event fires once for each page to print. All printing logic belongs in the PrintPage event procedure. The PrintPage event continues to fire as long as the HasMorePages property of the PrintDocument component has a value of True.
16. The page to print or display is a graphics object. Use the `DrawString` method to send a string of text to the page, specifying X and Y coordinates for the string.
17. Aligning columns of numbers is difficult using proportional fonts. Numbers can be right-aligned by formatting the number, measuring the length of the formatted string in pixels, and subtracting the length from the right end of the column for the X coordinate.

Key Terms

callback *306*
collection *289*
ComboBox control *288*
`Do` and `Loop` statements *296*
`Do/Loop` *296*
`DrawString` method *307*
drop-down combo box *288*
drop-down list *288*
entry test *296*
exit test *296*
`For` and `Next` statements *299*
`For/Next` loop *299*
Items property *290*
`Items.Add` method *290*
`Items.Clear` method *294*
Items.Count property *292*
`Items.Insert` method *291*
`Items.Remove` method *293*
`Items.RemoveAt` method *293*
iteration *296*
ListBox control *288*
loop *296*
loop index *299*
posttest *296*
pretest *296*
`Print` method *306*
print preview *311*
PrintDocument component *306*
PrintPage event procedure *306*
PrintPreviewDialog component *311*
SelectedIndex property *292*
simple combo box *288*
simple list box *288*
Sorted property *291*
`Using` block *313*

Review Questions

1. What is a list box? a combo box?
2. Name and describe the three styles of combo boxes.
3. How can you make scroll bars appear on a list box or combo box?
4. Explain the purpose of the SelectedIndex property and the Items.Count property.
5. When and how is information placed inside a list box or a combo box?
6. In what situation would a loop be used in a procedure?
7. Explain the difference between a pretest and a posttest in a `Do/Loop`.
8. Explain the differences between a `Do/Loop` and a `For/Next` loop.
9. What are the steps in processing a `For/Next` loop?
10. Discuss how and when the values of the loop index change throughout the processing of the loop.
11. What is the purpose of the PrintDocument component? the PrintPreview-Dialog component?
12. In what procedure do you write the logic for sending output to the printer?
13. What is the purpose of the X and Y coordinates on a print page?

Programming Exercises

7.1 Create a project for obtaining student information.

Startup form controls are as follows:

- Text boxes for entering the name and units completed.
- Radio buttons for Freshman, Sophomore, Junior, and Senior.
- Check box for Dean's List.
- A list box for the following majors: Accounting, Business, Computer Information Systems, and Marketing.
- A simple combo box for the name of the high school—initially loaded with Franklin, Highland, West Highland, and Midtown. If the user types in a new school name, it should be added to the list.
- *Print* button that prints the data from the form. Use the *Print Preview* dialog box.
- An *OK* button that clears the entries from the form and resets the focus. The button should be the Accept button for the form.

Menus

The *File* menu should have an item for *Print Schools* and *Exit*. The *Edit* menu should have an item for *Add High School*; the *Help* menu should have an item for the About box.

Note: Print your name at the top of the printer output for the schools. Display the printer output in the *Print Preview* dialog box.

7.2 R 'n R—for Reading 'n Refreshment needs a project that contains a form for entering book information.

Form Controls

- Text boxes for author and title.
- Radio buttons for type: fiction or nonfiction.
- Drop-down list for Subject that will include Best-Seller, Fantasy, Religion, Romance, Humor, Science Fiction, Business, Philosophy, Education, Self-Help, and Mystery.
- List box for Shelf Number containing RC-1111, RC-1112, RC-1113, and RC-1114.
- *Print* button that prints the data from the form. Use the *Print Preview* dialog box.
- An *OK* button that clears the entries from the form and resets the focus. Make this the Accept button.

Menus

The *File* menu will have items for *Print Subjects* and *Exit*. The *Help* menu will have an item for *About* that displays the About box.

Note: Print your name at the top of the printer output for the subjects. Display the printer output in the *Print Preview* dialog box.

7.3 Create a project to input chartering information about yachts and print a summary report showing the total revenue, number of charters, and average hours per charter.

Menus

The *File* menu will contain items for *Print Summary*, *Print Yacht Types*, and *Exit*. Place a separator before *Exit*. The *Edit* menu should have items for *Clear for Next Charter*, *Add Yacht Type*, *Remove Yacht Type*, and *Display Count of Yacht Types*. Include a separator after the *Clear* item. The *Help* menu will contain an *About* item that displays an About form.

The Form

- The form should contain text boxes for responsible party, hours chartered, and the calculated price of the charter.
- A drop-down combo box will contain the type of yacht: Ranger, Wavelength, Catalina, Coronado, Hobie, C & C, Hans Christian, and Excalibur. Any items that are added to the text box during processing must be added to the list.
- A drop-down list will contain the sizes: 22, 24, 30, 32, 36, 38, 45. (No new sizes can be entered at run time.)
- An *OK* button will calculate and display the price and add to the totals. The calculations will require price per hour. Use the following chart:

Size	Hourly Rate
22	95.00
24	137.00
30	160.00
32	192.00
36	250.00
38	400.00
45	550.00

- A *Clear* button will clear the contents of the screen controls. The functions of the *Clear* button are the same as for the *Clear for Next Charter* menu item.
- Make the *OK* button the Accept button and the *Clear* button the form's Cancel button.

Summary Report

The summary report will print the summary information and send the report to a *Print Preview* dialog box. The summary information will include Number of Charters, Total Revenue, and Average Hours Chartered. Include your name on the output and identifying labels for the summary information.

Yacht Types Report
Display the yacht types in the combo box in the *Print Preview* dialog box. Include your name and a title at the top of the report.

7.4 Create a project that contains a list box with the names of all U.S. states and territories. When the user types the first letters of the state into a text box, set the SelectedIndex property of the list box to display the appropriate name. Include an *Exit* menu item.

Alabama	Kentucky	Oklahoma
Alaska	Louisiana	Oregon
American Samoa	Maine	Pennsylvania
Arizona	Maryland	Puerto Rico
Arkansas	Massachusetts	Rhode Island
California	Michigan	South Carolina
Colorado	Minnesota	South Dakota
Connecticut	Mississippi	Tennessee
Delaware	Missouri	Texas
District of Columbia	Montana	Trust Territories
Florida	Nebraska	Utah
Georgia	Nevada	Vermont
Guam	New Hampshire	Virgin Islands
Hawaii	New Jersey	Virginia
Idaho	New Mexico	Washington
Illinois	New York	West Virginia
Indiana	North Carolina	Wisconsin
Iowa	North Dakota	Wyoming
Kansas	Ohio	

7.5 Maintain a list of bagel types for Bradley's Bagels. Use a drop-down combo box to hold the bagel types and use buttons or menu choices to *Add Bagel Type*, *Remove Bagel Type*, *Clear Bagel List*, *Print Bagel List*, *Display Bagel Type Count*, and *Exit*. Keep the list sorted in alphabetic order.

Do not allow a blank type to be added to the list. Display an error message if the user selects *Remove* without first selecting a bagel type.

Before clearing the list, display a message box to confirm the operation.

Here are some suggested bagel types. You can make up your own list.

Plain	Poppy seed
Egg	Sesame seed
Rye	Banana nut
Salt	Blueberry

7.6 Modify Programming Exercise 7.5 to not allow duplicate bagel types to be added to the list.

Case Studies

VB Mail Order

Create a project for VB Mail Order to maintain a list of catalogs. Use a drop-down combo box for the catalog names, and allow the user to enter new catalog names, delete catalog names, display a count of the number of catalogs, clear the catalog list, or print the catalog list.

Do not allow a blank catalog name to be added to the list. Display an error message if the user selects *Remove* without first selecting a catalog name. Before clearing the list, display a message box to confirm the operation.

To begin, the catalog list should hold these catalog names: Odds and Ends, Solutions, Camping Needs, ToolTime, Spiegel, The Outlet, and The Large Size.

Display the printed output in the *Print Preview* dialog box. Include your name and a heading at the top of the report.

VB Auto Center

Create an application for the car wash located at VB Auto Center.

The form will contain three list box or combo box controls that do not permit the user to type in items at run time. The first list will contain the names of the packages available for detailing a vehicle: Standard, Deluxe, Executive, or Luxury.

The contents of the other two lists will vary depending upon the package selected. Display one list for the interior work and one list for the exterior work. Store the descriptions of the items in string constants. You must clear the lists for the interior and exterior for each order and add new items to the lists each time the user makes a selection from the package list.

Use a drop-down list to allow the user to select the fragrance. The choices are Hawaiian Mist, Baby Powder, Pine, Country Floral, Pina Colada, and Vanilla.

Include menu items for *Print Order*, *Clear*, and *Exit* with appropriate access keys. The print option should send its output to the *Print Preview* window. Include your name and a heading at the top of the report.

The Order printout will contain the package name (Standard, Deluxe, Executive, or Luxury), the interior and exterior items included, and the fragrance selected. Use a `For/Next` loop when printing the interior and exterior lists.

	Item Description	S	D	E	L
Exterior	Hand Wash	✓	✓	✓	✓
	Hand Wax		✓	✓	✓
	Check Engine Fluids			✓	✓
	Detail Engine Compartment				✓
	Detail Undercarriage				✓
Interior	Fragrance	✓	✓	✓	✓
	Shampoo Carpets		✓	✓	✓
	Shampoo Upholstery				✓
	Interior Protection Coat (dashboard and console)			✓	
	Scotchgard™				✓

Note: S—Standard; D—Deluxe; E—Executive; L—Luxury

Video Bonanza

Maintain a list of movie categories. Use a drop-down combo box to hold the movie types, keeping the list in alphabetic order. Use buttons or menu choices to *Add a Category*, *Remove a Category*, *Clear All Categories*, *Print the Category List*, *Display the Movie Category Count*, and *Exit*. Include appropriate access keys on your form and/or menu items.

Do not allow a blank type to be added to the list. Display an error message if the user selects *Remove* without first selecting a movie category. Before clearing the list, display a message box to confirm the operation.

The starting categories are

- Comedy
- Drama
- Action
- Sci-Fi
- Horror

Display the printed output in the *Print Preview* dialog box. Include your name and a heading at the top of the report.

Very Very Boards

Write a project to maintain a list of shirt styles. Keep the styles in a drop-down combo box, with styles such as crew, turtleneck, or crop top.

Add a *Style* menu with options to *Add Style*, *Remove Style*, *Clear Style List*, and *Count Styles*. Add a *Print Style List* option to the *File* menu, and include access keys and keyboard shortcuts for the menu items.

Display the printed output in the *Print Preview* dialog box. Include your name and a heading at the top of the report.

CHAPTER

8

Arrays

at the completion of this chapter, you will be able to . . .

1. Establish an array and refer to individual elements in the array with subscripts.
2. Use the `For Each/Next` to traverse the elements of an array.
3. Create a structure for multiple fields of related data.
4. Accumulate totals using arrays.
5. Distinguish between direct access and indirect access of a table.
6. Write a table lookup for matching an array element.
7. Combine the advantages of list box controls with arrays.
8. Store and look up data in multidimensional arrays.

Single-Dimension Arrays

An **array** is a list or series of values, similar to a list box or a combo box. You can think of an array as a list box without the box—without the visual representation. Any time you need to keep a series of variables for later processing, such as reordering, calculating, or printing, you need to set up an array.

Consider an example that has a form for entering product information one product at a time. After the user has entered many products, you will need to calculate some statistics, perhaps use the information in different ways, or print it. Of course, each time the user enters the data for the next product, the previous contents of the text boxes are replaced. You could assign the previous values to variables, but they also would be replaced for each new product. Another approach might be to create multiple variables, such as Product1String, Product2String, Product3String, and so on. This approach might be reasonable for a few entries, but what happens when you need to store 50 or 500 products?

When you need to store multiple values, use an array. An array is a series of individual variables, all referenced by the same name. Sometimes arrays are referred to as ***tables*** or ***subscripted variables***. For an array for storing names, you may have NameString(0), NameString(1), NameString(2), and so on.

Each individual variable is called an ***element*** of the array. The individual elements are treated the same as any other variable and may be used in any statement, such as an assignment statement. The **subscript** (which also may be called an ***index***) inside the parentheses is the position of the element within the array. Figure 8.1 illustrates an array of 10 elements with subscripts from 0 to 9.

Figure 8.1

An array of string variables with 10 elements. Subscripts are 0 through 9.

NameString array

(0)	Janet Baker
(1)	George Lee
(2)	Sue Li
(3)	Samuel Hoosier
(4)	Sandra Weeks
(5)	William Macy
(6)	Andy Harrison
(7)	Ken Ford
(8)	Denny Franks
(9)	Shawn James

Subscripts

The real advantage of using an array is not realized until you use variables for subscripts in place of the constants.

```
NameString(IndexInteger) = ""
Debug.WriteLine(NameString(IndexInteger))
```

Subscripts may be constants, variables, or numeric expressions. Although the subscripts must be integers, Visual Basic rounds any noninteger subscript.

A question has probably occurred to you by now: How many elements are there in the NameString array? The answer is that you must declare the array name and the number of elements.

The Declaration Statements for Arrays—General Forms

You can declare arrays by using the `Dim`, `Public`, `Private`, or `Friend` keyword. Just as with any other variable, the location of the declaration determines the scope and lifetime of the array variables.

General Forms

```
Private ArrayName(UpperSubscript) As Datatype
Dim ArrayName() As Datatype  = {InitialValueList}
Dim ArrayName As Datatype() = {InitialValueList}
```

The first declaration above creates storage for the specified number of elements and initializes each numeric variable to 0. In the case of string arrays, each element is set to an empty string (no characters).

In the second and third forms of the declaration statements, you specify initial values for the array elements, which determines the number of elements. You cannot declare the upper subscript *and* initial values.

The Declaration Statements for Arrays—Examples

Examples

```
Dim NameString(25) As String
Dim BalanceDecimal(10) As Decimal
Dim ProductString(99) As String
Dim IndexInteger() As Integer = {1, 5, 12, 18, 20}
Dim IndexInteger As Integer() = {1, 5, 12, 18, 20}
Dim DepartmentsString() As String = {"Accounting", "Marketing", "Human Relations"}
Private CategoryString(10) As String
Friend IdNumbersString(5) As String
```

Array subscripts are zero based, so the first element is always element zero. The upper subscript is the highest subscript—one less than the number of elements. For example, the statement

```
Dim CategoryString(10) As String
```

creates an array of 11 elements with subscripts 0 through 10.

Notice that you declare a data type for the array. All of the array elements must be the same data type.

Valid Subscripts

A subscript must reference a valid element of the array. If a list contains 10 names, it wouldn't make sense to ask: What is the 15th name on the list? *or* What is the 2½th name on the list? Visual Basic rounds fractional subscripts and throws an exception for a subscript that is out of range.

Note: Arrays are based on System.Array, which is a collection.

Feedback 8.1

```
Dim NameString(20) As String
Const INDEX_Integer As Integer = 10
```

After execution of the preceding statements, which of the following are valid subscripts?

1. NameString(20)
2. NameString(INDEX_Integer)
3. NameString(INDEX_Integer * 2)
4. NameString(INDEX_Integer * 3)
5. NameString(0)
6. NameString(INDEX_Integer – 20)
7. NameString(INDEX_Integer / 3)
8. NameString(INDEX_Integer / 5 – 2)

For Each/Next Statements

When you use an array, you need a way to reference each element in the array. `For/Next` loops, which you learned to use in Chapter 7, work well to traverse the elements in an array. Another handy loop construct is the `For Each` and `Next`. The significant advantages of using the **`For Each`** and **`Next`** are that you don't have to manipulate the subscripts of the array or know how many elements there are in the array.

Note: Array elements are read-only in the body of a `For/Each` loop. You cannot modify the contents of an array element inside the body of a `For/Each` loop.

The For Each and Next Statements—General Form

General Form

```
For Each ElementName [As Datatype] In ArrayName
     ' Statement(s) in loop.
Next [ElementName]
```

Visual Basic automatically references each element of the array, assigns its value to ElementName, and makes one pass through the loop. If the array has 12 elements, for example, the loop will execute 12 times. The variable used for ElementName must be the same data type as the array elements or an Object data type. It's best to declare the variable for ElementName as part of the `For Each` statement, which creates a block-level variable.

In the following example, assume that the array NameString has already been declared and holds data, and the variable OneNameString will hold the individual values of NameString, one element at a time.

The For Each and Next Statements—Example

Example

```
For Each OneNameString As String In NameString
     ' Write one element of the array.
     Debug.WriteLine(OneNameString)
Next OneNameString
```

The `For Each` loop will execute if the array has at least one element. All the statements within the loop are executed for the first element. If the array has more elements, the loop continues to execute until all the elements are processed. When the loop finishes, execution of code continues with the line following the `Next` statement.

Note: You may use an `Exit For` statement within the loop to exit early.

Structures

You have been using the VB data types, such as Integer, String, and Decimal, since Chapter 3. Now you will learn to combine multiple fields of related data to create a new **structure**. In many ways, a structure is similar to defining a new data type. For example, an Employee structure may contain last name, first name, social security number, street, city, state, ZIP code, date of hire, and pay code. A Product structure might contain a description, product number, quantity, and price. You can combine the fields into a structure using the `Structure` and `End Structure` statements.

The Structure and End Structure Statements—General Form

General Form

```
[Public | Private | Friend] Structure NameOfStructure
     Dim FirstField As DataType
     Dim SecondField As DataType
     ...
End Structure
```

The `Structure` declaration cannot go inside a procedure. You generally place the `Structure` statement at the top of a file with the module-level declarations. You also can place a `Structure` in a separate file.

The Structure and End Structure Statements—Examples

Examples

```
Structure Employee
     Dim LastNameString As String
     Dim FirstNameString As String
     Dim SocialSecurityNumberString As String
     Dim StreetString As String
     Dim CityString As String
     Dim StateString As String
     Dim ZipCodeString As String
     Dim HireDate As Date
     Dim PayCodeInteger As Integer
End Structure

Friend Structure Product
     Dim DescriptionString As String
     Dim ProductNumberString As String
     Dim QuantityInteger As Integer
     Dim PriceDecimal As Decimal
End Structure

Structure SalesDetail
     Dim SaleDecimal() As Decimal
End Structure
```

By default, a structure is public. You can declare the structure to be `Friend` or `Private` if you wish.

If you include an array inside a structure, you cannot specify the number of elements. You must use a `ReDim` statement in your code to declare the number of elements.

Declaring Variables Based on a Structure

Once you have created a structure, you can declare variables of the structure, just as if it were another data type.

```
Dim OfficeEmployee As Employee
Dim WarehouseEmployee As Employee
Dim WidgetProduct As Product
Dim InventoryProduct(100) As Product
Dim HouseWaresSalesDetail As SalesDetail
Dim HomeFurnishingsSalesDetail As SalesDetail
```

Accessing the Elements in a Structure Variable

Each field of data in a variable declared as a structure is referred to as an *element* of the structure. To access elements, use the dot notation similar to that used for objects: Specify *Variable.Element*.

```
OfficeEmployee.LastNameString
OfficeEmployee.HireDate
WarehouseEmployee.LastNameString
WidgetProduct.DescriptionString
WidgetProduct.QuantityInteger
WidgetProduct.PriceDecimal
InventoryProduct(IndexInteger).DescriptionString
InventoryProduct(IndexInteger).QuantityInteger
InventoryProduct(IndexInteger).PriceDecimal
```

Notice the use of indexes in the preceding examples. Each example was taken from the preceding `Structure` and `Dim` statements. A variable that is not an array, such as WidgetProduct, does not need an index. However, for InventoryProduct, which was dimensioned as an array of 101 elements (0 through 100), you must specify not only the InventoryProduct item but also the element within the structure.

Including an Array in a Structure

The SalesDetail structure is a little more complicated than the other structures described above. In this structure, we want to include an array of seven variables, one for each day of the week. However, VB does not allow you to declare the number of elements in the `Structure` declaration. You must use the `ReDim` statement inside a procedure to give the array a size.

```
' Module-level declarations.
Structure SalesDetail
    Dim SaleDecimal() As Decimal
End Structure

Private HouseWaresSalesDetail As SalesDetail
```

```
' Inside a procedure:
'    Establish the number of elements in the array.
ReDim HouseWaresSalesDetail.SaleDecimal(6)

' In processing.
HouseWaresSalesDetail.SaleDecimal(DayIndexInteger) = CurrentDaySalesDecimal
```

Because the SaleDecimal element of the SalesDetail structure is declared as an array, you must use a subscript to refer to each individual element within the structure.

Feedback 8.2

1. Write a `Structure` statement to hold student data containing last name, first name, student number, number of units completed, and GPA. The new structure should be called "Student".
2. Declare an array of 100 students that will use the structure for student information.
3. Write the `Structure` statement for a structure called "Project" containing a project name, form name, and folder name.
4. Declare a variable called "MyProject" based on the Project structure.
5. Declare an array of 100 elements called "OurProjects", based on the Project structure.

Using Array Elements for Accumulators

Array elements are regular variables and perform in the same ways as all variables used so far. You may use the subscripted variables in any way you choose, such as for counters or total accumulators.

To demonstrate the use of array elements as total accumulators, eight totals will be accumulated. For this example, eight scout troops are selling raffle tickets. A separate total must be accumulated for each of the eight groups. Each time a sale is made, the number of tickets must be added to the correct total. The statement

```
Dim TotalInteger(7) As Integer
```

declares the eight accumulators with subscripts 0 to 7.

Adding to the Correct Total

Assume that your user inputs a group number into GroupTextBox.Text and the number of tickets sold into SaleTextBox.Text. The sales may be input in any order with multiple sales for each group. Your problem is to add each ticket sale to the correct total, numbered 0 to 7, for groups numbered 1 to 8.

You can subtract one from the group number to use as the subscript to add to the correct total. For example, if the first sale of 10 tickets is for group 4, the 10 must be added to TotalInteger(3). (Figure 8.2 shows the form and the variables used for this example.)

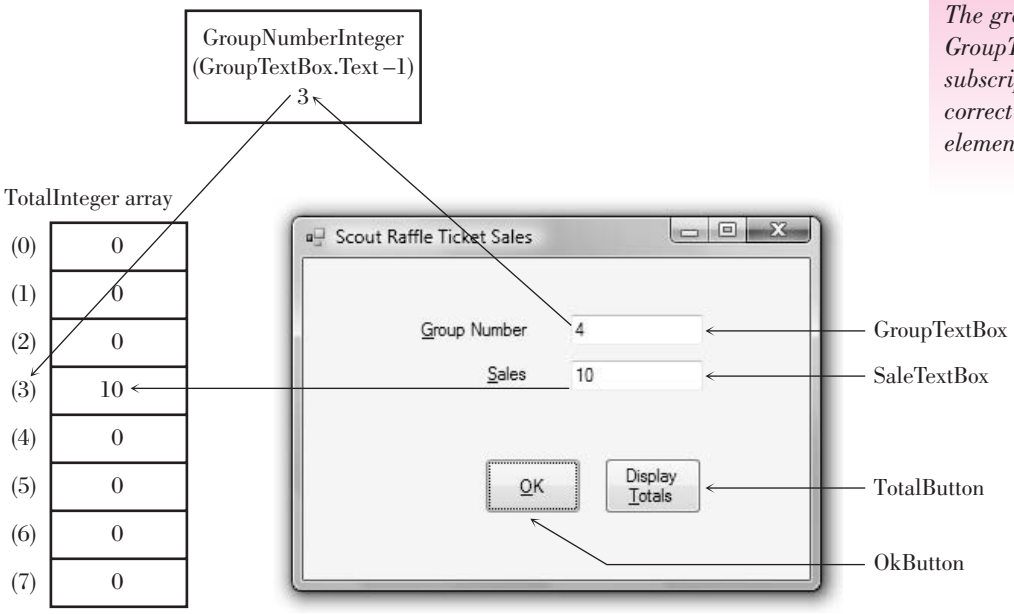


Figure 8.2

The group number entered in GroupTextBox is used as a subscript to determine the correct TotalInteger array element to which to add.

```
' Convert input group number to subscript.
GroupNumberInteger = Integer.Parse(GroupTextBox.Text) – 1
' Add sale to the correct total.
SaleInteger = Integer.Parse(SaleTextBox.Text)
TotalInteger(GroupNumberInteger) += SaleInteger
```

Of course, the user might enter an incorrect group number. Because you don't want the program to cancel with an exception, you must validate the group number.

```
Try
     ' Convert input group number to a subscript.
     GroupNumberInteger = Integer.Parse(GroupTextBox.Text) – 1
     If GroupNumberInteger >= 0 And GroupNumberInteger <= 7 Then
          ' Add sale to correct total.
          SaleInteger = Integer.Parse(SaleTextBox.Text)
          TotalInteger(GroupNumberInteger) += SaleInteger
     Else
          MessageBox.Show("Enter a valid group number (1-8)", "Data Entry Error", _
            MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
     End If
Catch
     MessageBox.Show("Numeric entries required for both group number and sales.", _
       "Data Entry Error", MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
End Try
```

Using the group number as an index to the array is a technique called ***direct reference***. The groups are assigned numbers from 1 to 8. You can subtract 1 from the group number to create the subscripts, which are 0 to 7.

Debugging Array Programs

You can view the contents of array elements when your program is in debugging time. Set a breakpoint and view the Autos window (Figure 8.3). You will need to click on the plus sign to the left of the array name to view the individual array elements.

Note: The Autos window is not available in the Express Edition of Visual Basic.

Figure 8.3

View the contents of an array in the Autos window at debugging time.

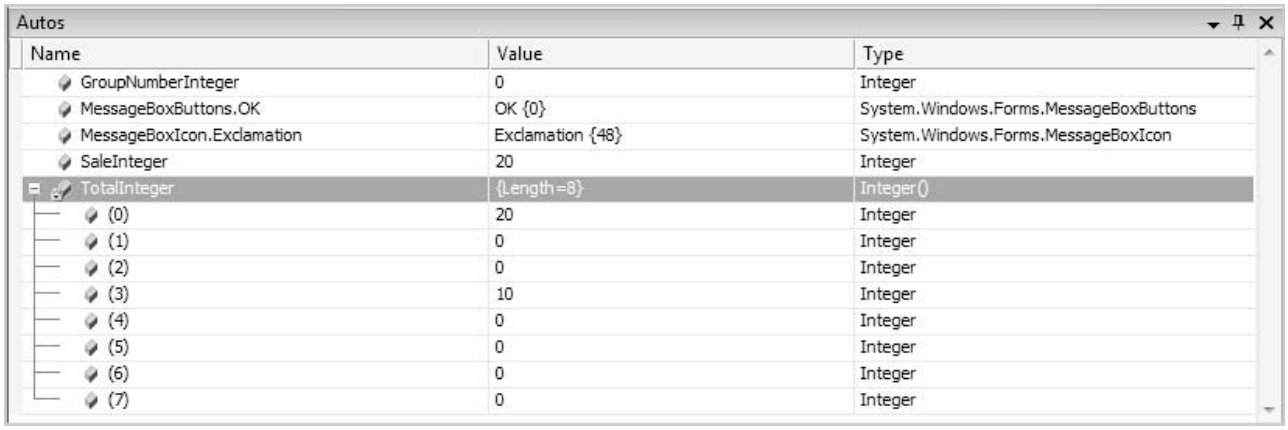


Table Lookup

Things don't always work out so neatly as having sequential group numbers that can be used to access the table directly. Sometimes you will have to do a little work to find (look up) the correct value and reference the array elements indirectly. Reconsider the eight scout troops and their ticket sales. Now the groups are not numbered 1 to 8, but 101, 103, 110, 115, 121, 123, 130, and 145. The group number and the number of tickets sold are still input, and the number of tickets must be added to the correct total. But now you must do one more step: determine to which array element to add the ticket sales, using a **table lookup**.

The first step is to establish a structure with the group numbers and totals and then dimension an array of the structure. Before any processing is done, you must load the group numbers into the table; the best place to do this is in the Form_Load event procedure, which is executed once as the form is loaded into memory.

Place the following statements at the top of a form class:

```
' Declare structure and module-level variables.
Structure Group
    Dim GroupNumberString As String
    Dim TotalInteger As Integer
End Structure

' Hold group number and total for 8 groups.
Private ArrayGroup(7) As Group
```

Then initialize the values of the array elements by placing these statements into the Form_Load event procedure:

```
Private Sub SalesForm_Load(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles MyBase.Load
      ' Initialize group numbers.

      ArrayGroup(0).GroupNumberString = "101"
      ArrayGroup(1).GroupNumberString = "103"
      ArrayGroup(2).GroupNumberString = "110"
      ArrayGroup(3).GroupNumberString = "115"
      ArrayGroup(4).GroupNumberString = "121"
      ArrayGroup(5).GroupNumberString = "123"
      ArrayGroup(6).GroupNumberString = "130"
      ArrayGroup(7).GroupNumberString = "145"
End Sub
```

During program execution, the user still enters the group number and the number of tickets sold into text boxes.

The technique used to find the subscript is called a *table lookup*. In this example, the object is to find the element number (0 to 7) of the group number and add to the corresponding group total. If the user enters the third group number ("110"), the subscript is 2 and the sale is added to the total for subscript 2. If the seventh group number ("130") is entered, the sale is added to the total with the subscript 6, and so on. Hence, you need a way, given the group number in GroupTextBox.Text, to find the corresponding subscript of the ArrayGroup array.

When Visual Basic executes the statement

```
ArrayGroup(IndexInteger).TotalInteger += SaleInteger
```

the value of IndexInteger must be a number in the range 0 to 7. The task for the lookup operation is to find the number to place in IndexInteger, based on the value of GroupTextBox.Text. Figure 8.4 shows the variables used for the lookup. Figure 8.5 shows the UML action diagram of the lookup logic.

Coding a Table Lookup

For a table lookup, you will find that a `Do/Loop` works better than `For Each`. As you compare to each element in the array and eventually find a match, you need to know the subscript of the matching element.

Figure 8.4

A lookup operation: The group number is looked up in the ArrayGroup array; the correct subscript is found and used to add the sale to the correct TotalInteger.

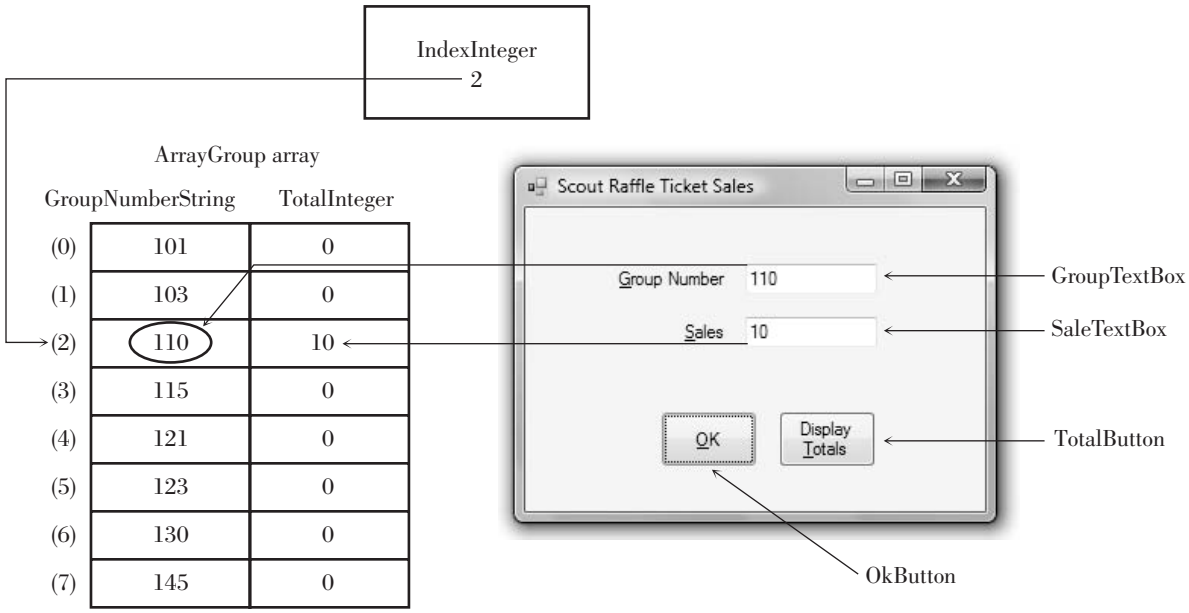
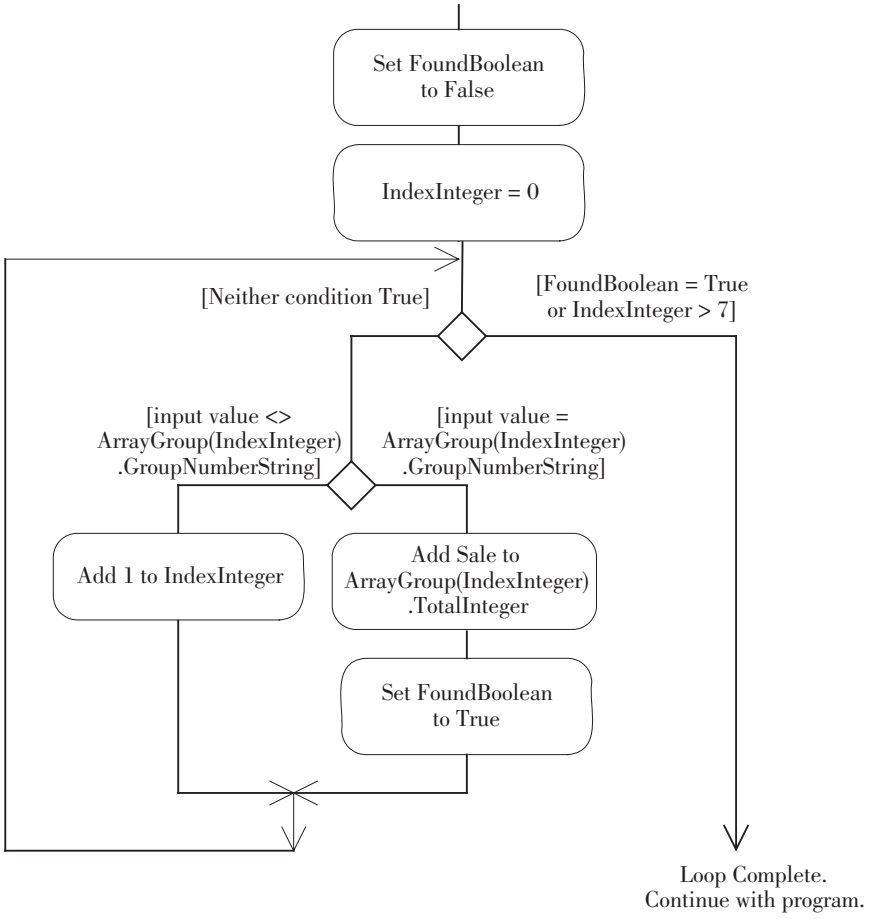


Figure 8.5

A UML action diagram of the logic of a lookup operation.



```
' Accumulate the sales by group number.
Dim SaleInteger As Integer
Dim IndexInteger As Integer = 0
Dim FoundBoolean As Boolean = False

' Look up input group number to find subscript.
Do Until FoundBoolean Or IndexInteger > 7
    If GroupTextBox.Text = ArrayGroup(IndexInteger).GroupNumberString Then
        ' Add sale to correct total.
        SaleInteger = Integer.Parse(SaleTextBox.Text)
        ArrayGroup(IndexInteger).TotalInteger += SaleInteger
        FoundBoolean = True
    Else
        IndexInteger += 1
    End If
Loop
```

Once again, you should do some form of validation. If the user enters an invalid group number, you should display a message box. You can check the value of the Boolean variable FoundBoolean after completion of the loop to determine whether the loop terminated because of a match or without a match.

```
If Not FoundBoolean Then
    MessageBox.Show("Enter a valid group number", "Data Entry Error", _
      MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
    With GroupTextBox
        .Focus()
        .SelectAll()
    End With
End If
```

The table-lookup technique will work for any table, numeric or string. It isn't necessary to arrange the fields being searched in any particular sequence. The comparison is made to one item in the list, then the next, and the next—until a match is found. In fact, you can save processing time in a large table by arranging the elements with the most-often-used entries at the top so that fewer comparisons must be made.

Using List Boxes with Arrays

In the previous example of a lookup, the user had to type some information into a text box, which was used to look up the information in an array. A more efficient and friendly solution might be to substitute a list box for the text box. You can store the eight group numbers in a list box and allow the user to select from the list (Figure 8.6).

The initial Items collection can contain the values 101, 103, 110, 115, 121, 123, 130, and 145.

You have probably already realized that you can use the SelectedIndex property to determine the array subscript. Remember that the SelectedIndex property holds the position or index of the selected item from the list.

In place of the lookup operation, we can use this code:

```
' Declare module-level variables.
Private TotalInteger(7) As Integer  ' Hold totals for 8 groups.

Private Sub OkButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles OkButton.Click
    ' Accumulate the sales by group number.
    Dim SaleInteger As Integer
    Dim IndexInteger As Integer
    Try
        IndexInteger = GroupListBox.SelectedIndex
        If IndexInteger <> -1 Then       ' Selection made.
            ' Add to correct total.
            SaleInteger = Integer.Parse(SaleTextBox.Text)
            TotalInteger(IndexInteger) += SaleInteger

            ' Clear the screen fields.
            GroupListBox.SelectedIndex = -1
            SaleTextBox.Text = ""
        Else
            MessageBox.Show("Select a group number from the list.", _
              "Data Entry Error", MessageBoxButtons.OK, _
              MessageBoxIcon.Exclamation)
        End If
    Catch
        MessageBox.Show("Sales must be numeric.")
    End Try
End Sub
```

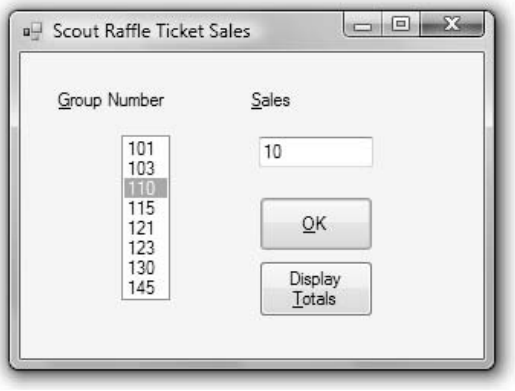


Figure 8.6

Allow the user to select from a list and you can use the list's SelectedIndex property as the subscript of the total array.

Multidimensional Arrays

You generally need to use two subscripts to identify tabular data, where data are arranged in **rows** and **columns**.

Many applications of two-dimensional tables quickly come to mind: insurance rate tables, tax tables, addition and multiplication tables, postage rates, foods and their nutritive value, population by region, rainfall by state.

To define a two-dimensional array or table, the Dim statement specifies the number of rows and columns in the array. The row is horizontal and the column is vertical. The following table has three rows and four columns:

The Declaration Statements for Two-Dimensional Arrays—General Forms

General Forms

```
Dim ArrayName(HighestRowSubscript, HighestColumnSubscript) As Datatype
Dim ArrayName(,) As Datatype = {ListOfValues}
```

The Declaration Statements for Two-Dimensional Arrays—Examples

Examples

```
Dim NameString(2, 3) As String
Dim NameString(,) As String = { {"James", "Mary", "Sammie", "Sean"}, _
     {"Tom", "Lee", "Leon", "Larry"}, {"Maria", "Margaret", "Jill", "John"} }
```

Both of these statements establish an array of 12 elements, with three rows and four columns. Just as with single-dimension arrays, you cannot specify the number of elements within parentheses *and* specify initial values.

Notice the comma inside the parentheses in the second example: You must use a comma to specify that there are two dimensions to the array. Specify the initial values with the first dimension (the row) first and the second dimension (the column) second. The compiler determines the number of elements from the initial values that you supply. The second example above fills the table in this sequence:

(0, 0) James	(0, 1) Mary	(0, 2) Sammie	(0, 3) Sean
(1, 0) Tom	(1, 1) Lee	(1, 2) Leon	(1, 3) Larry
(2, 0) Maria	(2, 1) Margaret	(2, 2) Jill	(2, 3) John

You must always use two subscripts when referring to individual elements of the table. Specify the row with the first subscript and the column with the second subscript.

The elements of the array may be used in the same ways as any other variable—in accumulators, counts, and reference fields for lookup; in statements like assignment and printing; and as conditions. Some valid references to the table include

```
NameString(1, 2) = "New Name"
NameString(RowInteger, ColumnInteger) = "New Name"
DisplayLabel.Text = NameString(1, 2)
DrawString(NameString(RowInteger, ColumnInteger), PrintFont, Brushes.Black, 100.0, 100.0)
```

Invalid references for the NameString table would include any value greater than 2 for the first subscript, greater than 3 for the second subscript, or less than 0 for either subscript.

Initializing Two-Dimensional Arrays

Numeric array elements are initially set to 0, and string elements are set to empty strings. And, of course, you can assign initial values when you declare the array. But many situations require that you reinitialize arrays to 0 or some other value. You can use nested `For/Next` loops to set each array element to an initial value.

Nested For/Next Example

The assignment statement in the inner loop will be executed 12 times, once for each element of NameString.

```
For RowInteger As Integer = 0 To 2
    For ColumnInteger As Integer = 0 To 3
        ' Initialize each element.
        NameString(RowInteger, ColumnInteger) = ""
    Next ColumnInteger
Next RowInteger
```

Printing a Two-Dimensional Table

When you want to print the contents of a two-dimensional table, you can use a `For Each/Next` loop. This example prints one array element per line.

```
' Print one name per line.
For Each ElementString As String In NameString
    ' Set up a line.
    e.Graphics.DrawString(ElementString, PrintFont, _
      Brushes.Black, HorizontalPrintLocationSingle, VerticalPrintLocationSingle)

    ' Increment the Y position for the next line.
    VerticalPrintLocationSingle += LineHeightSingle
Next ElementString
```

If you wish to print an entire row in one line, use a `For/Next` loop and set up the X and Y coordinates to print multiple elements per line.

```
' Print one line per row .
For RowInteger As Integer = 0 To 2
    For ColumnInteger As Integer = 0 To 3
        e.Graphics.DrawString(NameString(RowInteger, ColumnInteger), PrintFont, _
          Brushes.Black, HorizontalPrintLocationSingle, VerticalPrintLocationSingle)
        ' Move across the line.
        HorizontalPrintLocationSingle += 200
    Next ColumnInteger

    ' Start next line; Reset to left margin.
    HorizontalPrintLocationSingle = e.MarginBounds.Left
    ' Move down to next line.
    VerticalPrintLocationSingle += LineHeightSingle
Next RowInteger
```

Summing a Two-Dimensional Table

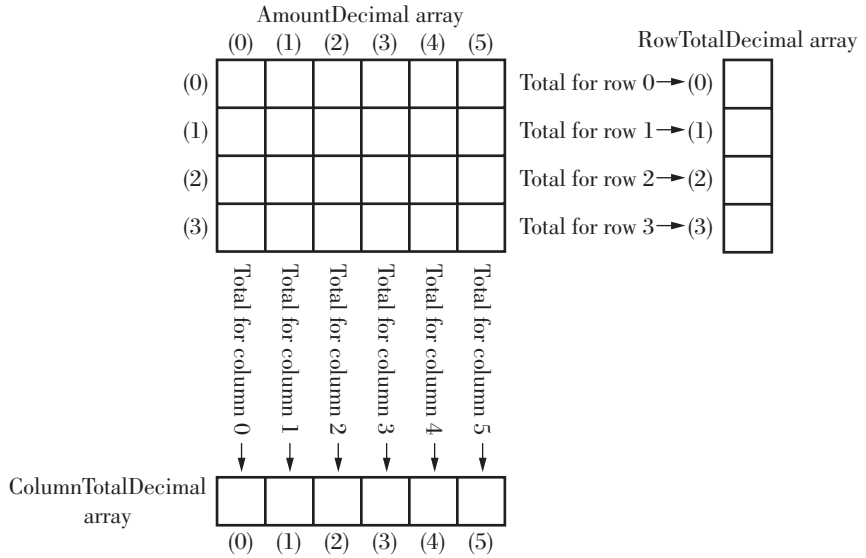
You can find the sum of a table in various ways. You may sum either the columns or the rows of the table; or, as in a cross-foot, you can sum the figures in both directions and double-check the totals.

To sum the array in both directions, each column needs one total variable and each row needs one total variable. Two one-dimensional arrays will work well for the totals. Figure 8.7 illustrates the variables used in this example.

```
' Crossfoot total a 2D table.

' Give the 4 x 6 array values for testing.
'   (Normally you would total values that are accumulated in a program.)
Dim AmountDecimal(,) As Decimal = _
  {{2.5D, 3D, 1.2D, 2.2D, 4.5D, 3.5D}, _
  {2D, 2D, 2D, 2D, 2D, 2D}, _
  {3D, 3.1D, 3.2D, 3.3D, 3.4D, 3.5D}, _
  {4.4D, 4.5D, 4.6D, 4.7D, 4.8D, 4.9D}}
Dim RowTotalDecimal(3) As Decimal
Dim ColumnTotalDecimal(5) As Decimal

For RowInteger As Integer = 0 To 3
    For ColumnInteger As Integer = 0 To 5
        RowTotalDecimal(RowInteger) += AmountDecimal(RowInteger, ColumnInteger)
        ColumnTotalDecimal(ColumnInteger) += AmountDecimal(RowInteger, ColumnInteger)
    Next ColumnInteger
Next RowInteger
```

Figure 8.7

Two one-dimensional arrays hold totals for the two-dimensional array.



Feedback 8.3

Write VB statements to do the following:

1. Dimension a table called TemperatureDecimal with five columns and three rows.

2. Set each element in the first row to 0.
3. Set each element in the second row to 75.
4. For each column of the table, add together the elements in the first and second rows, placing the sum in the third row.
5. Print the entire table. (Write only the logic for printing inside the PrintDocument_PrintPage event procedure.)

Lookup Operation for Two-Dimensional Tables

When you look up items in a two-dimensional table, you can use the same techniques discussed with single-dimensional arrays: direct reference and table lookup. The limitations are the same.

1. To use a direct reference, row and column subscripts must be readily available. For example, you can tally the hours used for each of five machines (identified by machine numbers 1 to 5) and each of four departments (identified by department numbers 1 to 4).

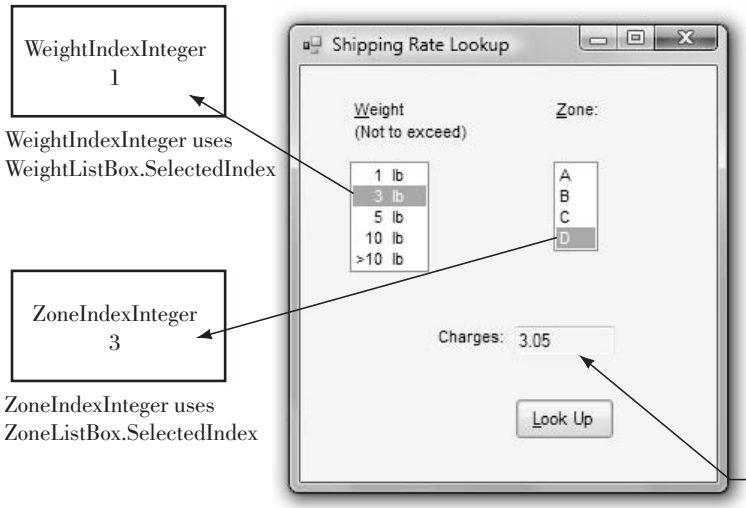
```
RowInteger = Integer.Parse(MachineTextBox.Text) - 1
ColumnInteger = Integer.Parse(DepartmentTextBox.Text) - 1
HoursDecimal = Decimal.Parse(HoursTextBox.Text)
MachineTotalDecimal(RowInteger, ColumnInteger) += HoursDecimal
```

2. A table lookup is the most common lookup technique.

Many two-dimensional tables used for lookup require additional one-dimensional arrays or lists to aid in the lookup process. For an example, use a shipping rate table (Figure 8.8) to look up the rate to ship a package. The shipping rate depends on the weight of the package and the zone to which it is being shipped. You could design the project with the weight and zones in list boxes, or you could use a text box and let the user input the data.

Figure 8.8

This shipping rate table in a two-dimensional array can be used to look up the correct shipping charge.



Weight (not to exceed)	Zone A	Zone B	Zone C	Zone D
1 lb	1.00	1.50	1.65	1.85
3 lb	1.58	2.00	2.40	3.05
5 lb	1.71	2.52	3.10	4.00
10 lb	2.04	3.12	4.00	5.01
>10 lb	2.52	3.75	5.10	7.25

Using List Boxes

In the example illustrated in Figure 8.8, a list box holds the weight limits, and another list holds the zones. The values for the two lists are set in the Items properties at design time. The five-by-four rate table is two-dimensional, and the values are set when the table is declared.

```
' Look up values from list boxes.

' Declare module-level variables.
Dim RateDecimal(,) As Decimal =
  {{1D, 1.5D, 1.65D, 1.85D}, _
  {1.58D, 2D, 2.4D, 3.05D}, _
  {1.71D, 2.52D, 3.1D, 4D}, _
  {2.04D, 3.12D, 4D, 5.01D}, _
  {2.52D, 3.75D, 5.1D, 7.25D}}

Private Sub LookupButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles LookupButton.Click
    ' Look up the shipping rate.

    Dim WeightIndexInteger As Integer
    Dim ZoneIndexInteger As Integer

    WeightIndexInteger = WeightListBox.SelectedIndex
    ZoneIndexInteger = ZoneListBox.SelectedIndex
    If WeightIndexInteger <> -1 And ZoneIndexInteger <> -1 Then
        ChargesTextBox.Text = _
          RateDecimal(WeightIndexInteger, ZoneIndexInteger).ToString("N")
    Else
        MessageBox.Show("Select the weight and zone.", "Information Missing", _
          MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
    End If
End Sub
```

Using Text Boxes

If you are using text boxes rather than list boxes for data entry, the input requires more validation. You must look up both the weight and zone entries before you can determine the correct rate. The valid zones and weight ranges will be stored in two separate one-dimensional arrays. The first step is to establish and fill the arrays. The five-by-four rate table is two-dimensional, and the values should be preloaded, as in the previous example.

Note that the `Try/Catch` blocks were omitted to clarify the logic. You should always use error trapping when converting input to numeric values.

```
' Look up values from text boxes.

' Declare module-level variables.
Dim RateDecimal(,) As Decimal = _
  {{1D, 1.5D, 1.65D, 1.85D}, _
  {1.58D, 2D, 2.4D, 3.05D}, _
  {1.71D, 2.52D, 3.1D, 4D}, _
  {2.04D, 3.12D, 4D, 5.01D}, _
  {2.52D, 3.75D, 5.1D, 7.25D}}
Dim WeightInteger() As Integer = {1, 3, 5, 10}
Dim ZoneString() As String = {"A", "B", "C", "D"}
```

```
Private Sub LookupButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles LookupButton.Click
    ' Look up the shipping rate.

    Dim WeightIndexInteger As Integer
    Dim ZoneIndexInteger As Integer
    Dim IndexInteger As Integer = 0
    Dim WeightInputInteger As Integer
    Dim WeightFoundBoolean As Boolean = False
    Dim ZoneFoundBoolean As Boolean = False

    Try
        ' Look up the weight to find the WeightIndexInteger.
        WeightInputInteger = Integer.Parse(WeightTextBox.Text)
        Do Until WeightFoundBoolean Or IndexInteger > 3
            If WeightInputInteger <= WeightInteger(IndexInteger) Then
                WeightIndexInteger = IndexInteger
                WeightFoundBoolean = True
            Else
                IndexInteger += 1
            End If
        Loop
        If Not WeightFoundBoolean Then
            ' Weight above 10 pounds.
            WeightIndexInteger = 4
            WeightFoundBoolean = True
        End If

        ' Look up the zone to find the ZoneIndexInteger.
        IndexInteger = 0
        Do Until ZoneFoundBoolean Or IndexInteger > 3
            If ZoneTextBox.Text.ToUpper() = ZoneString(IndexInteger) Then
                ZoneIndexInteger = IndexInteger
                ZoneFoundBoolean = True
            Else
                IndexInteger += 1
            End If
        Loop

        ' Display the appropriate rate.
        If ZoneFoundBoolean Then
          ChargesLabel.Text= _
            RateDecimal(WeightIndexInteger, ZoneIndexInteger).ToString("N")
        Else
          MessageBox.Show("Invalid zone.", "Information Missing or Invalid", _
            MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
        End If
    Catch
        MessageBox.Show("Invalid weight.", "Information Missing or Invalid", _
          MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
    End Try
End Sub
```

Your Hands-On Programming Example

Create a project for R 'n R—for Reading 'n Refreshment that determines the price per pound for bulk coffee sales. The coffees are divided into categories: regular, decaf, and special blend. The prices are set by the quarter pound, half

pound, and full pound. Use a *Find Price* button to search for the appropriate price based on the selections.

	Regular	Decaffeinated	Special Blend
¼ pound	2.60	2.90	3.25
½ pound	4.90	5.60	6.10
Full pound	8.75	9.75	11.25

Create a structure that contains the coffee type, amount, and price. Set up a module-level variable that is an array of 20 elements of your structure; this array will hold the transactions. Each time the *Find Price* button is pressed, look up and display the price of the coffee selection and add the data to the array.

Include a *Clear* button to clear the selections from the screen and a *Print* button that prints all of the transactions. Using *Print Preview*, print appropriate headings and the data from the transaction array.

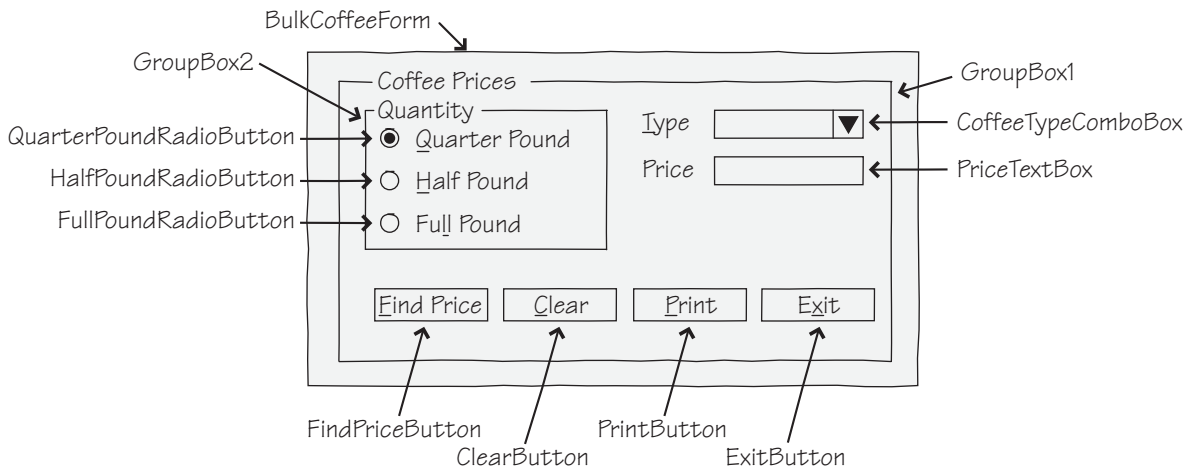
When the *Exit* button is pressed, give the user another opportunity to print all the transactions.

Planning the Project

Sketch a form (Figure 8.9), which your users sign off as meeting their needs.

Figure 8.9

A planning sketch of the form for the hands-on programming example.



Plan the Objects and Properties

Object	Property	Setting
BulkCoffeeForm	Name	BulkCoffeeForm
	Text	R 'n R for Reading and Refreshment
	AcceptButton	FindPriceButton
GroupBox1	Text	Coffee Prices

Object	Property	Setting
GroupBox2	Text	Quantity
CoffeeTypeComboBox	Name	CoffeeTypeComboBox
	Items	Regular Decaffeinated Special Blend
	DropDownStyle	DropDownList
Label1	Text	&Type
Label2	Text	Price
PriceTextBox	Name	PriceTextBox
	ReadOnly	True
	TabStop	False
QuarterPoundRadioButton	Name	QuarterPoundRadioButton
	Text	&Quarter Pound
	Checked	True
HalfPoundRadioButton	Name	HalfPoundRadioButton
	Text	&Half Pound
FullPoundRadioButton	Name	FullPoundRadioButton
	Text	Fu&ll Pound
FindPriceButton	Name	FindPriceButton
	Text	&Find Price
ClearButton	Name	ClearButton
	Text	&Clear
PrintButton	Name	PrintButton
	Text	&Print
ExitButton	Name	ExitButton
	Text	E&xit
PrintDocument1	Name	PrintDocument1
PrintPreviewDialog1	Name	PrintPreviewDialog1

Plan the Event Procedures

You need to plan the actions for the event procedures.

Procedure	Actions
FindPriceButton_Click	Find the column from the list selection. Find the row from the radio button selection. Look up the price in the table. Display the price in the label. Store the type, quantity, and price in the transaction array.
ClearButton_Click	Select the first radio button. Deselect the list entry. Clear the price label.
PrintButton_Click	Set up print preview. Print the report.

Procedure	Actions
ExitButton_Click	Display message box giving the user opportunity to print. If the user wants to print Execute PrintButton_Click procedure. End If Terminate the project.
All radio buttons_Click	Save the name of the selected button.
PrintDocument1_PrintPage	Print title. Loop to print all of the stored transactions.

Write the Project Follow the sketch in Figure 8.9 to create the form. Figure 8.10 shows the completed form, and Figure 8.11 shows sample report output.

- Set the properties of each object, according to your plan.
- Write the code. Working from the pseudocode, write each event procedure.
- When you complete the code, use a variety of data to thoroughly test the project.

Figure 8.10

The form for the hands-on programming example.

Figure 8.11

A sample report created by the program.

The Project Coding Solution

```
' Program:          Ch08HandsOn
' Programmer:       Bradley/Millspaugh
' Date:             June 2008
' Description:      Look up the price for bulk coffee
'                   based upon quantity and type.
'                   Uses a structure and arrays, and prints a report
'                   of the transactions from the array.
' Folder:           Ch08HandsOn

Public Class BulkCoffeeForm
    ' Declare structure and module-level variables
    Structure CoffeeSale
        Dim TypeString As String
        Dim QuantityString As String
        Dim PriceDecimal As Decimal
    End Structure

    Private TransactionCoffeeSale(20) As CoffeeSale
    Private NumberTransactionsInteger As Integer
    Private PriceDecimal(,) As Decimal = _
      {{2.6D, 2.9D, 3.25D}, {4.9D, 5.6D, 6.1D}, {8.75D, 9.75D, 11.25D}}
    Private SelectedButtonString As String

    Private Sub ClearButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ClearButton.Click
        ' Remove the selection from the list and
        '    clear the price.

        ' Select first radio button.
        QuarterPoundRadioButton.Checked = True
        ' Clear coffee type selection.
        CoffeeTypeComboBox.SelectedIndex = -1
        PriceTextBox.Text = ""
    End Sub

    Private Sub ExitButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ExitButton.Click
        ' Terminate the project.
        Dim ResponseDialogResult As DialogResult

        ResponseDialogResult = MessageBox.Show("Print the report?", _
          "Terminate the Application", MessageBoxButtons.YesNo, _
          MessageBoxIcon.Question)
        If ResponseDialogResult = DialogResult.Yes Then
            printButton_Click(sender, e)
        End If
        Me.Close()
    End Sub

    Private Sub FindPriceButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles FindPriceButton.Click
        ' Lookup the price using the quantity and type.

        Dim RowInteger, ColumnInteger As Integer
        Dim SalePriceDecimal As Decimal
```

```
    ' Allow only 20 transactions.
    If NumberTransactionsInteger < 20 Then
        ColumnInteger = CoffeeTypeComboBox.SelectedIndex
        If ColumnInteger <> -1 Then
            ' Coffee selection made, determine quantity selected.
            Select Case SelectedButtonString
                Case "QuarterPoundRadioButton"
                    RowInteger = 0
                    TransactionCoffeeSale(NumberTransactionsInteger).QuantityString _
                      = "Quarter Pound"
                Case "HalfPoundRadioButton"
                    RowInteger = 1
                    TransactionCoffeeSale(NumberTransactionsInteger).QuantityString _
                      = "Half Pound"
                Case "FullPoundRadioButton"
                    RowInteger = 2
                    TransactionCoffeeSale(NumberTransactionsInteger).QuantityString _
                      = "Full Pound"
                Case Else
                    ' No selection made; use quarter pound.
                    RowInteger = 0
                    TransactionCoffeeSale(NumberTransactionsInteger).QuantityString _
                      = "Quarter Pound"
            End Select

            ' Retrieve price of selection.
            SalePriceDecimal = PriceDecimal(RowInteger, ColumnInteger)
            PriceTextBox.Text = SalePriceDecimal.ToString("C")
            ' Save this transaction.
            TransactionCoffeeSale(NumberTransactionsInteger).TypeString _
              = CoffeeTypeComboBox.Text
            TransactionCoffeeSale(NumberTransactionsInteger).PriceDecimal _
              = SalePriceDecimal
            NumberTransactionsInteger += 1
        Else
            MessageBox.Show("Select the coffee type.", "Selection Incomplete", _
              MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
        End If
    Else
        MessageBox.Show("Sorry, only 20 transactions allowed.")
    End If
End Sub

Private Sub PrintButton_Click(ByVal sender As Object, _
 ByVal e As System.EventArgs) Handles PrintButton.Click
    ' Print the report using Print Preview.

    PrintPreviewDialog1.Document = PrintDocument1
    PrintPreviewDialog1.ShowDialog()
End Sub

Private Sub PrintDocument1_PrintPage(ByVal sender As Object, _
  ByVal e As System.Drawing.Printing.PrintPageEventArgs) _
  Handles PrintDocument1.PrintPage

    ' Handle print and print previews.

    Dim PrintFont As New Font("Arial", 12)
    Dim HeadingFont As New Font("Arial", 14, FontStyle.Bold)
    Dim LineHeightSingle As Single = PrintFont.GetHeight + 2
```

```
        Dim Column1HorizontalLocationSingle As Single = e.MarginBounds.Left
        Dim VerticalPrintLocationSingle As Single = e.MarginBounds.Top
        Dim Column2HorizontalLocationSingle As Single = 300
        Dim Column3HorizontalLocationSingle As Single
        Dim PrintLineString As String
        Dim FontSizeF As New SizeF
        Dim FormattedPriceString As String

        ' Set up and display heading lines.
        PrintLineString = "R 'n R Coffee Sales"
        e.Graphics.DrawString(PrintLineString, HeadingFont, _
          Brushes.Black, Column2HorizontalLocationSingle, VerticalPrintLocationSingle)
        PrintLineString = "by Programmer Name"
        VerticalPrintLocationSingle += LineHeightSingle
        e.Graphics.DrawString(PrintLineString, PrintFont, _
          Brushes.Black, Column2HorizontalLocationSingle, VerticalPrintLocationSingle)
        VerticalPrintLocationSingle += LineHeightSingle * 2

        ' Loop through the transactions.
        For Each IndividualCoffeeSale As CoffeeSale In TransactionCoffeeSale
            ' Don't print if blank.
            If IndividualCoffeeSale.QuantityString <> "" Then
                ' Set up a line.

                ' Quantity.
                e.Graphics.DrawString(IndividualCoffeeSale.QuantityString, PrintFont, _
                  Brushes.Black, Column1HorizontalLocationSingle, _
                  VerticalPrintLocationSingle)

                ' Type.
                e.Graphics.DrawString(IndividualCoffeeSale.TypeString, PrintFont, _
                  Brushes.Black, Column2HorizontalLocationSingle, _
                  VerticalPrintLocationSingle)

                ' Right-align the price.
                FormattedPriceString = FormatNumber(IndividualCoffeeSale.PriceDecimal)
                ' Measure string in this font.
                FontSizeF = e.Graphics.MeasureString(FormattedPriceString, PrintFont)
                ' Subtract width of string from column position.
                Column3HorizontalLocationSingle = 550 - FontSizeF.Width
                e.Graphics.DrawString(FormattedPriceString, PrintFont, _
                  Brushes.Black, Column3HorizontalLocationSingle, _
                  VerticalPrintLocationSingle)

                ' Increment the Y position for the next line; Double space.
                VerticalPrintLocationSingle += LineHeightSingle * 2
            End If
        Next
    End Sub

    Private Sub QuarterPoundRadioButton_CheckedChanged(ByVal sender _
      As System.Object, ByVal e As System.EventArgs) _
      Handles FullPoundRadioButton.CheckedChanged, _
      HalfPoundRadioButton.CheckedChanged, _
      QuarterPoundRadioButton.CheckedChanged

        ' Save the name of the selected radio button.
        ' This procedure is executed each time any radio button is selected.

        SelectedButtonString = CType(sender, RadioButton).Name
    End Sub
End Class
```

Summary

1. A series of variables with the same name is called an *array*. The individual values are referred to as elements, and each element is accessed by its subscript, which is a position number.
2. Array subscripts or indexes are zero based; they must be integers in the range of the array elements. VB rounds noninteger values.
3. You can assign initial values in the array declaration *or* specify the highest subscript allowed.
4. A special form of the `For` loop called `For Each` is available for working with arrays. The `For Each` eliminates the need for the programmer to manipulate the subscripts of the array.
5. You can declare a structure to combine related fields and then declare variables and arrays of the structure. `Structure` statements must appear in the declarations section at the top of a file.
6. Arrays can be used like any other variables; they can be used to accumulate a series of totals or to store values for a lookup procedure.
7. The information in arrays may be referenced directly by subscript, or a table lookup may be used to determine the correct table position.
8. You can use the SelectedIndex property of a list box as a subscript of an array.
9. Arrays may be multidimensional. A two-dimensional table contains rows and columns and is processed similarly to a one-dimensional array. Accessing a multidimensional array frequently requires the use of nested loops.

Key Terms

array *330*
column *341*
direct reference *336*
element *330*
`For Each` and `Next` *332*
index *330*
row *341*
structure *333*
subscript *330*
subscripted variable *330*
table *330*
table lookup *337*

Review Questions

1. Define the following terms:
   (a) Array
   (b) Element
   (c) Subscript
   (d) Index
   (e) Subscripted variable
2. What is a structure? When might a structure be useful?
3. Describe the logic of a table lookup.
4. Name some situations in which it is important to perform validation when working with subscripted variables.
5. Compare a two-dimensional table to an array of a structure.
6. How can you initialize values in a two-dimensional table?

Programming Exercises

8.1 *Array of a structure*. Create a project to analyze an income survey. The statistics for each home include an identification code, the number of members in the household, and the yearly income.

A menu will contain *File*, *Reports*, and *Help*. The *File* menu will contain *Enter Data* and *Exit*. As the data are entered, they should be assigned from the text boxes to the elements of a structure.

The reports for the project will be sent to the printer and include the following:

(a) A report that displays the input data.
(b) A listing of the identification number and income for each household that exceeds the average income.
(c) The percentage of households having incomes below the poverty level.

Poverty Guidelines for 2008:

Family Size	Income
1	10210
2	13690
3	17170
4	20650
5	24130
6	27610
7	31090
8	34570
For each additional person add	3480

Test Data

ID Number	Number of Persons	Annual Income
2497	2	32500
3323	5	23000
4521	4	38210
6789	2	38000
5476	1	26000
4423	3	16400
6587	4	25000
3221	4	20500
5555	2	18000
0085	3	19700
3097	8	30000
4480	5	23400
0265	2	19700
8901	3	13000

8.2 *Two-dimensional table*. Modify Programming Exercise 8.1 to assign the data to a multidimensional array rather than use an array of a structure.

8.3 Create a project to keep track of concert ticket sales by your club. Ticket prices are based on the seating location. Your program should calculate the price for each sale, accumulate the total number of tickets sold in each section, display the ticket price schedule, and print a summary of all sales.

The form should contain a list box of the sections for seating.

Do not allow the user to receive an exception for subscript out-of-range.

Section	Price
Orchestra	40.00
Mezzanine	27.50
General	15.00
Balcony	10.00

8.4 *Array of a structure*. Create a project that will allow a user to look up state and territory names and their two-letter abbreviations. The user will have the options to *Look up the Abbreviation* or *Look up the State Name*. In the event that a match cannot be found for the input, display an appropriate error message.

Use radio buttons with a shared event procedure and a `Select Case` to determine which text box (state name or abbreviation) should have the focus and which should be set to ReadOnly.

Data

AL	Alabama	MT	Montana
AK	Alaska	NE	Nebraska
AS	American Samoa	NV	Nevada
AZ	Arizona	NH	New Hampshire
AR	Arkansas	NJ	New Jersey
CA	California	NM	New Mexico
CO	Colorado	NY	New York
CT	Connecticut	NC	North Carolina
DE	Delaware	ND	North Dakota
DC	District of Columbia	OH	Ohio
FL	Florida	OK	Oklahoma
GA	Georgia	OR	Oregon
GU	Guam	PA	Pennsylvania
HI	Hawaii	PR	Puerto Rico
ID	Idaho	RI	Rhode Island
IL	Illinois	SC	South Carolina
IN	Indiana	SD	South Dakota
IA	Iowa	TN	Tennessee
KS	Kansas	TX	Texas
KY	Kentucky	TT	Trust Territories
LA	Louisiana	UT	Utah
ME	Maine	VT	Vermont
MD	Maryland	VA	Virginia
MA	Massachusetts	VI	Virgin Islands
MI	Michigan	WA	Washington
MN	Minnesota	WV	West Virginia
MS	Mississippi	WI	Wisconsin
MO	Missouri	WY	Wyoming

8.5 *Two-dimensional table*. Create a project that looks up the driving distance between two cities. Use two drop-down lists that contain the names of the cities. Label one list "Departure" and the other "Destination". Use a *Look Up* button to calculate the distance.

Store the distances in a two-dimensional table.

	Boston	Chicago	Dallas	Las Vegas	Los Angeles	Miami	New Orleans	Toronto	Vancouver	Washington DC
Boston	0	1004	1753	2752	3017	1520	1507	609	3155	448
Chicago	1004	0	921	1780	2048	1397	919	515	2176	709
Dallas	1753	921	0	1230	1399	1343	517	1435	2234	1307
Las Vegas	2752	1780	1230	0	272	2570	1732	2251	1322	2420
Los Angeles	3017	2048	1399	272	0	2716	1858	2523	1278	2646
Miami	1520	1397	1343	2570	2716	0	860	1494	3447	1057
New Orleans	1507	919	517	1732	1858	860	0	1307	2734	1099
Toronto	609	515	1435	2251	2523	1494	1307	0	2820	571
Vancouver	3155	2176	2234	1322	1278	3447	2734	2820	0	2887
Washington DC	448	709	1307	2420	2646	1057	1099	571	2887	0

8.6 *Two-dimensional table*. Create a project in which the user will complete a 10-question survey. Create a form containing labels with each of the questions and a group of radio buttons for each question with the following responses: Always, Usually, Sometimes, Seldom, and Never.

Use a two-dimensional array to accumulate the number of each response for each question.

Have a menu or button option that will print an item analysis on the printer that shows the question number and the count for each response.

Sample of partial output:

Question	Always	Usually	Sometimes	Seldom	Never
1	5	2	10	4	6
2	2	2	10	2	1
3	17	0	10	0	0

Case Studies

VB Mail Order

Create a project that will calculate shipping charges from a two-dimensional table of rates. The rate depends on the weight of the package and the zone to which it will be shipped. The Weight column specifies the maximum weight for that rate. All weights over 10 pounds use the last row.

Optional extra: Print a summary of all shipping selections and total charges.

	Zone			
Weight	**A**	**B**	**C**	**D**
1	1.00	1.50	1.65	1.85
3	1.58	2.00	2.40	3.05
5	1.71	2.52	3.10	4.00
10	2.04	3.12	4.00	5.01
>10	2.52	3.75	5.10	7.25

VB Auto Center

VB Auto sells its own brand of spark plugs. To cross-reference to major brands, it keeps a table of equivalent part numbers. VB Auto wants to computerize the process of looking up part numbers in order to improve its customer service.

The user should be able to enter the part number and brand and look up the corresponding VB Auto part number. You may allow the user to select the brand (Brand A, Brand C, or Brand X) from a list or from radio buttons.

You can choose from two approaches for the look-up table. Store the part numbers either in a two-dimensional table or in an array of a structure. In either case, use the part number and brand entered by the user; look up and display the VB Auto part number.

VB Auto	**Brand A**	**Brand C**	**Brand X**
PR214	MR43T	RBL8	14K22
PR223	R43	RJ6	14K24
PR224	R43N	RN4	14K30
PR246	R46N	RN8	14K32
PR247	R46TS	RBL17Y	14K33
PR248	R46TX	RBL12-6	14K35
PR324	S46	J11	14K38
PR326	SR46E	XEJ8	14K40
PR444	47L	H12	14K44

Video Bonanza

Create a project that displays the aisle number of a movie category in a label. The movie categories will be in a list box. Store the aisle numbers and categories in an array.

A *Search* button should locate the correct location from the array and display it in a label. Make sure that the user has selected a category from the list and use the list box SelectedIndex property to find the appropriate aisle number.

Table Data

Aisle 1	Comedy
Aisle 2	Drama
Aisle 3	Action
Aisle 4	Sci-Fi
Aisle 5	Horror
Back Wall	New Releases

Very Very Boards

Modify your project from Chapter 6 to keep track of an order in an array. You can then print out the entire order with detail lines for each type of shirt. Convert the event handling for the radio buttons to share an event procedure. Use a `Case` structure for selection.

Create an array of a structure, which holds the quantity, size, monogram (Boolean), pocket (Boolean), price, and extended price for each type of shirt ordered. As each shirt type is added to an order, store the information in the array. Add a menu option to print out the order, which will have the customer name and order number at the top, and one line for each shirt type ordered. Use the following layout as a rough guide for your list. Make sure to align the numeric columns correctly. For the two Boolean fields (Monogram and Pocket), print Yes or No. Do not allow the user to print an invoice until the order is complete.

Very Very Boards Shirt Orders

By Your Name

Customer name: xxxxxxxxxxxxxxxxxxxxx

Order Number: xxxxx

Quantity	Size	Monogram	Pocket	Price Each	Extended Price
==========					
xxx	xxx	xxx	xxx	xx	x,xxx

Order Total: xx,xxx

CHAPTER

9

Web Applications

at the completion of this chapter, you will be able to . . .

1. Explain the functions of the server and the client in Web programming.
2. Create a Web Form and run it in a browser.
3. Describe the differences among the various types of Web controls and the relationship of Web controls to controls used on Windows Forms.
4. Understand the event structure required for Web programs.
5. Design a Web Form using tables.
6. Control the styles used on Web pages using cascading style sheets (CSS).
7. Validate Web input using the validator controls.
8. Use AJAX to update a portion of a Web page.
9. Define ASP.NET, XML, WSDL, and SOAP.

Visual Basic and Web Programming

So far, all of your projects have been based on Windows Forms and run stand-alone in the Windows environment. In this chapter you learn to program for the Internet. In Visual Basic you use **Web Forms** to create the user interface for Web projects. A Web Form displays as a document in a **browser** such as Mozilla Firefox, Opera, or Internet Explorer (IE). If you are using the VB Standard Edition, Professional Edition, or above (not Visual Web Developer), you can create documents that display on mobile devices such as cell phones and personal digital assistants (PDAs).

Important software note: Microsoft has a product for developing Web applications: Visual Web Developer 2008 Express Edition, which is a streamlined subset of Visual Studio. This chapter was created using Visual Studio Professional Edition, but the projects can be done using Visual Web Developer (VWD). The steps and screen captures may differ slightly if you are using VWD. If you are using the Express Edition of Visual Basic for your Windows applications, you will need to download and install Visual Web Developer for the Web applications.

Client/Server Web Applications

Most Windows applications are stand-alone applications; Web applications require a server and a client. The server sends Web pages to the client, where the pages display inside a browser application (Figure 9.1).

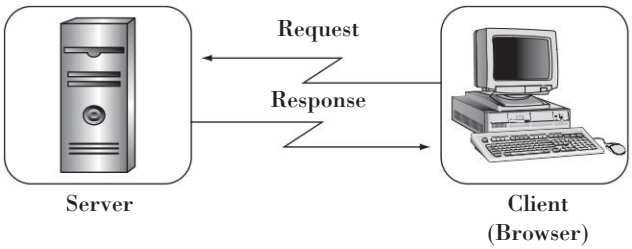


Figure 9.1

A server delivers Web pages to a client, where the pages display in a browser window. The server can be on a remote machine or on the same machine as the client.

Web Servers

To develop Web applications you can either use a remote Web server or make your local machine a Web server. Microsoft provides two pieces of software that can make the development machine function as a server: the Visual Studio Web server and Internet Information Services (IIS). The server software handles the Web server functions, and the browser acts as the client.

The Visual Studio Web server simplifies development testing and debugging. After you have debugged your Web application, you can use the tools in the IDE to transfer the application to an IIS Web server to share with others. The VS Web server is installed automatically when you install Visual Web Developer or Visual Studio.

Web Clients

Browsers display pages written in a markup language. Although the most common format is still hypertext markup language (HTML), many programmers are using the more dynamic features found in Extensible Hypertext Markup Language (XHTML). See the World Wide Web Consortium (W3C) at www.w3.org for more details. Web pages also may contain programming logic in

the form of script such as JavaScript, VBScript, or JScript; or as Java applets. The browser renders the page and displays it on the local system.

You have likely seen Web pages that look different when displayed in different browsers, or even in different versions of the same browser. Although many browser applications are available, the most common are Internet Explorer, Opera, and Mozilla FireFox.

You may know which browser your users are using, such as when you are programming for a network within a company, called an ***intranet***. Or you may develop applications that run on the Internet and might display in any browser. If your projects will run on different browsers, you should test and check the output on multiple browsers.

Web Pages

One characteristic of HTML **Web pages** is that they are **stateless**. That is, a page does not store any information about its contents from one invocation to the next. Several techniques have been developed to get around this limitation, including storing cookies on the local machine and sending state information to the server as part of the page's address, called the *uniform resource locator* (URL). The server can then send the state information back with the next version of the page, if necessary.

When a user requests a Web page, the browser (client) sends a request to the server. The server may send a preformatted HTML file, or a program on the server may dynamically generate the necessary HTML to render the page. One Microsoft technology for dynamically generating HTML pages is active server pages (ASP).

ASP.NET

The latest Web programming technology from Microsoft is ASP.NET 3.5, which represents major advances over the earlier ASP.NET and ASP. The ASP.NET product includes libraries, controls, and programming support that allows you to write programs that interact with the user, maintain state, render controls, display data, and generate appropriate HTML. When you use Web Forms in Visual Basic or Visual Web Developer, you are using ASP.NET.

Using VB and ASP.NET, you can create object-oriented, event-driven Web applications.

Visual Basic and ASP.NET

Each Web Form that you design has two distinct pieces: (1) the HTML and instructions needed to render the page and (2) the Visual Basic code. This separation is a big improvement over older methods that mix the HTML and programming logic (script or applets). A Web Form generates a file with an .aspx extension for the HTML and another file with an .aspx.vb extension for the Visual Basic code.

Don't panic if you don't know HTML; the HTML is generated automatically by the Visual Studio IDE. You visually create the document using the IDE's designer; you can then view and modify the HTML tags in the Visual Studio editor.

The VB code contains the program logic to respond to events. This code file is called the "code-behind" file. The code looks just like the code you have been writing for Windows applications, but many of the events for the controls on Web Forms are different from those of Windows Forms. Another change is that the VB code is not compiled into an executable (.exe) file as it is for Windows applications.

Types of Web Sites

Web applications are referred to as *Web sites* in Visual Studio 2008. VS provides four types of Web sites, which you can see in the *Open Web Site* dialog box (Figure 9.2). Notice the options down the left side of the dialog box: File System, Local IIS, FTP Site, and Remote Site.

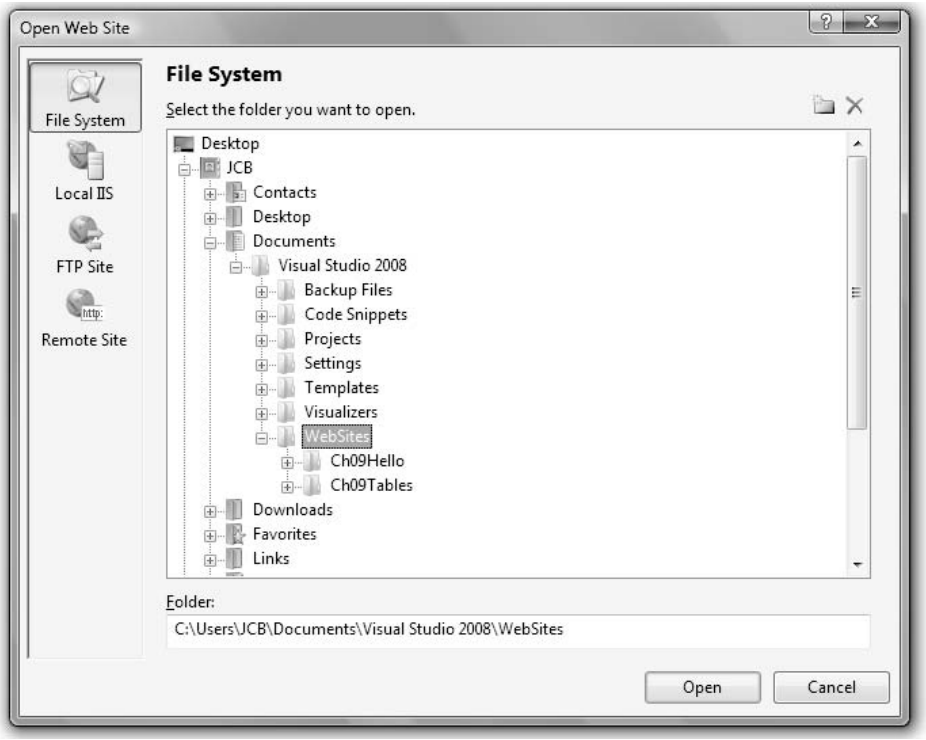


Figure 9.2

The four types of Web sites supported by Visual Web Developer appear on the left edge of the Open Web Site dialog box. Visual Studio supports one additional choice: Source Control.

File System Web Sites

A File System Web site stores the Web pages and associated files in any folder on the local computer or other computer on the network. The Web pages are then tested using the Visual Studio Web server. The examples in this chapter all use File System sites.

The features of File System sites and the Visual Studio Web server provide several advantages for Web developers over using IIS. The VS Web server does not expose the computer to security vulnerabilities and does not require administrative rights to create and debug a Web project. Also, the VS Web server can run on the Home Edition of Windows Vista or Windows XP, which most home users are running.

TIP

Use a File System Web site for development. You can use the *Copy Web Site* feature to convert to IIS or a remote server after you debug the application. ■

IIS Web Sites

Internet Information Services (IIS) is Microsoft's production Web server and is part of the operating system in Windows 2000, Windows XP Professional, Windows Vista, and Windows Server, but not in Windows XP Home Edition. IIS includes a Web server, FTP server, e-mail server, and other services. When

you run IIS on your local computer, you are hosting a Web server that you must take extra steps to secure.

You must have administrative rights on the computer to create IIS Web projects. If the security on your campus or corporate network does not allow the proper permissions, you cannot create IIS Web applications.

When you create a Web site using local IIS (instead of the new VS Web server), by default the files are stored in the C:\inetpub\wwwroot folder. However, you can create a virtual IIS directory elsewhere on your computer and store your Web site there.

Remote Sites and FTP Sites

It is possible that your campus network will be set up for you to do development on a remote Web server. However, you must be granted administrative rights on the host computer. You cannot use an FTP site to create a new Web site; you can only open a previously created FTP Web site in Visual Studio.

Follow your instructor's directions for the type of site to use.

Creating a Web Site

You can create a new Web application in one of two ways, depending on the edition of the VB software you are using. For Visual Web Developer 2008 Express Edition, select *File / New Web Site*. If you are using Visual Studio 2008 Professional Edition, you can begin the same way, or you can choose to select *File / New Project* and then select *Web* for the *Project Type*. The following discussion focuses on the *New Web Site* technique, since it can be used for either VWD or the Professional Edition.

In the *New Web Site* dialog box (Figure 9.3), you select *ASP.NET Web Site* for the template, *File System* for the location, and *Visual Basic* for the language. The *Location* field is set to a folder called WebSites\Visual Studio 2008, which is the suggested location for a File System site.

The default for a File System Web site project location and name is C:\Users\UserName\Documents\Visual Studio 2008\WebSites\WebSite1. You can browse to select a different folder if you wish. Give the project a name by changing the name (WebSite1) in the *Location* box.

Note: The default for a local IIS project location and name is http://*localhost/ProjectName* (localhost is translated by IIS to your local virtual directory, usually C:\Inetpub\wwwroot).

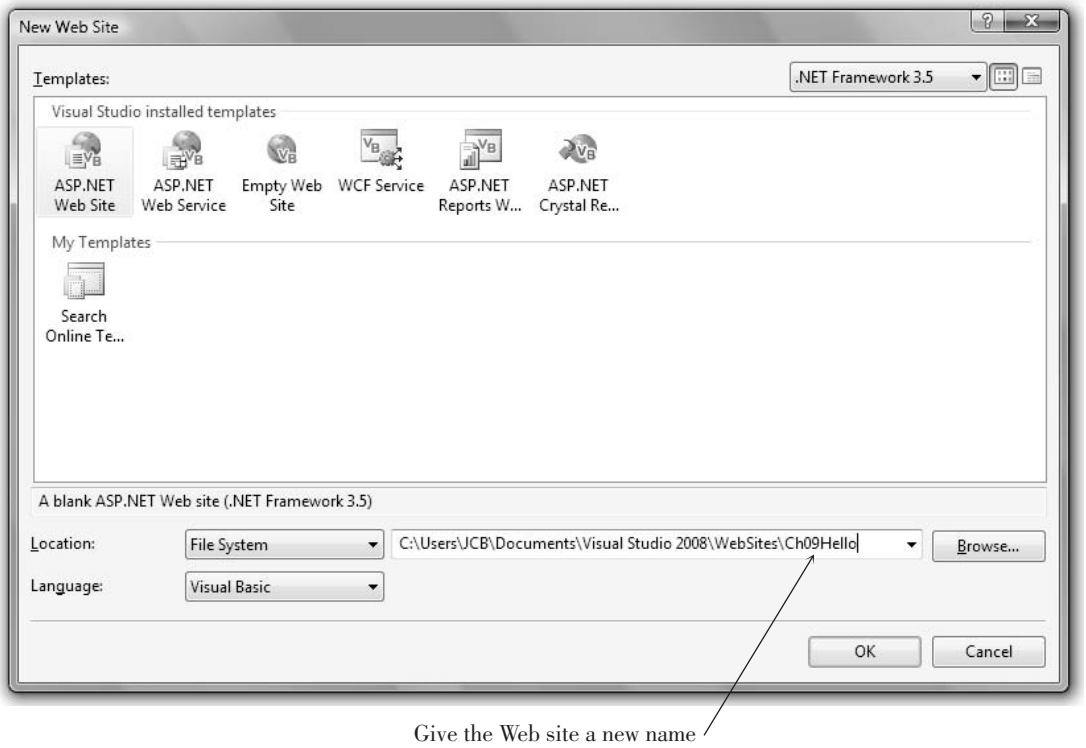
Caution: VB creates the Web site in the default folder (C:\Users\UserName\Documents\Visual Studio 2008\WebSites*ProjectName*), but also creates an additional folder with only the .sln and .suo files. This extra folder appears in the location specified as the default location for Visual Studio projects, which you can check and modify in *Tools \ Options \ Projects and Solutions \ General*.

Web Page Files

A new Web site automatically contains one Web page, called Default.aspx, which contains the visual representation of the page. A second file, Default.aspx.vb, the code-behind file, holds the VB code for the project. This model is very similar to a Windows project, which also keeps the visual

Figure 9.3

Begin a new Web project by entering the location and project name on the New Web Site *dialog box. Note that this dialog box can vary depending on how the software was installed and configured.*



elements separate from the code. But in the case of Web pages, the visual elements are created with HTML tags rather than VB code.

ASP.NET provides two models for managing controls and code. In addition to the **code separation model** described in the preceding paragraph, you also can use a **single-file model**, which combines the visible elements and the VB code in a single file. In early versions of ASP (before .NET), the single-file model was the only format available, so you may see old applications created in this style. We will use the code separation model for all programs in this text.

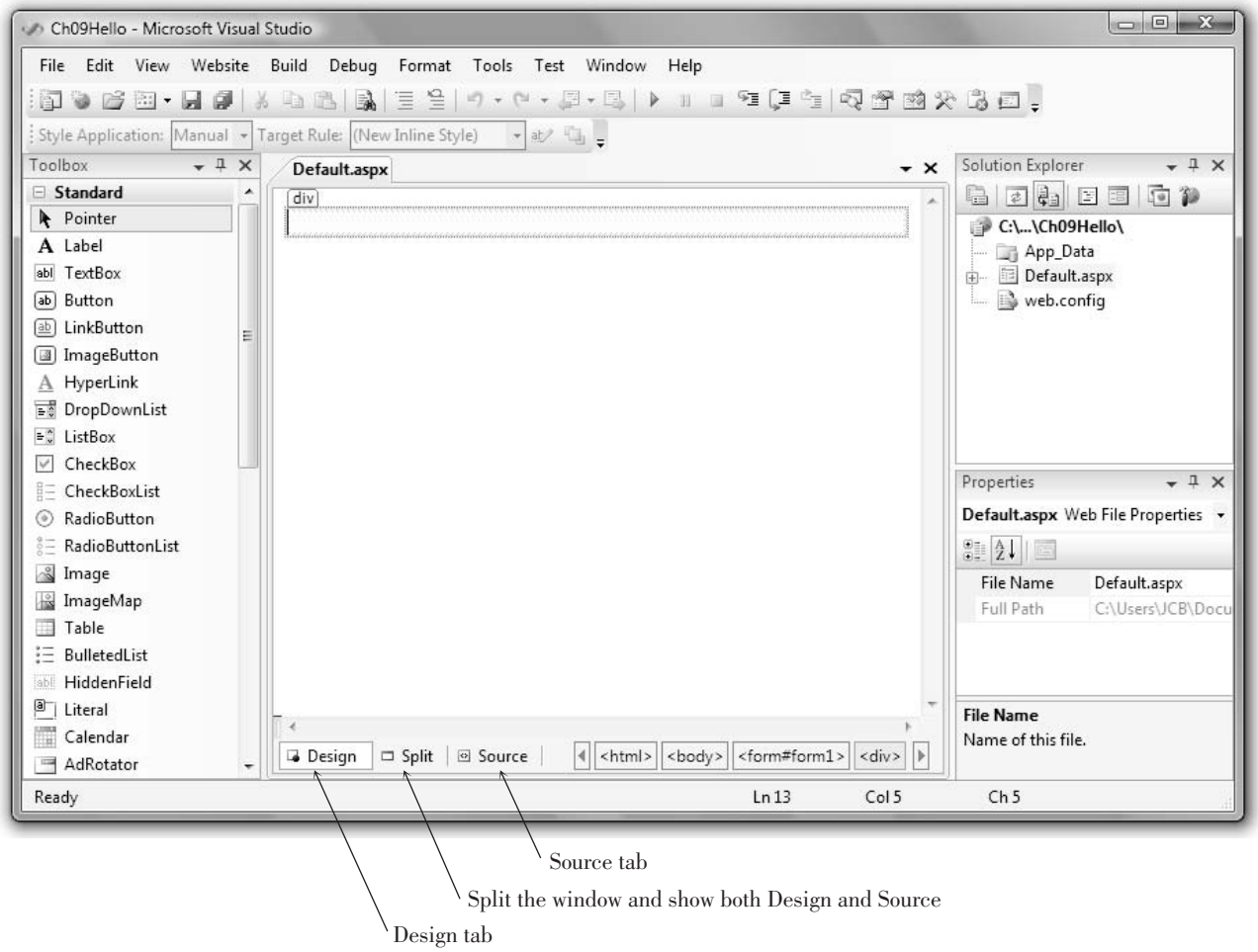
Web Forms in the Visual Studio IDE

As soon as you open a new Visual Basic Web application, you notice many differences from Windows Forms. Instead of a Windows Form, you see a new Web Form (Figure 9.4), also called a *Web page* or *Web document*. The toolbar is different, as is the list of files in the Solution Explorer. The toolbox has different controls, and even those that look the same, such as TextBoxes, Buttons, and Labels, are actually different from their Windows counterparts and have some different properties and events. For example, Web controls have an ID property rather than a Name property.

The IDE allows you to view the Design, the Source (HTML and ASP.NET), or a Split window. Click on the *Design* tab at the bottom of the window (Figure 9.4) to display the page. The Properties window may not appear automatically; press the Properties button or select *View / Properties Window* to display it.

Figure 9.4

The Visual Web Developer IDE with a new Web site opened. If the page's Source tab is selected, click the Design tab.



Creating Your First Web Form—Step-by-Step

This simple step-by-step exercise creates a Web application that displays a Hello message on a document in a browser window.

These instructions are written for the Professional Edition. If you are using Visual Web Developer, the menu choices may be slightly different.

Begin the Project

STEP 1: Open Visual Studio 2008 or Visual Web Developer 2008 Express Edition.

STEP 2: From the *File* menu select *New Web Site* and set the Web site name to "Ch09Hello" by changing the location to "C:\Users\UserName\Documents\Visual Studio 2008\WebSites\Ch09Hello". Click *OK*.

Notes: You can use the folder of your choice in place of WebSites. If you are using a shared computer, select a folder in your Documents folder or your own disk or flash drive. If you are using Windows XP, use a folder in your My Documents folder.

STEP 3: If you don't see a blank page in the Document window, click on the *Design* tab at the bottom of the window or click on the *View Designer* button in the Solution Explorer (Shortcut: Shift + F7).

Create the User Interface

You add elements to a Web page in a manner similar to writing text in a word processor. You must press Enter to move to a new line and press the spacebar to move across a line.

STEP 1: Click underneath the box at the top of the page and press Enter a few times; type "Enter Name: ". (Do not include the quotes, but do include the colon and a space.)

STEP 2: Add a TextBox control from the Standard section of the toolbox. You can drag the text box onto the form or double-click the tool in the toolbox. Double-clicking makes the text box appear at the insertion point.

Note: The text box is a server control, and the text "Enter Name:" is static HTML. You will learn more about these elements later in this chapter.

STEP 3: Set the ID property of the text box to NameTextBox. You may want to click the *Alphabetic* button in the Properties window to sort the properties. The ID property appears at the top of the list due to the parentheses, just as the Name property appears at the top of the list in Windows Forms.

STEP 4: Click after the text box, press Enter twice, and add a Label control.

STEP 5: Set the Label's ID property to MessageLabel and delete the Text property. The label will display its ID property at design time but not at run time.

STEP 6: Click after the label, press Enter a couple of times, and add a Button control. Set the ID property to SubmitButton and the Text property to "Submit".

STEP 7: In the Properties window, drop down the list of objects and select DOCUMENT, which is the Web Form. Set the BgColor property (background color) to a color of your choice.

STEP 8: Set the document's Title property to "Hello Application". The Title property displays in the title bar of the browser when you run the application.

Add Code

STEP 1: Double-click on the *Submit* button and add the following code.

```
'Web Site:        Ch09Hello
'Web page:        Default.aspx
'Programmer:      Your Name
'Date:            June 2008
'Description:     Concatenate the name and display in a label.

Partial Class _Default
    Inherits System.Web.UI.Page

    Protected Sub SubmitButton_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles SubmitButton.Click
        ' Display the name and a message.

        MessageLabel.Text = "Hello " & NameTextBox.Text & "!"
    End Sub
End Class
```

Run the Web Application

The menu choices and toolbar buttons for running a Web application differ somewhat for Visual Web Developer and the full version of Visual Studio.

STEP 1: Run the project. In Visual Web Developer, run without debugging using Ctrl + F5 or select *Start without Debugging* from the *Debug* menu. In the full VS, you can still run without debugging using Ctrl + F5, even though it does not appear on the menu.

Note: You also can right-click on the aspx file or on the page in the Document window and select *View in Browser*.

STEP 2: The default browser should launch and open the page with your page showing.

Note: If you are running the Windows XP firewall, you may receive a message that the firewall has blocked the Web Server and asking what you would like to do; choose *Unblock* to permit the server to render your page and then refresh the page in the browser window.

STEP 3: Enter a name and press the *Submit* button. A "Hello" message should appear in the label.

STEP 4: Close the browser window to end execution.

Viewing the HTML Code

When you are viewing your Web Form in the designer, you can see three tabs at the bottom of the form: *Design*, *Split*, and *Source*. You can click on the *Source* tab to see the static HTML code. The HTML creates the visual elements on the page and is automatically generated, like the Windows-generated code in a Windows Form. The *Split* tab splits the Document window horizontally and shows you both the design and the source.

Controls

Several types of controls are available for Web Forms. You can mix the control types on a single form. Refer to Figure 9.5 to view the toolbox. For most of your work, you will use the controls in the Standard section of the toolbox.

- *Standard (ASP.NET server controls)*. These are the richest, most powerful controls provided by ASP.NET and the .NET framework. Web server controls do not directly correspond to HTML controls but are rendered differently for different browsers in order to achieve the desired look and feel. Some of the special-purpose Web server controls are Calendar, CheckBoxList, AdRotator, and RadioButtonList.
- *Data*. This list of controls includes the GridView and DataList for displaying data.
- *Validation*. These controls are used to validate the data before they are sent to the server.
- *Navigation*. This list includes a Menu control.
- *Login*. Visual Studio includes login controls and wizards.
- *WebParts*. The WebParts set of components enables users to change the appearance and behavior of the interface from the browser.
- *AJAX Extensions*. These are a set of AJAX (Asynchronous JavaScript and XML) controls that provide for faster Web page loading and richer interfaces.

- *HTML*. These are the standard HTML elements that operate only on the client. You cannot write any server-side programming logic for HTML controls. As you submit forms to the server, any HTML controls pass to the server and back as static text. You might want to use HTML controls if you have existing HTML pages that are working and you want to convert to ASP.NET for additional capabilities.
- *Others*. Depending on your version of VS, you may have other sections, such as Reporting.

You can see the available controls in the toolbox when a Web Form is in Design view. Generally, the Standard section is showing (refer to Figure 9.4). Try selecting other toolbox tabs, such as *Data*, *Validation*, *Navigation*, *Login*, *WebParts*, and *HTML*.

In Design view, you can tell the difference between client-side HTML controls and server-side controls. Click on a control and a popup DataTip tells you the type of control and its ID (Name). Figure 9.6 shows two button controls, one an ASP.NET server control and the other an HTML control.

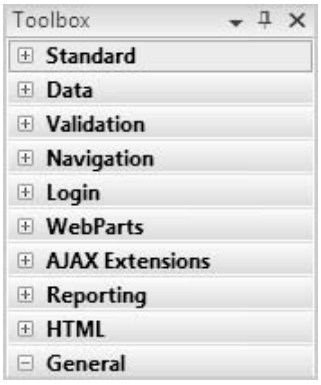


Figure 9.5

The Standard section of the toolbox holds the ASP.NET server controls, which you will use primarily. Click on each of the tabs to view the controls in each section of the toolbox.

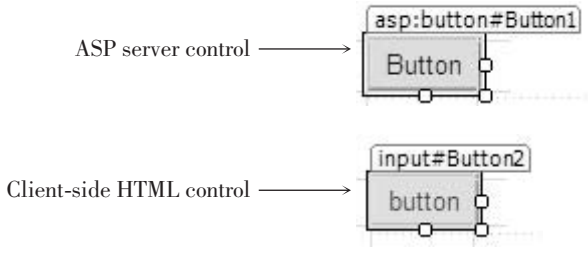


Figure 9.6

The popup DataTip for each control identifies the type of control and its ID.

Event Handling

You write VB code for events of Web controls in the same way that you write for Windows controls. The events may actually occur on either the client or the server. The process of capturing an event, sending it to the server, and executing the required methods is all done for you automatically.

The events of Web Forms and controls are somewhat different from those of Windows Forms. For example, a Web Form has a Page_Load event rather than a Form_Load event. You can see the events of the page using the editor when viewing the "code behind" file; in the *Class name* list on the left, select *(Page Events)* and drop down the *Method name* list (on the right) to see the list of events for the page. You also can select any control on the page to see the events of the control. For example, if you select a button control, you can see that you still have a Click event, but the list of events is much shorter than it is for Windows Forms.

Files

The files that you find in a Web application differ greatly from those in a Windows application (Figure 9.7). Two files make up the form: the aspx file and the aspx.vb file. The aspx file holds the specifications for the user interface that are used by the server to render the page. The aspx.vb file holds the Visual Basic code that you write to respond to events. The aspx.vb file is the code-behind file for the aspx file. When you are designing the user interface, you select the *FormName.aspx* tab and select the *Design* tab at the bottom of the window; when you are working on the code procedures, you select the *FormName.aspx.vb* tab.

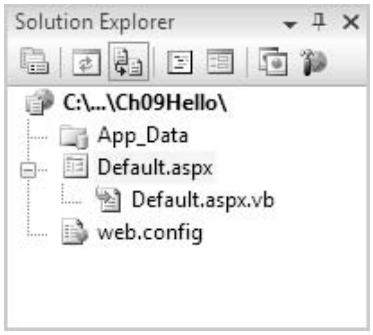


Figure 9.7

The Solution Explorer for a Web application. The Web page called "Default" consists of two files: Default.aspx (the visual elements) and Default.aspx.vb (the VB code-behind file).

Debugging

Running a Web application in the Visual Studio IDE is different from running a Windows application. The IDE does not automatically generate the code necessary for debugging a Web application. If you want to use the debugging tools, such as breakpoints and single-stepping, you must take steps to add the debugging functions to your project.

Run without Debugging

If you choose to run without debugging, you can press Ctrl + F5, or in Visual Web Developer, choose *Debug / Start without Debugging*.

Run with Debugging

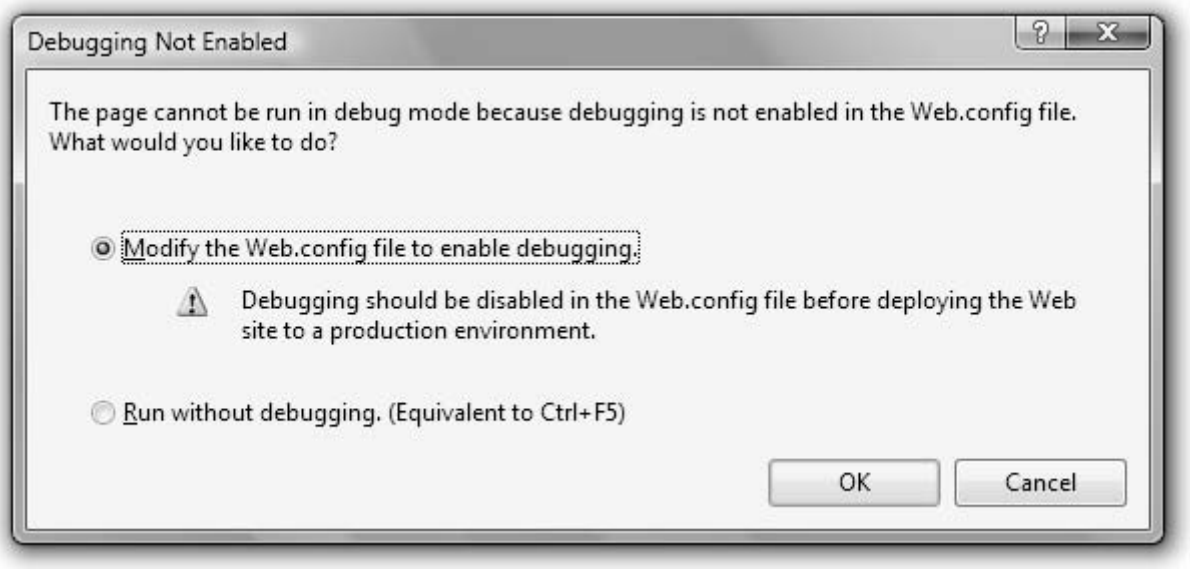
To add the necessary support for debugging, your project must have the following line in the Web.config file:

```
<compilation debug="true" />
```

If you try to run with debugging (F5), you receive an error telling you that it can't start with debug mode because debugging is not enabled in the Web.config file (Figure 9.8). It gives you two options: modify the Web.config file to enable debugging or run without debugging (equivalent to Ctrl + F5).

Figure 9.8

This dialog box appears if you attempt to run with debugging. Select Modify the Web.config file *if you want to use the debugging tools; otherwise select* Run without debugging.



After you allow modification of the Web.config file, you can set breakpoints, single-step execution, and display the contents of variables and properties. Try setting a breakpoint in the SubmitButton event procedure and rerun the program. The project compiles and displays in the browser. After you click on the button, the breakpoint halts execution and you can view the code and the values of properties, just as you can in Windows applications. Single-step execution using *Debug / Step Into*, and view your objects and properties in the Autos or Locals window (Locals only in VWD).

Note: Script debugging must be enabled in your browser to use the debugging tools.

TIP

Always remove debugging support before deploying an application. Debugging code slows the application considerably. ■

Testing in Other Browsers

You can test your project in another browser, such as Mozilla Firefox. From the Solution Explorer window, right-click on the project name and select *Browse With*. You can select from browsers that are installed on your computer.

Feedback 9.1

1. What two files make up a Web Form? What is the purpose of each file?
2. How can you display a preview of how your Web Form will display in a browser without actually running the program?
3. What is the difference between an ASP.NET server control and an HTML control? When might you want to use each type?

Laying Out Web Forms

You must always be aware that users may have different browsers, different screen sizes, and different screen resolutions. ASP.NET generates appropriate HTML to render the page in various browsers but cannot be aware of the screen size, resolution, or window size on the target machine.

Using Tables for Layout

If you want to have more control over placement of elements on your Web page, you can add an HTML **table**. You can add controls and text to the table cells to align the columns as you want them.

The table is an HTML control, which doesn't need any server-side programming. Although there is a Web server Table control, that is generally used when you want to write code to add rows, columns, or controls at run time.

You can either add a table to a Web page by selecting the Table tool from the toolbox HTML section, or allow the IDE to give you more help. Select *Insert Table* from the *Table* menu. In the *Insert Table* dialog box (Figure 9.9), you can choose the number of rows and columns, as well as set many attributes of the entire table.

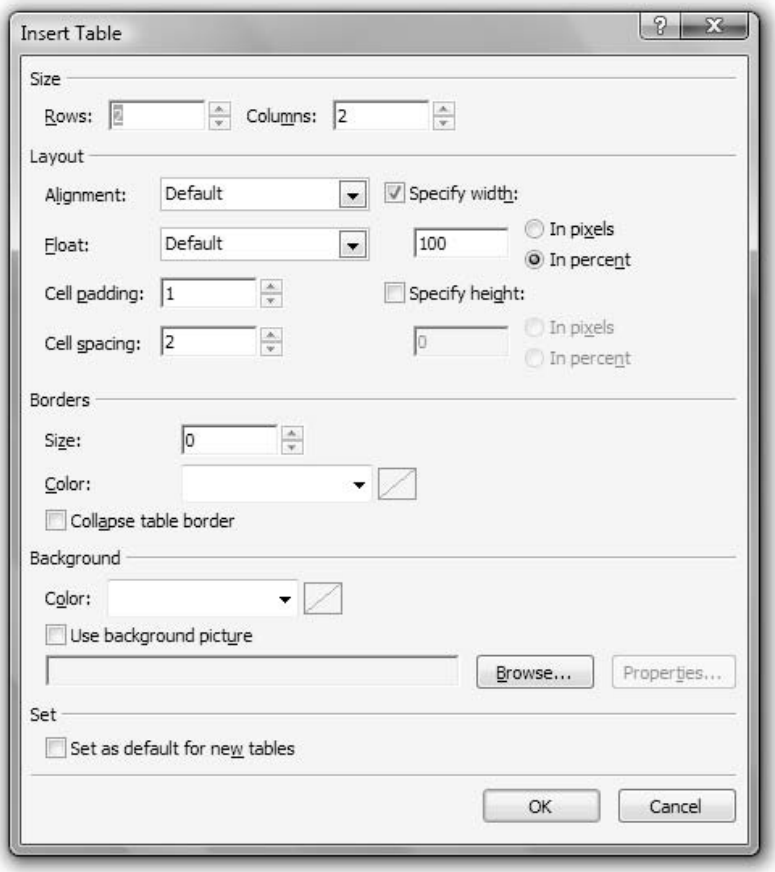


Figure 9.9

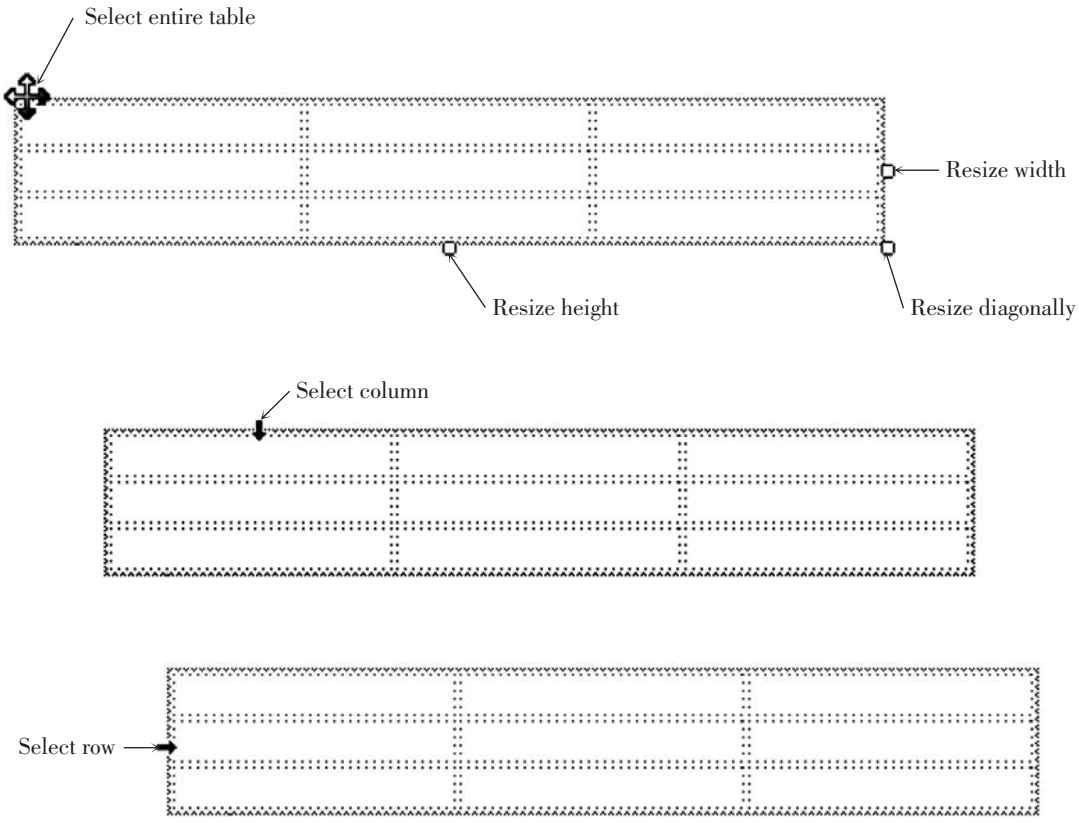
In the Insert Table dialog box, you can create a new table and set many properties of the table.

After you create a table, you can set many more properties, such as borders, alignment, and background color for the entire table, for individual rows, or for individual cells (Figure 9.10). Note that the HTML colors differ from the ones you can select for the document. You can adjust the column widths by dragging the bar between columns. If you want to move the table, you must click outside the table and insert or delete lines on the page.

To add or delete a table row, first select a row. Then right-click and use the context menu. You can use the same technique to add or delete a column.

Figure 9.10

Move the mouse pointer around to make the various arrows and handles appear. You can click on the arrows to select the entire table, a row, or a column. You also can resize the table by dragging the resizing handles.



Entering Controls or Text in a Table

You can add controls to any table cell or type text in a cell during design time. If you want to be able to refer to the text in a cell at run time, add a label and give it an ID; otherwise you can type text directly into the cell. Figure 9.11 shows a table in Design view. Although the table's border is set to zero, the borders appear at design time but not at run time (Figure 9.12).

When you are working with a table, there are some menu options that may help you adjust your table. The *Table* menu not only allows you to select the table and to insert columns, rows, or cells, but it also provides the ability to merge cells. This means that you can make the entire top row a single cell for your title or you may combine a couple of cells for a larger image.

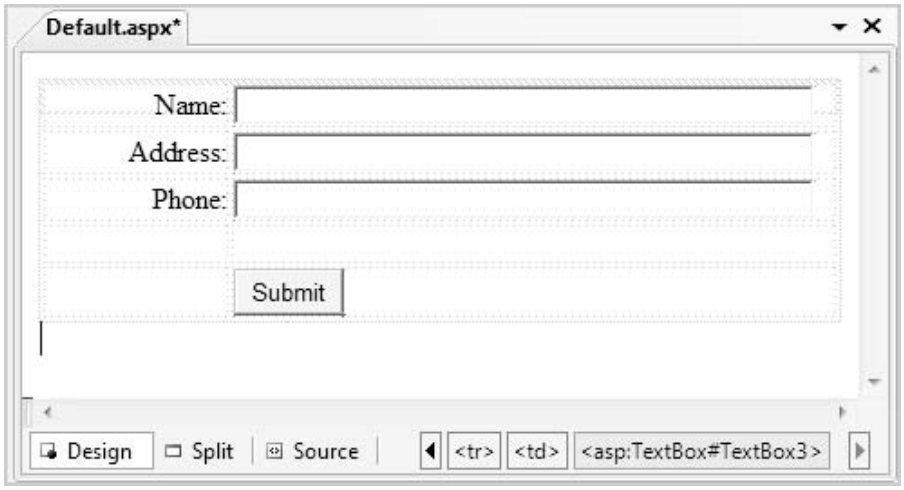
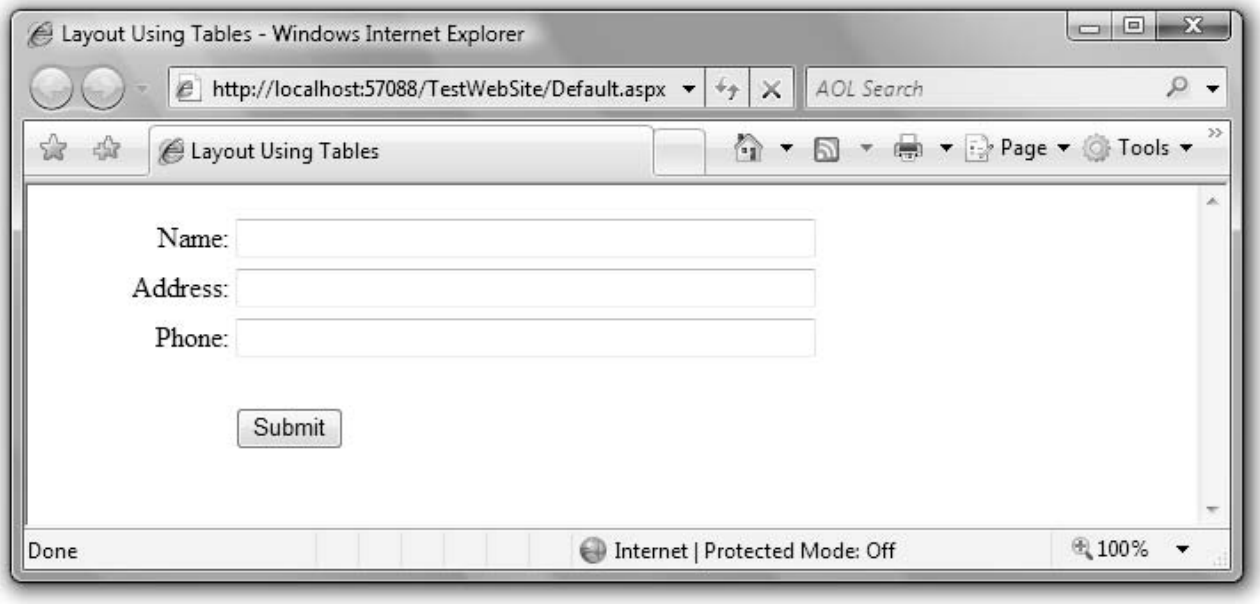


Figure 9.11

Add text and controls to the table cells. Although the Border property is set to zero, the borders still show at design time.

Figure 9.12

The table at run time. With the Border property set to zero, the borders do not appear.



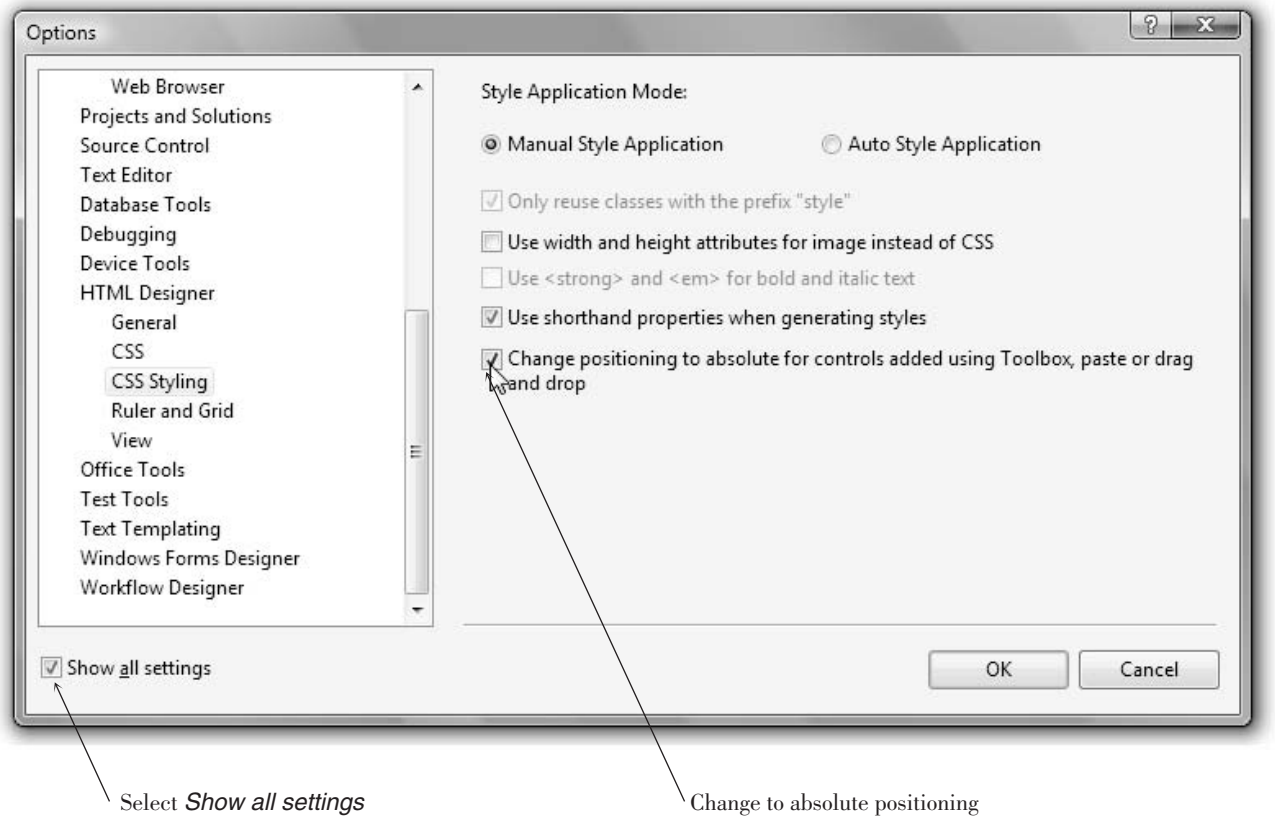
Absolute Positioning

You can choose to place controls on a Web page using **absolute positioning**. This option places controls in a specific X and Y position. If you choose absolute positioning, be aware that controls may not show up if the user has set the browser window to a small size, or they may overlap each other if the user has selected a large font size for the browser window.

To turn on absolute positioning, select *Tools / Options* and check the box to show all settings (Figure 9.13). Go to the tab for *HTML Designer*, *CSS Styling* and check the box for *Change positioning to absolute for controls added using Toolbox, paste or drag and drop*.

Figure 9.13

Turn on absolute positioning in the Options dialog box.



When you are using absolute positioning, you can drag a control using the white tab at the top of a selected control (Figure 9.14).

Absolute positioning keeps controls in the same position relative to the container—the Web page in our case. You also can set individual controls to an absolute position using cascading style sheets, which are discussed later in this chapter.

Including Images on Web Pages

You can add graphics to a Web page using the Image control. The concept is similar to the PictureBox control on Windows Forms, but the graphic file is connected differently due to the nature of Web applications. Each Image control has an ImageUrl property that specifies the location of the graphic file.

To place an image on a Web page, you should first copy the graphic into the Web site folder. If the project is open in the IDE when you add the graphic files, click the *Refresh* button at the top of the Solution Explorer to make the files show up.

You can add an Image control to a cell in a table or directly on a Web page. In the ImageUrl property, click on the Property button (...) to open the *Select Image* dialog box (Figure 9.15). If you have added the graphic to the project folder and either clicked the Solution Explorer *Refresh* button or reopened the project, the graphic file will appear in the *Contents* pane.

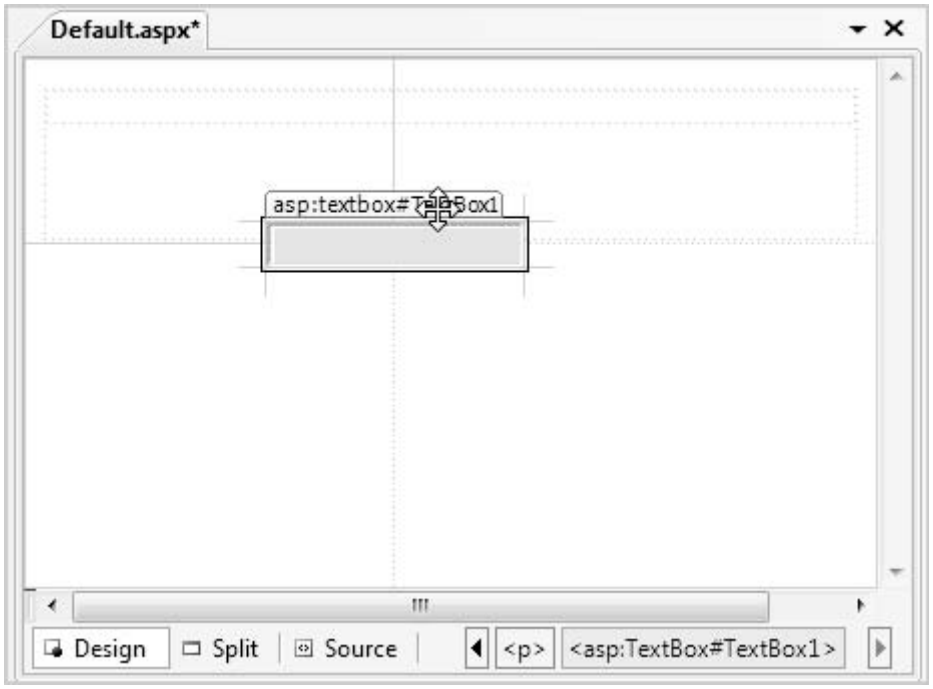


Figure 9.14

Drag a control to a new position using the tab at the top of the selected control.

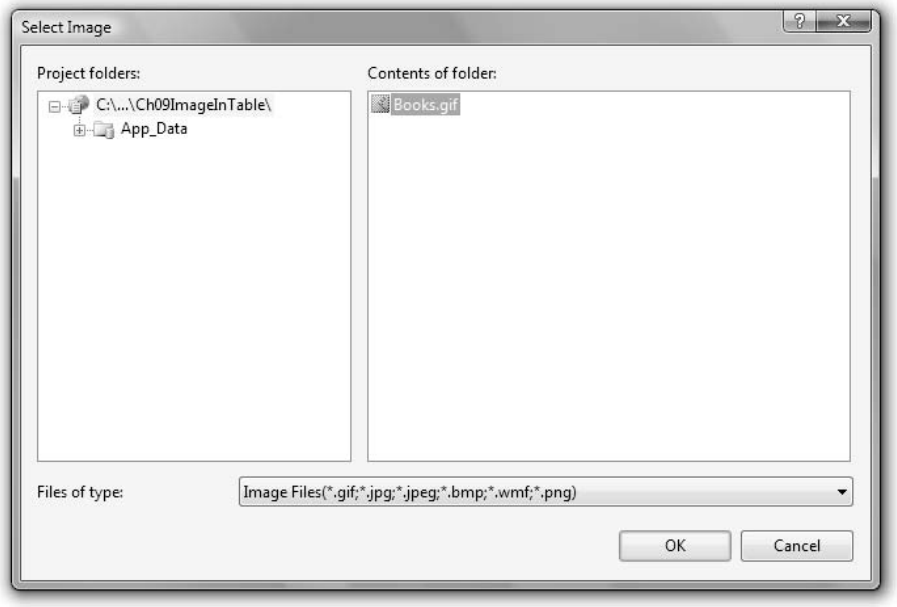


Figure 9.15

Select the graphic for the ImageUrl property of the Image control in the Select Image dialog box.

The page in Figure 9.16 is made up of a table of three rows and three columns. The image and company title are in the first row and the text box is in the second row. The hyperlink shown in the last row is discussed in the section "Navigating Web Pages" later in this chapter.

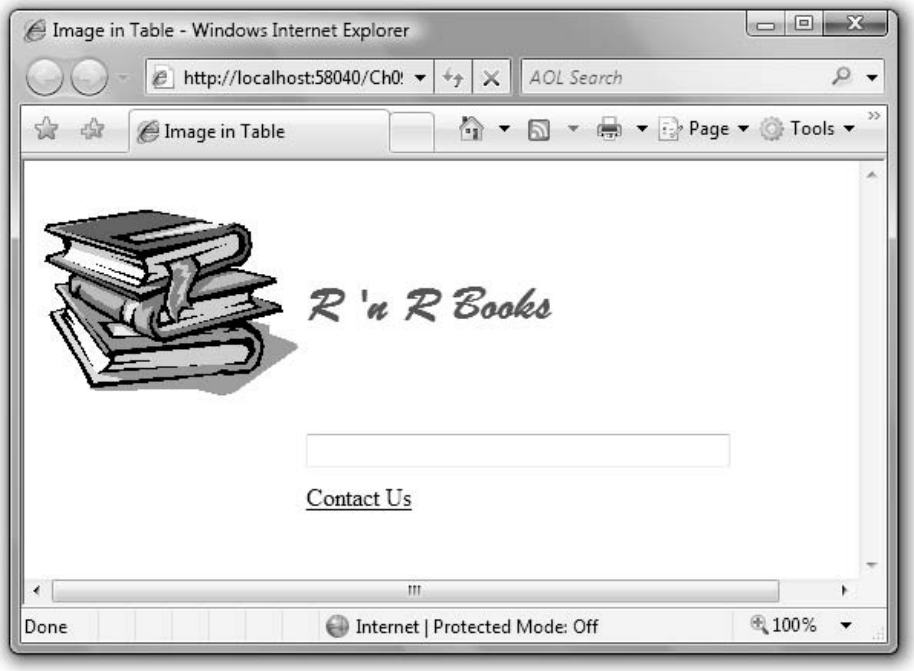


Figure 9.16

Place images, text, and controls where you want them by using a table. The elements on this page are inserted into table cells. The graphic appears in an Image control.

Feedback 9.2

1. Name two ways to place a button at the bottom of a Web page.
2. What is the difference between an HTML Table control and a Web Table control?
3. Where should you store images for a Web application?

Cascading Style Sheets

One huge improvement in Visual Studio 2008 are the new tools for using styles in Web applications. These new tools, called *Expression Web*, expand, enhance, and simplify using **cascading style sheets (CSS)**. You can use cascading style sheets to create, modify, and apply styles to single elements on a page, one entire page, all pages of an application, or all applications of an organization.

Using Styles

Styles are rules that can specify page layout, position, font, color, alignment, margins, borders, background, and bullet and numbering formats. You can create and apply new styles within a page, attach an external .css file and apply the styles, and even save the styles in a page to an external .css file for use on other pages or Web sites.

You can choose to define styles in several locations, including on the Web page for individual elements, called an *inline style*; in a *style* section of a Web page, called a *page style*; or in an external style sheet (.css file) that is linked or imported into the Web page. Generally programmers use inline styles for elements that appear only once on a page, page styles for elements that may be used in more than one location on the page, and external style sheets for

elements that may appear on more than one page of a Web site or in multiple Web sites.

The term "cascading" in cascading style sheets refers to the order of precedence of style rules. More locally created styles override the rules of the more globally created styles. For example, you might apply an h1 style from the style sheet (global) that sets the font, color, size, and alignment. And if you also apply a style defined in the page for the color and size, the local (page-defined) color and size take precedence, but the font and alignment of the style-sheet style are still in effect. And if you also apply an inline style for the size, the inline (more local) style will override the size but keep the color of the page-defined style and the font and alignment of the style-sheet style.

Types of Styles

In Visual Studio, you will use several new tools to define, apply, modify, and change the location of styles. The Apply Styles window and the Manage Styles window, both of which you will learn about in the next section, use the icons in Table 9.1 to identify the various types of styles.

New Style Tools

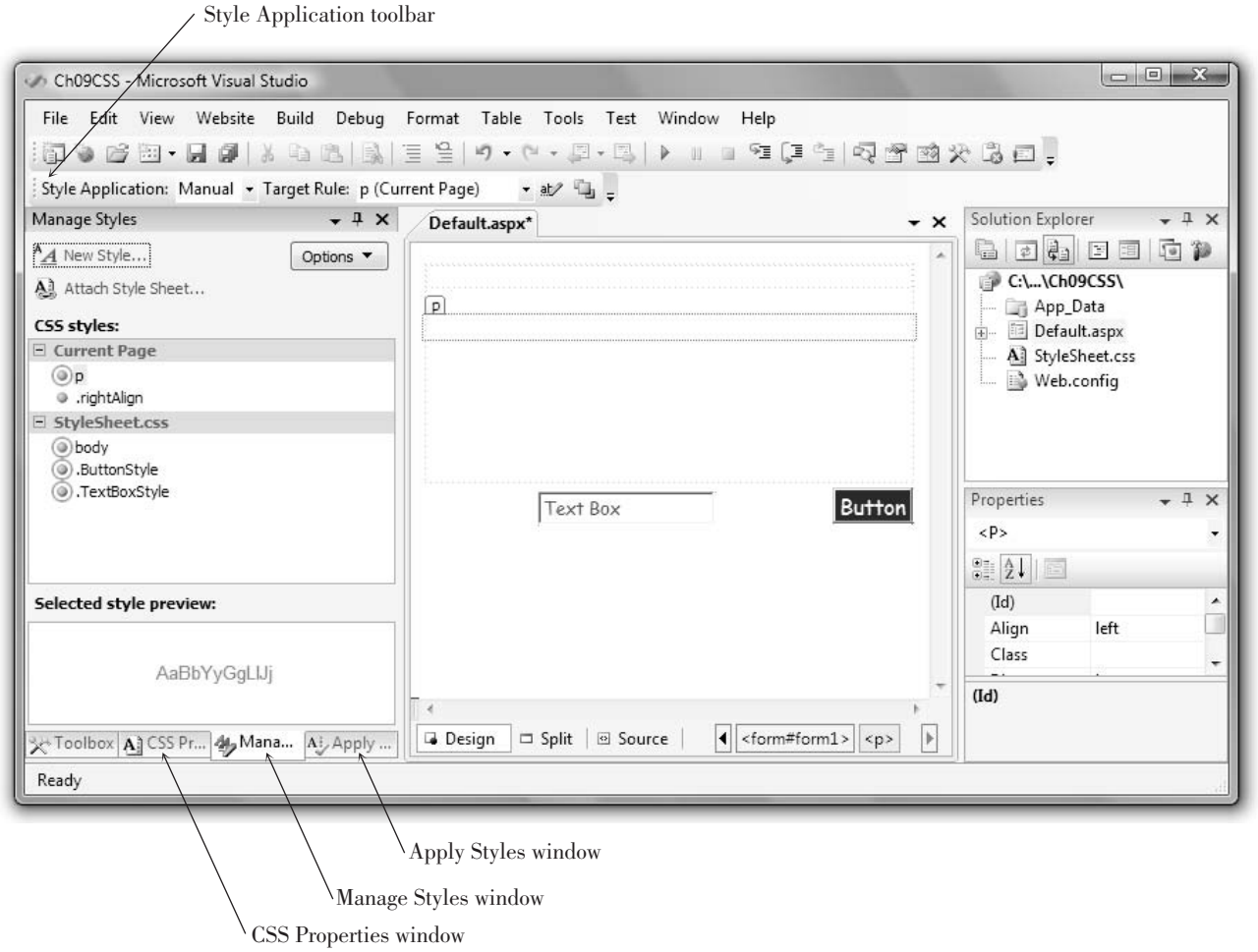
The Visual Studio 2008 IDE and Visual Web Developer have new windows that make it easy to define, apply, and manage styles. The new windows–CSS Properties, Manage Styles, and Apply Styles–appear by default in the same area as the toolbox and are available from the *View* menu. Also, a new Style Application toolbar appears in the default layout of the IDE. Figure 9.17 shows the new tools.

Cascading Style Sheet (CSS) Style Types **Table 9.1**

Icon	Style Type	How Referenced
• (Red dot)	ID-based style; defined in a .css file. Applies to a specific element by ID.	Style name preceded by a pound sign. Example: `#footer`
• (Green dot)	Class-based style; defined in a .css file or the current page. Defines style properties that you want to apply to some, but not all, elements of a particular type, such as some <p> (paragraph) elements.	Style name preceded by a period. Example: `.intro`
• (Blue dot)	Element-based style; defined in the style block of a page. Applies to all elements that use a particular tag, such as <p> (for paragraph) or <td> (for table cell).	Style name only. Example: `p {margin-left: 25px; margin-right: 25px}`
• (Yellow dot)	Inline style. Applies only to the specified item; will not be reused by another element.	In Design view, apply formatting such as font, size, and bold, from the *Format* menu or the formatting toolbar. In Source view, formatting appears using the style element of the opening tag. Example: `<p style="font-weight: bold; font-style: italic>`
◉ (Circled dot)	Indicates that the style is used on the current page.	A dot without a circle indicates that the style is defined but not used.
@ (At sign)	Indicates an imported external cascading style sheet.	

Figure 9.17

The new style windows and the Style Application toolbar.



The Style Application Toolbar

You can use the first drop-down list on the Style Application toolbar to select either *Manual* or *Auto* style application. The *Auto* selection disables the remaining items in the toolbar and allows the software to determine where to place the CSS code. Select *Manual* to choose the location of the styles using the *Target Rule* drop-down list.

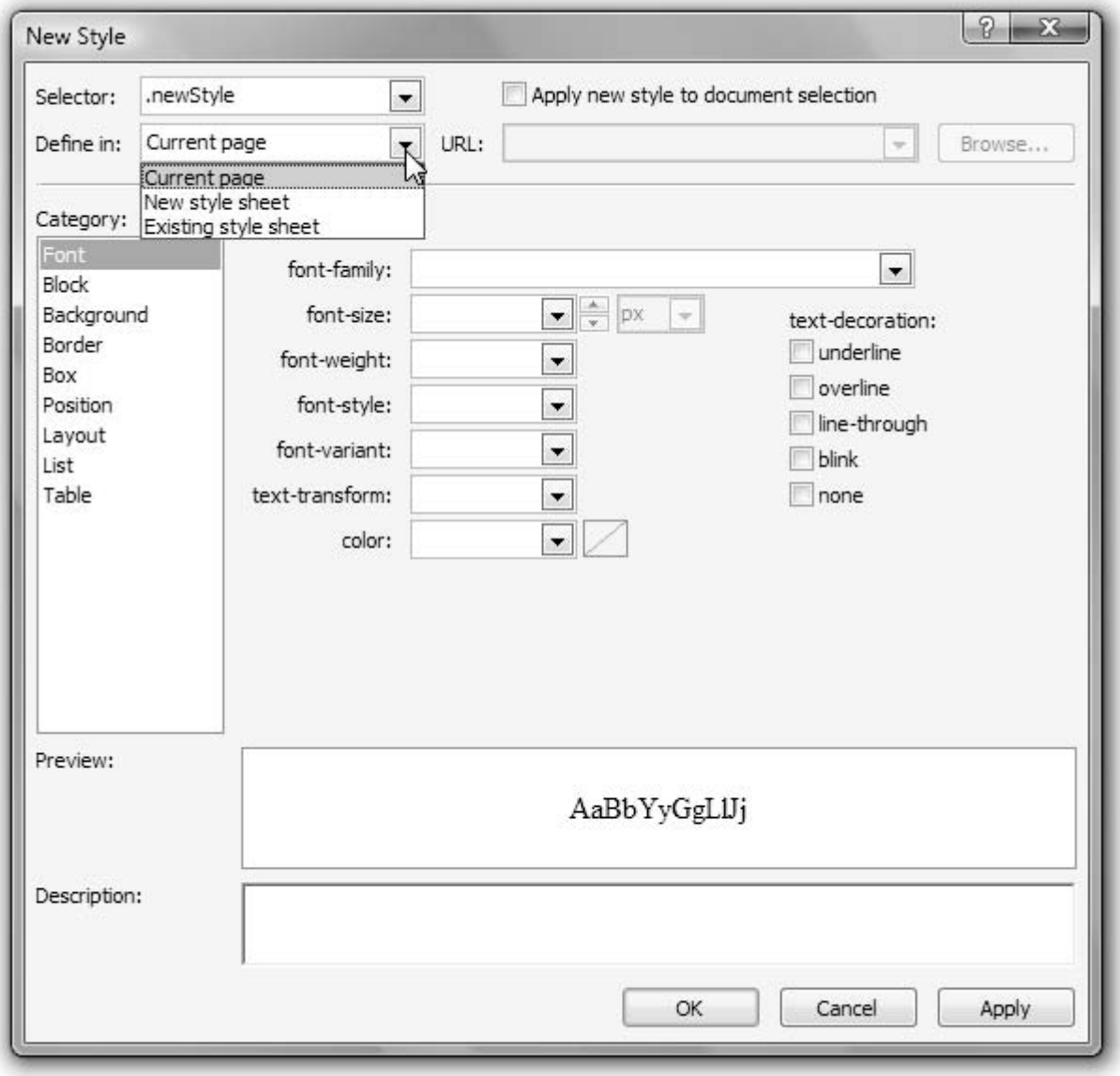
As an example, set the Style Application mode to *Manual* and drop down the *Target Rule* list. One option is *New Inline Style*, which places the style code directly into the HTML source code. You also can choose to create an external .css file that can be reused on multiple pages or projects. In this example we will select the *Apply New Style* option, which will allow us to create a new style in a new or existing .css file.

Defining Styles

You define a new style in the *New Style* dialog box (Figure 9.18), which you can display from several locations. Choose *New Style* from the *Format* menu, or select *New Style* in either the Manage Styles window or the Apply Styles window.

Figure 9.18

Define a new style in the New Style *dialog box. Enter the name for the new style or choose the tag for an element type in the* Selector *box. The* Define in *box allows you to choose the location for the new style.*



You also can right-click in the CSS Properties window and choose *New Style* from the context menu.

In the *New Style* dialog box, choose the category and then make settings. For example, click on *Font* in the *Category* list and set the font attributes; click on *Block* and set such attributes as text-align, text-indent, and vertical-align; click on *List* to set bullet and numbering attributes; and *Table* has settings for such attributes as borders and spacing.

Managing Styles

In the Manage Styles window (refer to Figure 9.17), you can see a preview of each style. Hover the mouse pointer over a style name to display the code in the

style. You also can see the settings for a given style in the CSS Properties window.

In the Manage Styles window, you can drag styles from one category to another to change the location of the style definition. For example, if you created a style in the current page and want to move it to the .css file so that you can use it in other pages, drag the style name from the Current Page pane to the StyleSheet.css (or other name of a .css file) pane. If you have more than one .css file attached to the page, you can choose the file to which to add a style.

Applying Styles

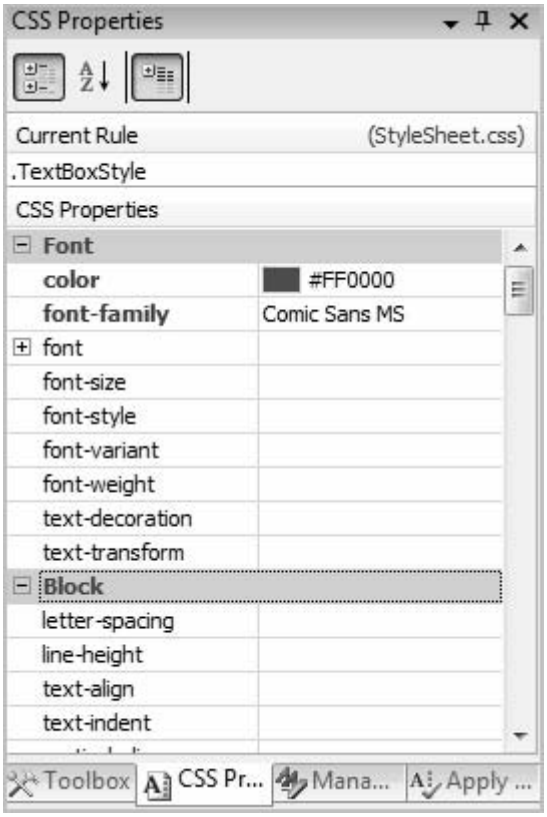
You can apply styles from several locations, including the Apply Styles window, the Manage Styles window, and the *New Style* dialog box. When you create a new style on the *New Style* dialog box, check the box for *Apply new style to document selection* (refer to Figure 9.18). Using the Apply Styles window, select the element on the page and click the desired style. To use the Manage Styles window, select the element on the page, then right-click the desired style name and select *Apply Style* from the context menu.

Modifying Styles

You can change the attributes of a style from either the Apply Styles or Manage Styles window. Select the style name, right-click, and select *Modify Style* from the context menu. You also can modify style attributes in the CSS Properties window (Figure 9.19).

Figure 9.19

View and modify style elements in the CSS Properties window.



Navigating Web Pages

ASP.NET provides several techniques for navigating from one Web page to another. The easiest form of navigation is to use a HyperLink control.

Using Hyperlinks

You may need to allow your user to navigate to another site or to another page in your application. You can add a HyperLink to a Web page. The HyperLink control allows you to enter a Text property for the text to display for the user and a NavigateUrl property that specifies the URL to which to navigate.

When you select the NavigateUrl property for a HyperLink control, the *Select URL* dialog box appears (Figure 9.20). You can select the page from the list. If you want to navigate to another Web site, simply type the Web address as the NavigateUrl property value.

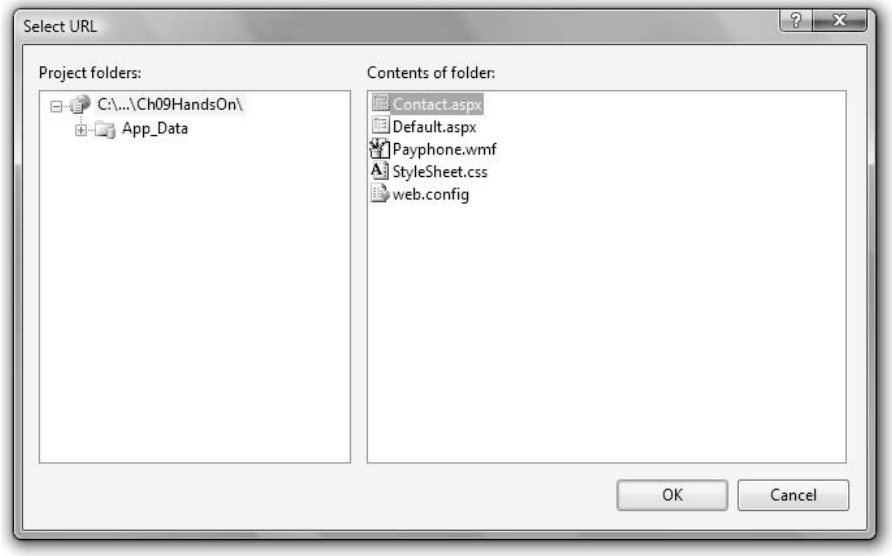


Figure 9.20

Select the page to which to navigate for a HyperLink control from the Select URL *dialog box.*

Adding a Second Web Page

Often you need to include multiple Web pages in your application. For example, you can have a separate page to display contact information for your company. You can create a Web Form that contains labels about the company and a HyperLink control to return to the company's home page. The following step-by-step exercise adds a page to the Hello project you created earlier and adds HyperLinks to each page to navigate back and forth.

Add a New Form to the Hello Project

STEP 1: Open the Ch09Hello Web site in the IDE if necessary.

STEP 2: Select *Add New Item* from the *Website* menu.

Note: If the templates are not listed, make sure that the project is displaying in the Solution Explorer.

STEP 3: In the *Add New Item* dialog box (Figure 9.21), set the *Name* box to ContactInfo.aspx. The language should be set to Visual Basic.

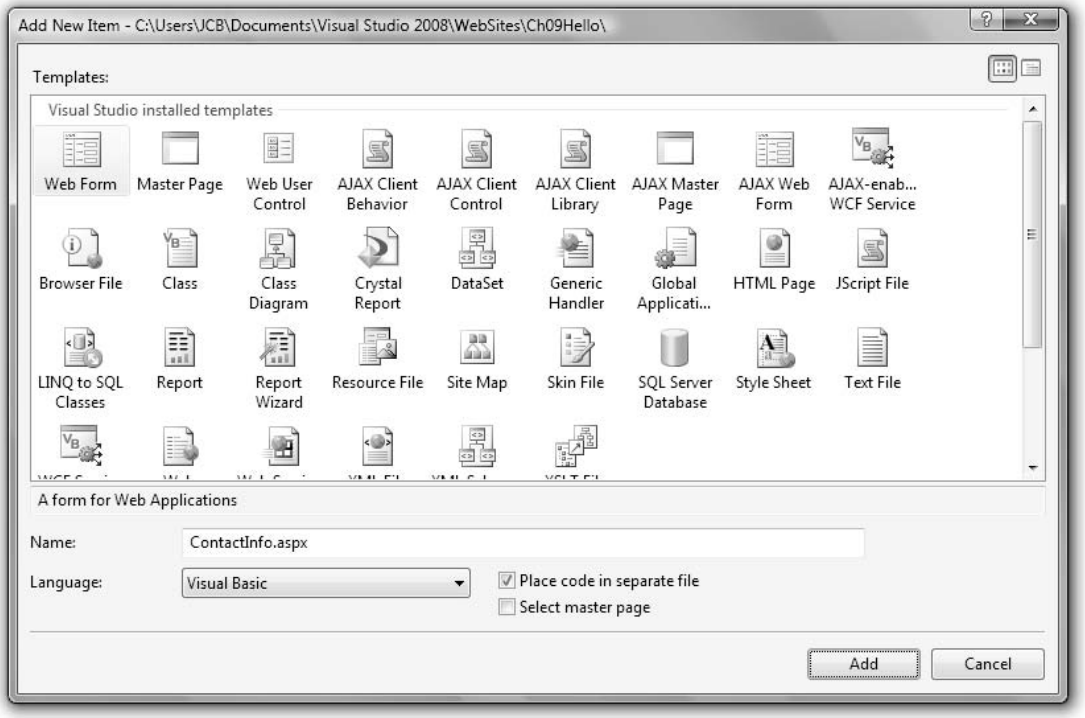
STEP 4: Make sure that the check box for *Place code in separate file* is selected. This option should be selected for all pages in a project.

STEP 5: Click *Add*. The ContactInfo.aspx file appears in the Document window.

STEP 6: If the source code for HTML is displaying, display Design view by selecting the tab at the bottom of the Document window or by clicking on the *View Designer* button in the Solution Explorer window.

Figure 9.21

To add a new Web Form to a Web site, select Web Form *in the* Add New Item *dialog box. Make sure to choose Visual Basic for the language and select* Place code in separate file.



Add Controls to the New Page

STEP 1: Set the document's Title property to "Hello Contact Information".

STEP 2: Add a HyperLink control to the top of the page.

STEP 3: Set the HyperLink's Text property to "Return to Home Page".

STEP 4: Click on the Property button for the HyperLink's NavigateUrl property to open the *Select URL* dialog box.

STEP 5: Select Default.aspx (Figure 9.22), the main page of this Web site, and click *OK*.

STEP 6: Press Enter three or four times and enter the contact information. (Make up any information.)

Add a HyperLink to the Main Page

STEP 1: Display Default.aspx in the designer and add a HyperLink control to the bottom of the page.

STEP 2: Set the Text property of the control to "Contact Information".

Figure 9.22

Select Default.aspx, the main page of the Web site, as the page to which to navigate.

STEP 3: Set the NavigateUrl property to ContactInfo.aspx.

STEP 4: Run the application. Test the links on both pages, which should navigate back and forth between the two pages.

Note: If the Default.aspx page is not the first page in the browser, in the IDE right-click Default.aspx in the Solution Explorer window and select *Set as Start Page* from the context menu.

Feedback 9.3

1. What property of a HyperLink control indicates to which Web page the control is linked?
2. Describe how to set up the HyperLinks to navigate from a main page to a second page and back again to the main page.

Using the Validator Controls

ASP.NET provides several controls that can automatically validate input data. You add a **validator control**, attach it to an input control such as a text box, and set the error message. At run time, when the user inputs data, the error message displays if the validation rule is violated. These validation controls run on the client-side, so the page does not have to be submitted to the server to view and clear the message. Table 9.2 lists the ASP.NET validator controls.

Note that a blank entry passes the validation for each of the controls except the RequiredFieldValidator. If you want to ensure that the field is not blank *and* that it passes a range check, for example, attach both a RangeValidator and a RequiredFieldValidator control to a field.

For the ErrorMessage property of the validator controls, you can either enter a complete message or set the property to an asterisk. When the user leaves the field blank or enters invalid data, the asterisk will appear.

Validator Controls **Table 9.2**

Control	Purpose	Properties to Set
RequiredFieldValidator	Requires that the user enter something into the field.	ControlToValidate ErrorMessage
CompareValidator	Compares the value in the field to the value in another control or to a constant value. You also can set the Type property to a numeric type and the CompareValidator will verify that the input value can be converted to the correct type.	ControlToValidate ControlToCompare *or* ValueToCompare Type (To force type checking) ErrorMessage
RangeValidator	Makes sure that the input value falls in the specified range.	ControlToValidate MinimumValue MaximumValue Type (To force type checking) ErrorMessage
RegularExpressionValidator	Validates against a regular expression, such as a required number of digits, or a formatted value, such as a telephone number or social security number. Use the Regular Expression Editor to select or edit expressions; open by selecting the Property button on the ValidationExpression property.	ControlToValidate ValidationExpression ErrorMessage
ValidationSummary	Displays a summary of all of the messages from the other validation controls.	DisplayMode (Can be set to a list, bulleted list, or a single paragraph.)

Feedback 9.4

Describe how to validate a text box called NumberTextBox using validator controls. A numeric entry is required, in the range 0 to 1000. The field must not be blank.

Maintaining State

As you learned earlier, a Web page holds static data. Each time a page is displayed, or redisplayed, it is a new "fresh" copy of the page. In fact, each time the page is posted back to the server, a new fresh copy of the *program* is loaded. The server responds to the postback, handles any events that have occurred, sends the page back to the client (the browser), and releases the memory used by the program. Unless steps are taken to maintain the values of variables and the controls on the page, called the *state* of the page, all values will be lost in every postback.

Retaining the Contents of Controls

Although regular HTML does not retain the contents of controls during a postback, ASP.NET *can* retain and redisplay control contents. Web controls have an EnableViewState property, which indicates that you want the server to send the control's contents back with the page. EnableViewState is set to True by default, so control contents reappear for each postback.

Retaining the Values of Variables

Local variables in a Web application work just like local variables in a Windows application: The variables are re-created each time the procedure begins. But module-level variables in Web applications do not work like the ones you are used to in Windows. Because the program is reloaded for each postback, the values of module-level variables are lost unless you take steps to save them. You can store the value of a module-level variable in a control on the Web page; the control's EnableViewState property takes care of holding the value during postback.

Note: More advanced techniques for maintaining state, such as cookies and session variables, are beyond the scope of this text. These techniques are covered in the authors' Advanced VB text.

You can either set up a label with its Visible property set to False or use the HiddenField control in the toolbox. Then assign the module-level variable to the invisible control. For an invisible label, use the Text property; for the hidden field, you must use the Value property, which is a string. In the following example, DiscountTotalHiddenField is a control on the page and DiscountTotalDecimal is a module-level variable.

```
' Declare a module-level variable
Private DiscountTotalDecimal As Decimal

Private Sub SubmitButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles SubmitButton.Click
    ' Perform calculations.
    Dim DiscountDecimal As Decimal

    ' Omitted code to convert input to numeric and calculate a discount.

    ' Add to the discount total.
    DiscountTotalDecimal += DiscountDecimal
    ' Save the discount total in a hidden field.
    DiscountTotalHiddenField.Value = DiscountTotalDecimal.ToString()
End Sub
```

Checking for Postback

When an ASP.NET Web application loads, the Page_Load event occurs. But unlike Windows applications, the page is reloaded for each "round-trip" to the server (each postback). Therefore, the Page_Load event occurs many times in a Web application. The page's IsPostBack property is set to False for the initial page load and to True for all page loads following the first. If you want to perform an initialization task once, you can test for `IsPostBack = False` (or `Not IsPostBack`) in the Page_Load event procedure. And if you want to make sure that you perform an action only on postback (not the initial page load), you can check for `IsPostBack = True`.

```
Private Sub Page_Load(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles MyBase.Load

      ' If a value exists for the Discount total...
      If IsPostBack And DiscountTotalHiddenField.Value <> "" Then
          DiscountTotalDecimal = Decimal.Parse(DiscountTotalHiddenField.Value)
      End If
```

Notice that the module-level variable DiscountTotalDecimal is assigned a value only on postback *and* DiscountTotalHiddenField already has been assigned a value.

Feedback 9.5

Why is it necessary to check for a postback when writing Web applications?

AJAX

One of the newest improvements for Web applications is **Asynchronous JavaScript and XML (AJAX)** for creating interactive applications. AJAX allows you to reload only a portion of the Web page, rather than the entire page, on each postback.

Often large portions of a Web page are unchanged for a postback. Using standard protocols, the entire page is redrawn every time. Using AJAX, the loading speed can increase dramatically by downloading and rendering only the portion that *does* change.

AJAX is an open and cross-platform technology that works on many operating systems. Many AJAX objects are available in the tool library, and any developer can contribute more objects due to the open nature of the standards. You can find more information at www.asp.net/community/.

AJAX is included in Visual Studio 2008, so you can use it on your Web pages. Any page that uses AJAX features must include a ScriptManager component, which is available in the toolbox under AJAX Extensions. After you place the ScriptManager component on the page, you can add other controls, such as the UpdatePanel, which is a container for other controls.

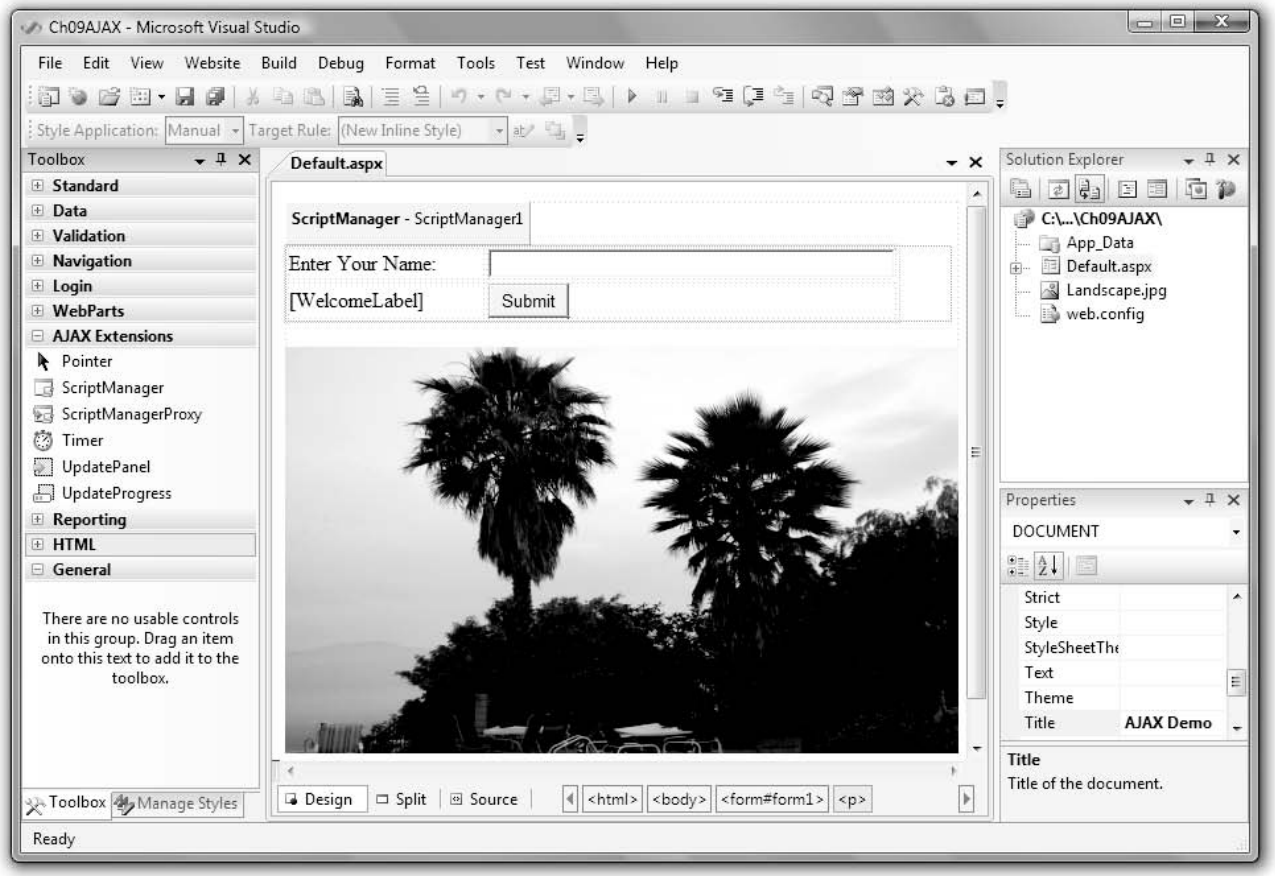
Placing controls inside of an UpdatePanel determines what portion of the page updates on a postback. One fun way to test this is to place a label containing the time inside the update panel and another outside the panel. When a Submit button posts back to the server, only the time inside the update panel changes. *Hint*: See "Retrieving the System Date and Time" in Appendix B for the methods to display the time.

In the following small program (Figure 9.23), the user enters a name in a text box and clicks the *Submit* button. The page then welcomes the user by name. The large image is outside the UpdatePanel so it does not redraw when the page posts back the response.

```
Protected Sub SubmitButton_Click(ByVal sender As Object, _
  ByVal e As System.EventArgs) Handles SubmitButton.Click
    ' Concatenate Welcome to the name.

    WelcomeLabel.Text = "Welcome" & NameTextBox.Text
End Sub
```

Figure 9.23

A Web page that uses AJAX must have a ScriptManager component. The UpdatePanel holds the controls that should be posted back to the server. The area outside the UpdatePanel remains unchanged.



Managing Web Projects

Moving and renaming Web projects is extremely easy when you are using File System Web sites, as opposed to IIS sites. Always make sure that the project is closed, and then you can rename the project folder, move it to another location on the computer, or copy it to another computer. To open the moved or renamed project, open the IDE first, select *File / Open Web Site*, and navigate to the project's folder.

You should be aware that Visual Studio creates two folders for each Web site that you create. The first folder holds all of the Web pages and other files for the Web site. The second folder is a project folder that holds only the .sln and .suo files and is created in the default location for project files. You can handle these solution files in one of two ways: (1) You can ignore the files and continue to open the Web site folder using the *Open Web Site* menu item in the IDE; or (2) You can open the Web site from the .sln file. Unfortunately, the .sln file contains hard-coded paths that do not change when you copy or rename the Web site's folder. Unless you want to manually edit the .sln file in an editor, such as Notepad, it's best to just ignore these extra files.

Using the Copy Web Site Tool

You can use the Copy Web Site tool to copy an entire Web site from one location to another on the same computer, or to another computer on a network, or to a remote site. The tool can copy the Web site to a remote server where it can be accessed by multiple users. Select *Website / Copy Web Site* to begin the operation. For a demonstration, see the MSDN Help page "Walkthrough: Copying a Web Site Using the Copy Web Site Tool".

Some Web Acronyms

You have seen many acronyms in this chapter, such as HTML, ASP, IIS, and URL. But we have only scratched the surface. As you read the Help files for VB and begin developing Web applications, you will want to know the meaning of many more. These include the following:

XML	Extensible Markup Language. This popular tag-based notation is used to define data and their format and transmit the data over the Web. XML is entirely text-based, does not follow any one manufacturer's specifications, and can pass through firewalls. See the pages "XML" and "XML Tools in Visual Studio" in Help for further information.
SOAP	Simple Object Access Protocol. An XML-based protocol for exchanging component information among distributed systems of many different types. Since it is based on XML, its messages can pass through network firewalls. See http://www.w3.org/TR/soap12-part1/
HTTP	Hypertext Transfer Protocol. The protocol used to send and receive Web pages over the Internet using standardized request and response messages.
Web Service	Code in classes used to provide middle-tier services over the Internet.
WSDL	Web Services Description Language. An XML document using specific syntax that defines how a Web service behaves and how clients interact with the service.

Your Hands-On Programming Example

R 'n R has decided to start selling books online. Create a Web site to calculate the amount due including discounts. Allow the user to display the total of the discounts.

The user enters the quantity, title, and price of a book, and the program calculates the extended price, a 15 percent discount, and the discounted price.

The input must be validated. The quantity and price are required fields, and the quantity must be an integer between 1 and 100.

Additionally, the program will maintain a total of all discounts given and display that total on the page in response to a button click.

Include a second page for contact information.

Note: This project is a Web version of the Book Sales program for R 'n R from Chapter 3.

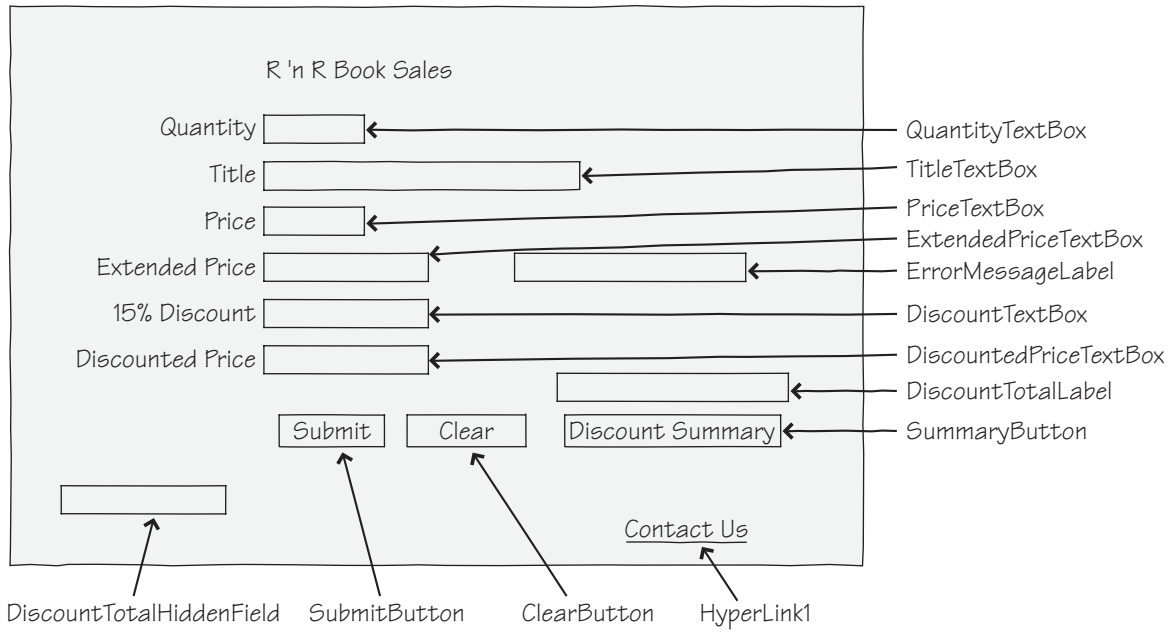
Planning the Project

Sketch the Web forms (Figure 9.24), which your users sign off as meeting their needs.

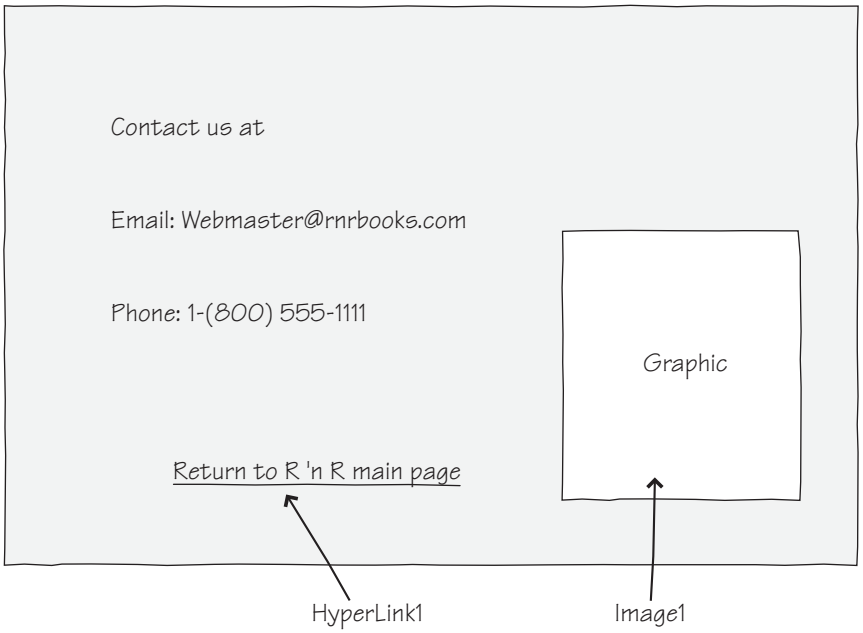
Figure 9.24

Sketch the forms for the hands-on programming example; a. the main (default) page and b. the contacts page.

a.



b.



Plan the Objects and Properties

Default Page

Object	Property	Setting
HTML Table (8 rows by 3 columns)		
Text entered directly in cells (not in controls)		R 'n R Book Sales (Font: Bold, Arial, Medium) Quantity Title Price Extended Price 15% Discount Discounted Price
QuantityTextBox	ID Text	QuantityTextBox (blank)
TitleTextBox	ID Text	TitleTextBox (blank)
PriceTextBox	ID Text	PriceTextBox (blank)
ExtendedPriceTextBox	ID Text ReadOnly BackColor	ExtendedPriceTextBox (blank) True Transparent (*Hint*: Select from Web colors)
DiscountTextBox	ID Text ReadOnly BackColor	DiscountTextBox (blank) True Transparent
DiscountedPriceTextBox	ID Text ReadOnly BackColor	DiscountedPriceTextBox (blank) True Transparent
DiscountTotalLabel	ID Text Visible	DiscountTotalLabel (blank) False
DiscountTotalHiddenField	ID	DiscountTotalHiddenField
SubmitButton	ID Text	SubmitButton Submit
ClearButton	ID Text	ClearButton Clear
SummaryButton	ID Text Causes Validation	SummaryButton Discount Summary False
QuantityRequiredFieldValidator	ID ControlToValidate ErrorMessage	QuantityRequiredFieldValidator QuantityTextBox *
QuantityRangeValidator	ID ControlToValidate Type MaximumValue MinimumValue ErrorMessage	QuantityRangeValidator QuantityTextBox Integer 100 1 1-100 Only.

Object	Property	Setting
PriceRequiredFieldValidator	ID	PriceRequiredFieldValidator
	ControlToValidate	PriceTextBox
	ErrorMessage	Required Field
PriceRangeValidator	ID	PriceRangeValidator
	ControlToValidate	PriceTextBox
	Type	Currency
	ErrorMessage	Must be numeric
ErrorMessageLabel	ID	ErrorMessageLabel
	Text	(blank)
	ForeColor	Red
HyperLink1	Text	Contact Us
	NavigateUrl	Contact.aspx

Hint: Create a style to apply to the text boxes that should have numeric amounts right-aligned. In the Block category, set text-align: right. You can apply the style to right-aligned labels as well as text boxes.

Contact Page

Object	Property	Setting
Text entered directly in cells (not in controls)		Contact us at Email: Webmaster@rnrbooks.com *Note*: This will convert to an e-mail link automatically. Phone: 1-(800) 555-1111
HyperLink1	Text	Return to R 'n R main page
	NavigateUrl	HomePage.aspx
Image1	ImageUrl	Payphone.wmf (Stored in project folder) (Image found in StudentData\Graphics)

Plan the Procedures

Default Page

Procedure	Actions
Page_Load	If PostBack and hidden field has a value Load discount total from hidden field.
SubmitButton_Click	Clear any text in ErrorMessageLabel. Convert input text values to numeric. Calculate the extended price = price * quantity. Calculate the discount = extended price * discount rate. Calculate the discounted price = extended price − discount. Add the discount to the discount total. Assign the discount total to the hidden field. Format and display the results. Handle any conversion exceptions.
ClearButton_Click	Clear all text boxes and labels.
SummaryButton_Click	Display the discount total in a label.

Contact Page
The contact page has no event procedures.

Write the Project Follow the sketch in Figure 9.24 to create the Web pages. Figure 9.25 shows the completed pages, and Figure 9.26 shows the pages in Design view.

- Set the properties of each of the objects according to your plan.
- Write the code. Working from the pseudocode, write each procedure.
- When you complete the code, use a variety of data to thoroughly test the project. Make sure to test with empty fields, data out of range, and nonnumeric data in the numeric fields.

Figure 9.25

The finished Web application; a. the main (default) page and b. the contacts page.

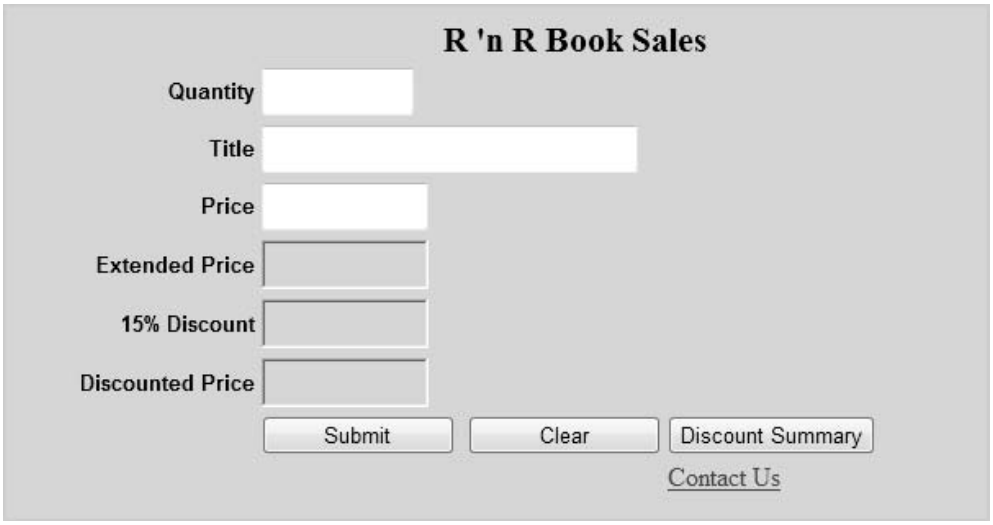
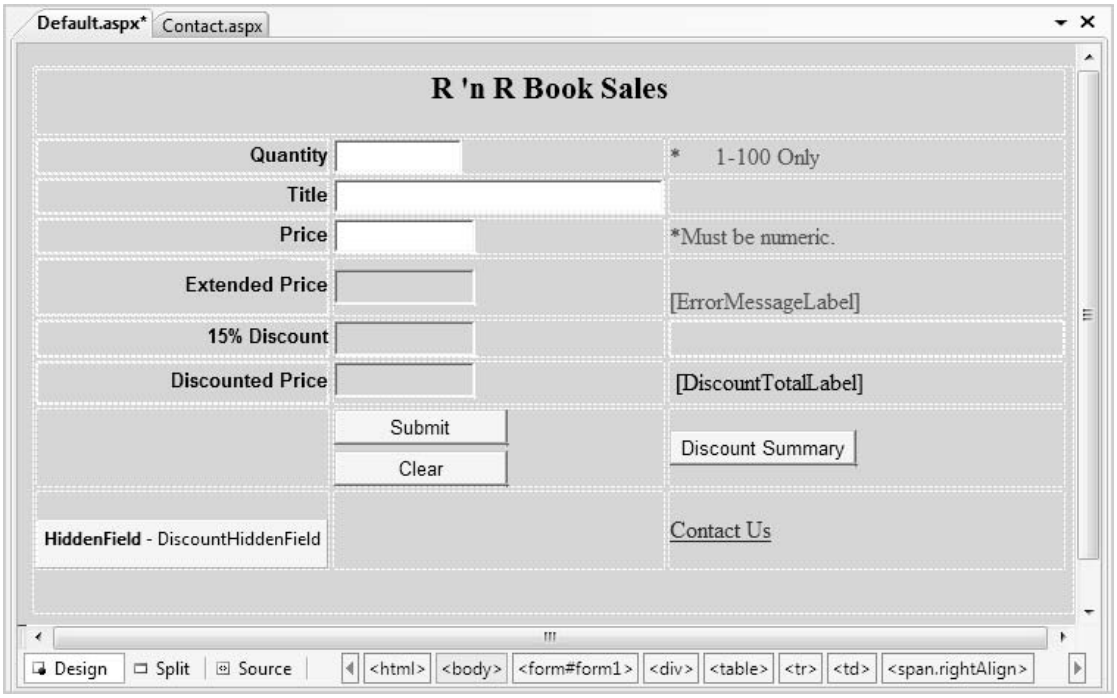


Figure 9.26

Lay out the controls in Design view; a. the main (default) page and b. the contacts page.



The Project Coding Solution

```
'Program:        Chapter 9 HandsOn
'Programmer:     Bradley/Millspaugh
'Date:           June 2008
'Page:           Default
'Description:    A Web site to calculate the extended price for books sold,
'                a discount, and the discounted amount. Calculates and displays
'                the total discounts.
'                Uses validator controls for input validation.
'Folder:         Ch09HandsOn

Partial Class Default_aspx
  Inherits System.Web.UI.Page

  Private DiscountTotalDecimal As Decimal
  Const DISCOUNT_RATE_Decimal As Decimal = 0.15D

  Sub SubmitButton_Click(ByVal sender As Object, _
    ByVal e As System.EventArgs) Handles SubmitButton.Click
        ' Calculate values for sale.
        Dim QuantityInteger As Integer
        Dim PriceDecimal, ExtendedPriceDecimal As Decimal
        Dim DiscountDecimal, DiscountedPriceDecimal As Decimal

        ErrorMessageLabel.Text = String.Empty
        Try
            ' Convert input values to numeric variables.
            QuantityInteger = Integer.Parse(QuantityTextBox.Text)
            PriceDecimal = Decimal.Parse(PriceTextBox.Text)

            ' Calculate values for sale.
            ExtendedPriceDecimal = QuantityInteger * PriceDecimal
            DiscountDecimal = ExtendedPriceDecimal * DISCOUNT_RATE_Decimal
            DiscountedPriceDecimal = ExtendedPriceDecimal – DiscountDecimal

            ' Add to the discount total.
            DiscountTotalDecimal += DiscountDecimal

            ' Save the discount total in a label.
            DiscountHiddenField.Value = DiscountTotalDecimal.ToString()

            ' Format and display answers.
            ExtendedPriceTextBox.Text = ExtendedPriceDecimal.ToString("C")
            DiscountTextBox.Text = DiscountDecimal.ToString("N")
            DiscountPriceTextBox.Text = DiscountedPriceDecimal.ToString("C")
        Catch ex As Exception
            ErrorMessageLabel.Text = "Unable to calculate. Check for numeric values."
        End Try
  End Sub

  Private Sub ClearButton_Click(ByVal sender As Object, _
    ByVal e As System.EventArgs) Handles ClearButton.Click
      ' Clear previous amounts from the page.
```

```
        QuantityTextBox.Text = ""
        TitleTextBox.Text = ""
        PriceTextBox.Text = ""
        ExtendedPriceTextBox.Text = ""
        DiscountTextBox.Text = ""
        DiscountPriceTextBox.Text = ""
        DiscountTotalLabel.Text = ""
        ErrorMessageLabel.Text = ""
    End Sub

    Sub Page_Load(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles Me.Load
        ' Check for existing value for the discount total.

        With DiscountHiddenField
            If IsPostBack And .Value <> "" Then
                DiscountTotalDecimal = Decimal.Parse(.Value)
            End If
        End With
    End Sub

    Private Sub SummaryButton_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles SummaryButton.Click
        ' Display the total discount.

        ' DiscountTotalLabel.Text = "Total Discounts: $" & DiscountHiddenField.Value
        DiscountTotalLabel.Text = "Total Discounts:" & DiscountTotalDecimal.ToString("C")
    End Sub
End Class
```

Summary

1. A Web application runs in a browser whereas most Windows applications run stand-alone.
2. A Web site has a client, which is the system running the Web page in a browser, and a server, which is the location of the Web page files.
3. Different browsers may display Web pages differently. Web developers must test their applications on multiple browsers unless they know that all users will use the same browser, such as in a company intranet.
4. Web pages are static and stateless. They require processing to change the appearance of the page and cannot store variables on their own.
5. ASP.NET is the Web technology included in Visual Studio. Web Forms in Visual Basic use ASP.NET.
6. A Web Form consists of two files: the .aspx file that holds the code to render the user interface and the .aspx.vb file that holds the VB code.
7. The controls for Web pages are different from those used on Windows Forms.
8. In Design view, the *HTML* tab displays the HTML that is automatically generated.
9. You can display a page preview as it will appear in a browser.

10. Controls on Web pages may be HTML (client-side) controls or Web server controls, which are the controls provided by ASP.NET. Web server controls are rendered specifically for the browser being used.
11. Although the events of Web controls are somewhat different from those for Windows controls, coding for the events is the same.
12. A different set of files is generated for Web projects than for Windows projects.
13. In a Web page, controls are placed one after another, from top to bottom, similar to a word processing document.
14. You can use an HTML table to lay out controls and text in rows and columns.
15. The positioning of a page or a control may be set to absolute, which allows you to set the location by dragging the control to the desired position.
16. Add graphics to a page using an Image control. The control's ImageUrl property holds the location of the file.
17. Cascading style sheets can be used to set font properties, position, border, and the background for Web pages and controls. The location of the style definition determines the type of style—inline, page, or .css file.
18. Validator controls allow testing for a required field, proper type of data, or a range of values.
19. The EnableViewState property of a Web control determines whether the control maintains its value during postback. To maintain the value of a program module-level variable, assign the variable's value to a hidden or invisible control.
20. A HyperLink control is used for navigation. Set the NavigateUrl property to the page to which to navigate, which can be in the current project or another Web site.
21. You can add multiple pages to a Web application and set up navigation between the pages.
22. To move a Web project from one computer to another, make sure the project is not open in the IDE and copy the project's folder.
23. AJAX (Asynchronous JavaScript and XML) improves the speed of Web applications. By using the Update Panel, only a portion of a Web page is submitted and reloaded on a postback.
24. XML is used to store and transfer data on the Internet. XML is tag-based and text-only and can be transmitted through network firewalls. SOAP and WSDL are based on XML.

Key Terms

absolute position *375*
AJAX *388*
browser *362*
cascading style sheet (CSS) *378*
code separation model *366*
intranet *363*
single-file model *366*
stateless *363*
table *373*
validator control *385*
Web Form *362*
Web page *363*

Review Questions

1. Explain the differences between the execution of a Windows application and a Web site.
2. Differentiate between the client and the server for a Web application.
3. What is meant by the statement that Web pages are stateless?
4. What options are available for locations of Web site files?
5. What are the differences between HTML controls and standard controls?
6. How does event handling differ from that for Windows applications?
7. Describe at least two methods for controlling the layout of controls on a Web page.
8. What functions are done by validator controls? How can you set up a validator control?
9. Describe the purpose and functionality of AJAX. What is meant by open standards?
10. What is the purpose of XML? of SOAP?

Programming Exercises

9.1 Rewrite your project from Chapter 3 to be a Web project; include validation.

9.2 Rough Riders Rodeo wants to sell tickets online. Allow the user to enter the number of tickets needed. The data entry screen should also include the shipping address for the tickets, a credit card number, expiration date, and a drop-down box allowing the user to select the type of credit card. Also include a check box for attending the Awards Event. Include a hyperlink for confirming the order. Make the link invisible to begin but display it after the *Submit* button has been clicked.

The confirmation page should say "Thank you for your order".

The tickets are $15 for just the rodeo, $25 if they want to attend the awards event. Note that all members of the party must select the same type of tickets.

When the user selects the *Submit* button, display the amount due and display a link to confirm the order (make the existing link visible). Use an UpdatePanel to improve performance.

9.3 Create a Web page for entering new customer information. The fields include name, e-mail, username, and password. Include a second text box to confirm the password. Set the TextMode property of the two password fields to "Password". Use a table to lay out your controls.

Validate that all fields contain information. Display appropriate messages for any empty fields. Include a *Submit* button.

When all information is entered and the *Submit* button is pressed, compare the two password fields to see if they are equal. If not, clear both text boxes and display a message to reenter the password information. When the passwords match, display a message that says "Welcome" and the name of the customer.

Case Studies

VB Mail Order

Write the VB Mail Order project from Chapter 4 as a Web project. Use validator controls for the validation. Place an image or logo on the page located outside an AJAX Update Panel. Include a second page with contact information for the company.

VB Auto Center

Write the VB Auto Center project from Chapter 4 as a Web project. Use validator controls for the validation. Include a second page with contact information for the company.

Suggestion: Use a RadioButtonList control.

Video Bonanza

Write the Video Bonanza project from Chapter 3 or Chapter 4 as a Web project. Use validator controls for the validation. Include a second page with contact information for the company.

Suggestion: Use a RadioButtonList control.

Very Very Boards

Write the Very Very Boards project from Chapter 4 as a Web project. Use validator controls for the validation, including a range validator for the quantity. Include a second page with contact information for the company.

Suggestion: Use a RadioButtonList control.

CHAPTER

10

Database Applications

at the completion of this chapter, you will be able to . . .

1. Use database terminology correctly.
2. Create Windows and Web projects that display database data.
3. Display data in a DataGridView control.
4. Bind data to text boxes and labels.
5. Allow the user to select from a combo box or list box and display the corresponding record in data-bound controls.
6. Query an object using LINQ.

Databases

Most data handling today is done with relational databases. Many manufacturers produce database management systems (DBMSs), each with its own proprietary format. One challenge for software developers has been accessing data from multiple sources that are stored in different formats. Most of the new tools available to developers, including Microsoft's Visual Studio, attempt to handle data from multiple locations (servers) and data stored in different formats.

Visual Basic and Databases

You can use Visual Basic to write projects that display and update the data from databases. Visual Basic uses ADO.NET, which is the next generation of database technology, based on Microsoft's previous version called *ActiveX Data Objects (ADO)*. One big advantage of ADO.NET is that information is stored and transferred in Extensible Markup Language (XML). You will find more information about XML in the section "XML Data" later in this chapter.

ADO.NET allows you to access database data in many formats. The basic types of providers are OleDb, SQLClient for SQL Server (Microsoft's proprietary DBMS), Odbc, and Oracle. Using OleDb you can obtain data from sources such as Access, Oracle, Sybase, or DB2. The examples in this text use Microsoft's SQL Server Express (SSE), which installs automatically with Visual Studio.

Database Terminology

To use databases, you must understand the standard terminology of relational databases. Although there are various definitions of standard database terms, we will stick with the most common terms, those used in SQL Server and Access.

A database file (with an .mdf or .mdb extension) can hold multiple tables. Each **table** can be viewed like a spreadsheet, with rows and columns. Each **row** in a table represents the data for one item, person, or transaction and is called a ***record***. Each **column** in a table is used to store a different element of data, such as an account number, a name, an address, or a numeric amount. The elements represented in columns are called ***fields***. You can think of the table in Figure 10.1 as consisting of rows and columns or of records and fields.

Most tables use a **primary key field** (or combination of fields) to identify each record. The primary key field is often a number such as employee number, account number, identification number, or social security number; or it may be a text field, such as last name, or a combination, such as last name and first name.

A relational database generally contains multiple tables and relationships between the tables. For example, an Employee table may have an Employee ID field, and the Payroll table also will have an Employee ID field. The two tables are related by Employee ID. You can find the employee information for one payroll record by retrieving the record for the corresponding Employee ID in the Employee table. One reason to create relationships between tables is to keep the data compact and easy to maintain. By having multiple payroll records related to one employee record through the Employee ID, an employee's address, for example, can be changed in one spot without having to go to each payroll record to update it.

ISBN	Title	Author	Publisher
0-111-11111-1	89 Years in a Sand Trap	Beck, Fred	Hill and Wang
0-15-500139-6	Business Programming in C	Millspaugh, A. C.	The Dryden Press
0-394-75843-9	Cultural Literacy	Hirsch, E. D. Jr.	Vintage
0-440-22284-2	Five Days in Paris	Steel, Danielle	Dell Publishing
0-446-51251-6	Megatrends	Naisbitt, John	Warner Books
0-446-51652-X	Bridges of Madison County	Waller, Robert James	Warner Books
0-446-60274-4	The Rules	Fein/Schneider	Warner Books
0-451-16095-9	The Stand	King, Stephen	Signet
0-452-26011-6	Song of Solomon	Morrison, Toni	Plume/Penguin
0-517-59905-8	How to Talk to Anyone, Anytime, Anywhere	King, Larry	Crown
0-534-26076-4	A Quick Guide to the Internet	Bradley, Julia Case	Integrated Media Group

Record or row

Field or column

Figure 10.1

A database table consists of rows (records) and columns (fields).

Any time a database table is open, one record is considered the current record. As you move from one record to the next, the current record changes.

XML Data

XML is an industry-standard format for storing and transferring data. You can find the specifications for XML at http://www.w3.org/XML, which is the site for the World Wide Web Consortium (W3C).

You don't need to know any XML to write database applications in VB. The necessary XML is generated for you automatically, like the automatically generated VB code and HTML. However, a few facts about XML can help you understand what is happening in your programs.

Most proprietary database formats store data in binary, which cannot be accessed by other systems or pass through Internet firewalls. Data stored in XML is all text, identified by tags, similar to HTML tags. An XML file can be edited by any text editor program, such as Notepad.

If you have seen or written any HTML, you know that opening and closing tags define elements and attributes. For example, any text between `<b>` and `</b>` is rendered in bold by the browser.

```
<b>This text is bold.</b> <i>This is italic.</i>
```

The tags in XML are not predefined as they are in HTML. The tags can identify fields by name. For example, following are three records of the

RnrBooks database exported to XML. (Later in this chapter you will be using the RnrBooks database for VB projects.)

```
<?xml version="1.0" encoding="UTF-8"?><dataroot xmlns:od="urn:schemas-microsoft-com:officedata">
  <Books>
    <ISBN>0-15-500139-6</ISBN>
    <Title>Business Programming in C</Title>
    <Author>Millspaugh, A. C.</Author>
    <Publisher>The Dryden Press</Publisher>
  </Books>
  <Books>
    <ISBN>0-446-51652-X</ISBN>
    <Title>Bridges of Madison County</Title>
    <Author>Waller, Robert James</Author>
    <Publisher>Warner Books</Publisher>
  </Books>
  <Books>
    <ISBN>0-451-16095-9</ISBN>
    <Title>The Stand</Title>
    <Author>King, Stephen</Author>
    <Publisher>Signet</Publisher>
  </Books>
</dataroot>
```

In addition to an XML data file, you usually also have an XML schema file. The schema describes the fields, data types, and any constraints, such as required fields. ADO.NET validates the data against the schema and checks for constraint violations. The schema also is defined with XML tags and can be viewed or edited in a text editor. You will be able to see the schema for your databases in a VB project by viewing the .xsd file shown in the Solution Explorer.

The format of XML data offers several advantages for programming. Because an XML schema provides for strong data typing, the various data types can be handled properly. And ADO.NET can treat the XML data as objects, allowing the IntelliSense feature of the Visual Studio environment to provide information for the programmer. In addition, data handling in XML and ADO.NET executes faster than in earlier forms of ADO.

Feedback 10.1

1. Assume you have a database containing the names and phone numbers of your friends. Describe how the terms *file*, *table*, *row*, *column*, *record*, *field*, and *primary key field* apply to your database.
2. What is an advantage of transferring data as XML rather than as a proprietary format such as Access or SQL Server?

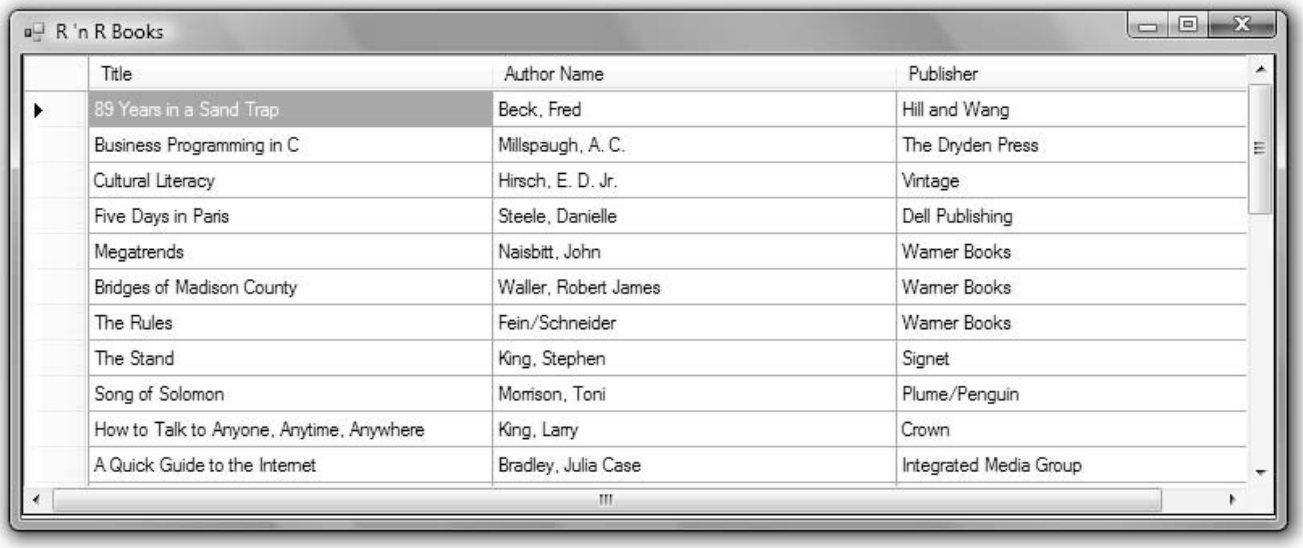
Using ADO.NET and Visual Basic

In Visual Basic, you can display data from a database on a Windows Form or a Web Form. You add controls to the form and bind data to the controls. The controls may be labels or text boxes or one of the special controls designed just for data, such as the DataGridView or DataList. However, just as you found in Chapter 9,

the controls for a Windows application are different from the controls for a Web application and have different properties and events. In this chapter, you will write database applications using both Windows Forms and Web Forms. Figure 10.2 shows a data table displaying in a DataGridView on a Windows Form.

Figure 10.2

The DataGridView control is bound to a table in a dataset. The data fields display automatically in the cells of the grid.



You must use several classes and objects to set up data access in Visual Basic.

Data Access in Visual Studio

The Visual Studio Data Sources window provides an easy way to create data-bound controls on a form. As you will see later in this chapter, you can drag tables and fields from the window onto a form to automatically create controls that are bound to the data. You can display the data in grids or individual fields, which are referred to as *details*. You also can drag a field from the Data Sources window and drop it on an existing control, which causes **data binding** to be set up automatically.

When you add data-bound controls to a form, two things occur: An .xsd file is added to the Server Explorer window, and BindingSource, TableAdapter, and DataSet objects are added to the form's component tray.

The following list is an overview of database objects; each of the classes is further described in the sections that follow.

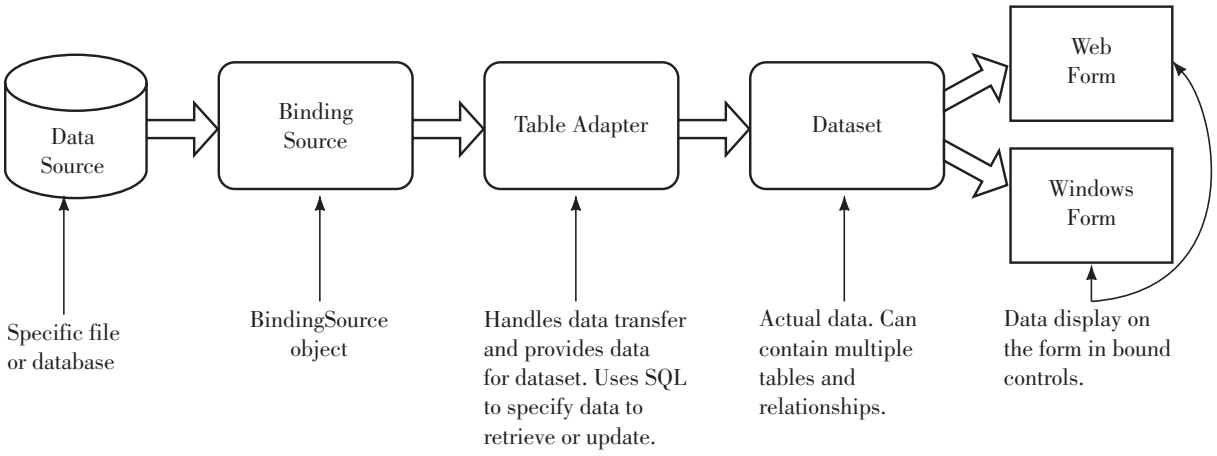
- *Binding source*. A binding source establishes a link to the actual data, which is a specific file and/or database.
- *Table adapter*. A table adapter handles retrieving and updating the data. A table adapter automatically generates SQL statements that you can use to access or update data. SQL, or Structured Query Language, is an industry-standard language that is used to select and update data in a relational database.

- *Dataset.* A dataset contains the actual data. The data in a single dataset may come from multiple binding sources and/or multiple table adapters.

Figure 10.3 shows a visual representation of the required steps.

Figure 10.3

To display database data in bound controls on a form, you need a binding source, a table adapter, and a dataset.



Binding Sources

A **binding source** object establishes a link from a specific file or database to your program. In this chapter, you will use a wizard to automatically create BindingSource objects. You also can add new BindingSource objects using the Data Sources window or the *Data* menu.

Note: Earlier versions of VB used *Connection objects* rather than BindingSources.

Table Adapters

A **table adapter** does all of the work of passing data back and forth between a **data source** (the binding source) and a program (the dataset). The binding source for a table adapter does not have to be a database; it also can be a text file, an object, or even an array. No matter where the actual data (the source) for the binding source are, the table adapter transfers data from the source to the dataset (fills) or transfers data from the dataset to the source (updates) all via XML.

Datasets

A **dataset** is a temporary set of data stored in the memory of the computer. In ADO.NET, datasets are disconnected, which means that the copy of data in memory does not keep an active connection to the data source. This technique is a big improvement over the recordsets in earlier versions of ADO, which maintain open connections to the data source. A dataset may contain multiple tables; however, the examples in this chapter use only one table per dataset.

Any controls that you have bound to the dataset will automatically fill with data.

Feedback 10.2

Explain the purpose of and the differences between *binding sources*, *table adapters*, and *datasets*.

Creating a Database Application

In the following step-by-step exercise, you will create a Windows application that displays data from the Books table of the RnrBooks.mdf database. You will display the fields from the table in a **DataGridView control** on a Windows Form. Refer to Figure 10.2 for the finished application.

A Windows Database Application—Step-by-Step

This step-by-step exercise uses the RnRBooks.mdf SQL Server database file, which is available in the StudentData folder from the text download site (www.mhhe.com/vb2008/). Make sure that the file is available before starting this project.

Start a New Project

STEP 1: Start a new Windows Application project called "Ch10DataGridView".

STEP 2: Name the form "BooksForm" and set the Text property to "R 'n R Books". Widen the form to about three times the original size.

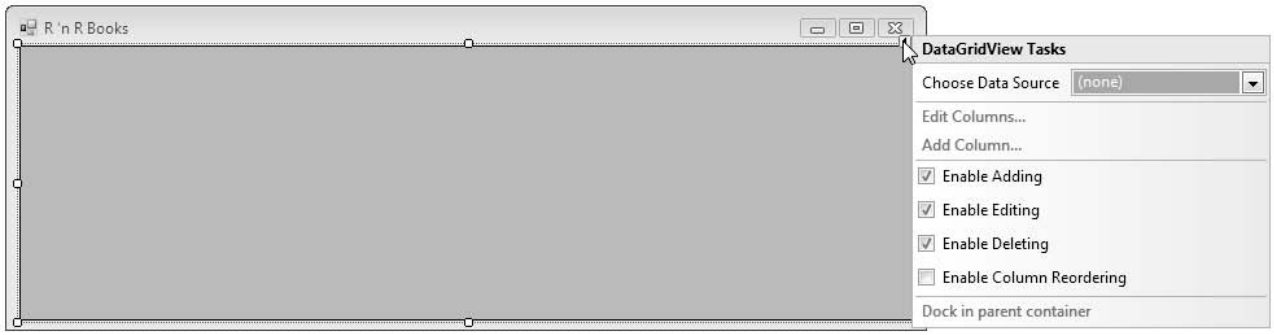
STEP 3: Select *Save All* from the *File* menu or the toolbar button.

Add a Grid to Display the Data

STEP 1: Add a DataGridView control to the form. You can find the control in the toolbox in both the *All Windows Forms* tab and the *Data* tab. Click the Smart Tag arrow to pop up the smart tag (Figure 10.4).

Figure 10.4

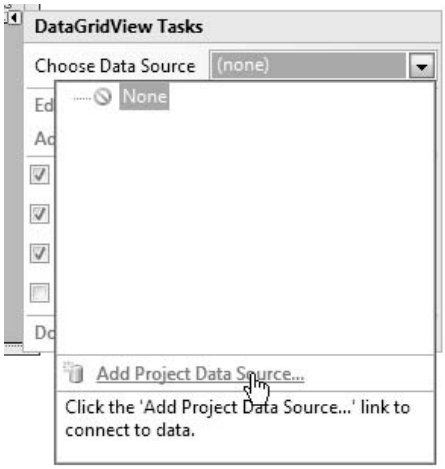
Add a DataGridView control to a form and pop up its smart tag.



STEP 2: On the smart tag, drop down the list for *Choose Data Source*. Select *Add Project Data Source* from the drop-down (Figure 10.5), which activates the Data Source Configuration Wizard. Click *Next*.

Figure 10.5

Add a new data source to a project from the smart tag of the DataGridView.



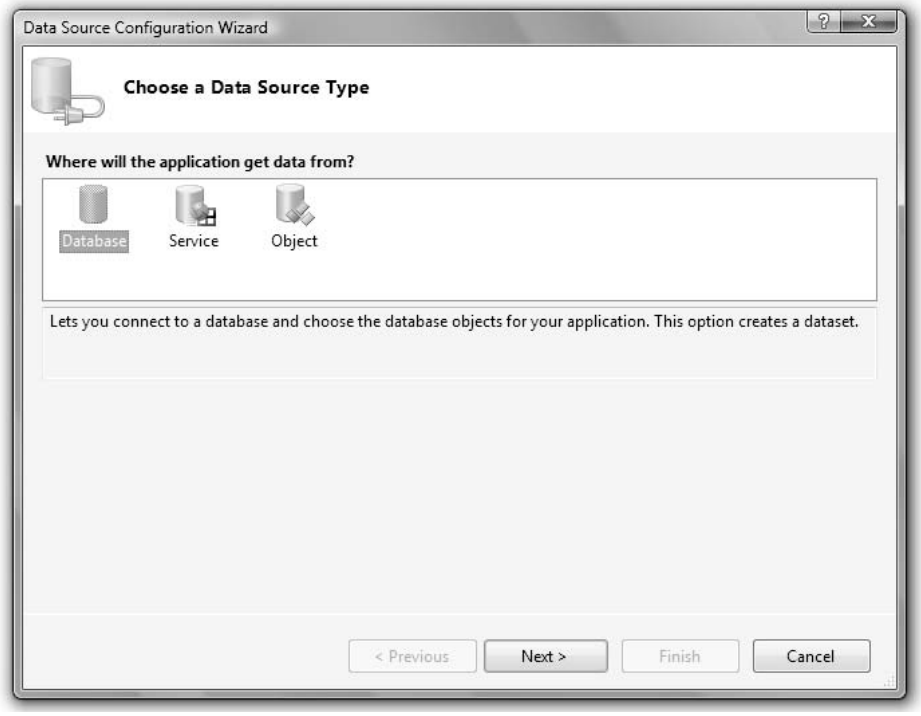
STEP 3: Select *Database* (Figure 10.6) and click *Next*.

Note that it isn't necessary to copy the database .mdf file into the project folder; the wizard will ask you later if you want to add the data file to the project, which automatically copies the file to your project folder. You can select the file from anywhere it is available. When the project runs, it uses the copy in your project folder. If you want to use a database file stored somewhere else, for example to share with other applications, you will not add the file to your project.

STEP 4: Select *New Connection* to set up the connection for the binding source object. The next dialog asks what type of database you want to use. Select *Microsoft SQL Server Database File*, which will use SQL Express, unless you are using the full version of SQL Server.

Figure 10.6

Add a new data source to a project from the smart tag of the DataGridView.



STEP 5: In the *Add Connection* dialog box (Figure 10.7), the Data source should be set to "Microsoft SQL Server Database File (SqlClient)." Browse to select the RnRBooks.mdf file. You can find it anywhere it is available, including on a CD; later the file will be added to your project. Click *Open* and then *Test Connection*; you should see a message that the test connection succeeded. Click *OK*.

Figure 10.7

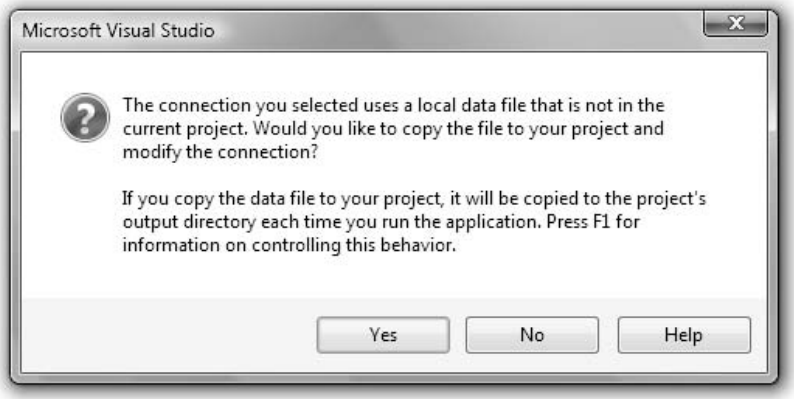
Select New Connection to display the Add Connection dialog box and set up the connection to the database file.

STEP 6: Back on the wizard page, your new connection should now appear selected; click *Next* .

A dialog pops up asking if you want to add the file to your project (Figure 10.8). Click *Yes*, which will make your project portable, so that you can run it on different computers without worrying about the file location.

Figure 10.8

This dialog gives you the option of making a copy of the database file in the current folder. Select Yes.

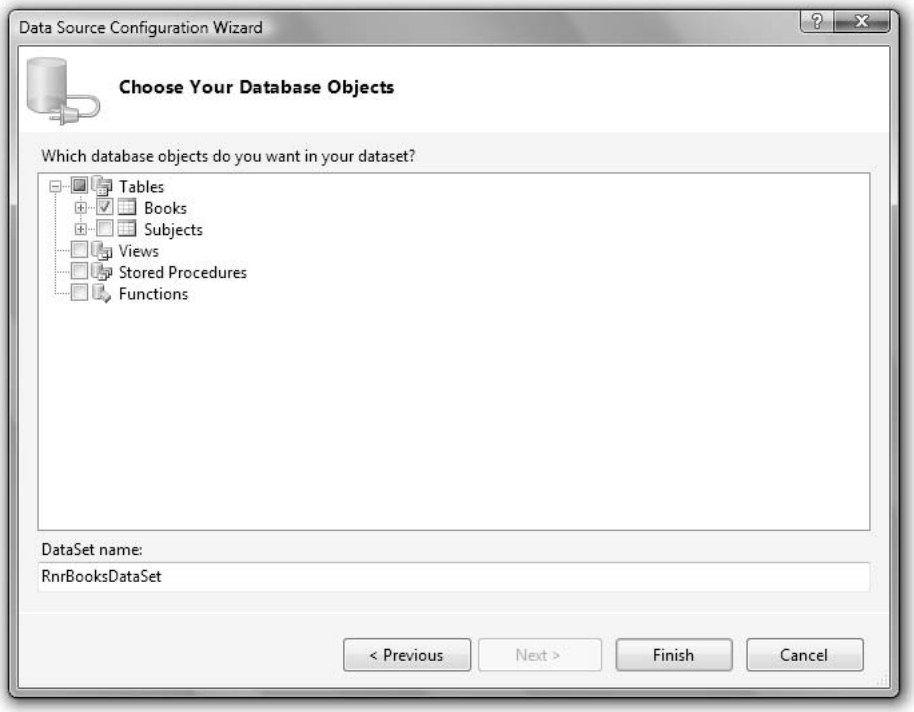


STEP 7: Click *Next*. The database objects in the RnRBooks database will appear.

STEP 8: Expand the Tables node and place a check mark in front of Books (Figure 10.9). Click *Finish*.

Figure 10.9

Click on the plus sign for Tables to expand the node and select the Books table.



STEP 9: Notice that the grid column headings now have the names of the fields. Later you will learn to resize the widths of the columns.

Run the Data Application

STEP 1: Run your program. The grid should fill with data. At this point, the user can resize the columns by dragging the dividers between column headings.

STEP 2: Close the form or click the *Stop Debugging* button (Shift + F5) in the IDE to stop program execution.

Examine the Components

STEP 1: Take a look in the components tray (Figure 10.10). Your form now contains a TableAdapter component, a DataSet component, and a BindingSource component. The wizard automatically names the dataset with the name of the database source and the others using the name of the table.

STEP 2: Now look at the form's code. The Form_Load procedure automatically contains the code to fill the dataset from the table adapter.

```
BooksTableAdapter.Fill(RnrBooksDataSet.Books)
```

Format the DataGridView

STEP 1: Switch back to the designer and click on the DataGridView and then click on the Smart Tag arrow—the small arrow on the right side of the grid or form. In the smart tag that pops up, select *Edit Columns* (Figure 10.11).

Figure 10.10

The data components that were generated by the Data Source Configuration Wizard appear in the component tray of the form.

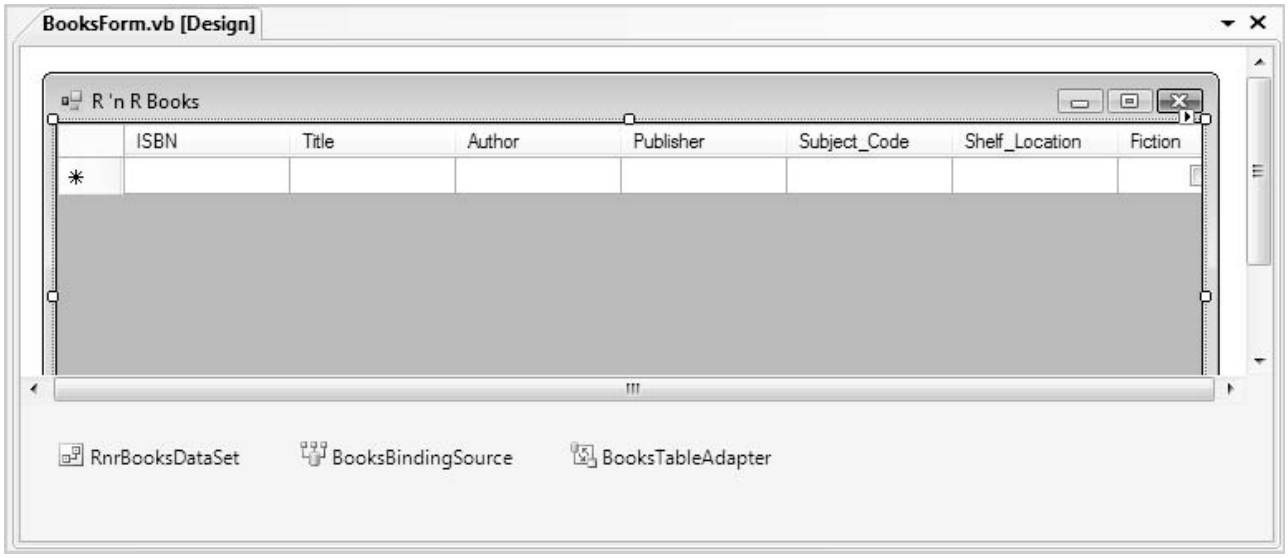
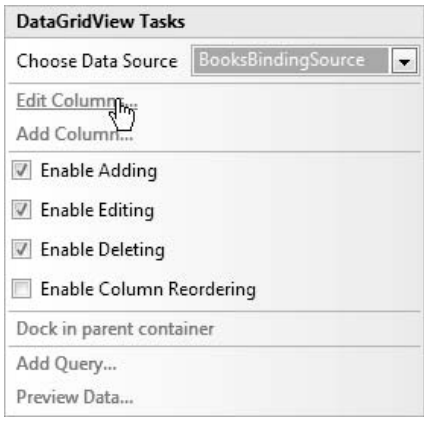


Figure 10.11

Pop up the smart tag and select Edit Columns *to format the grid.*

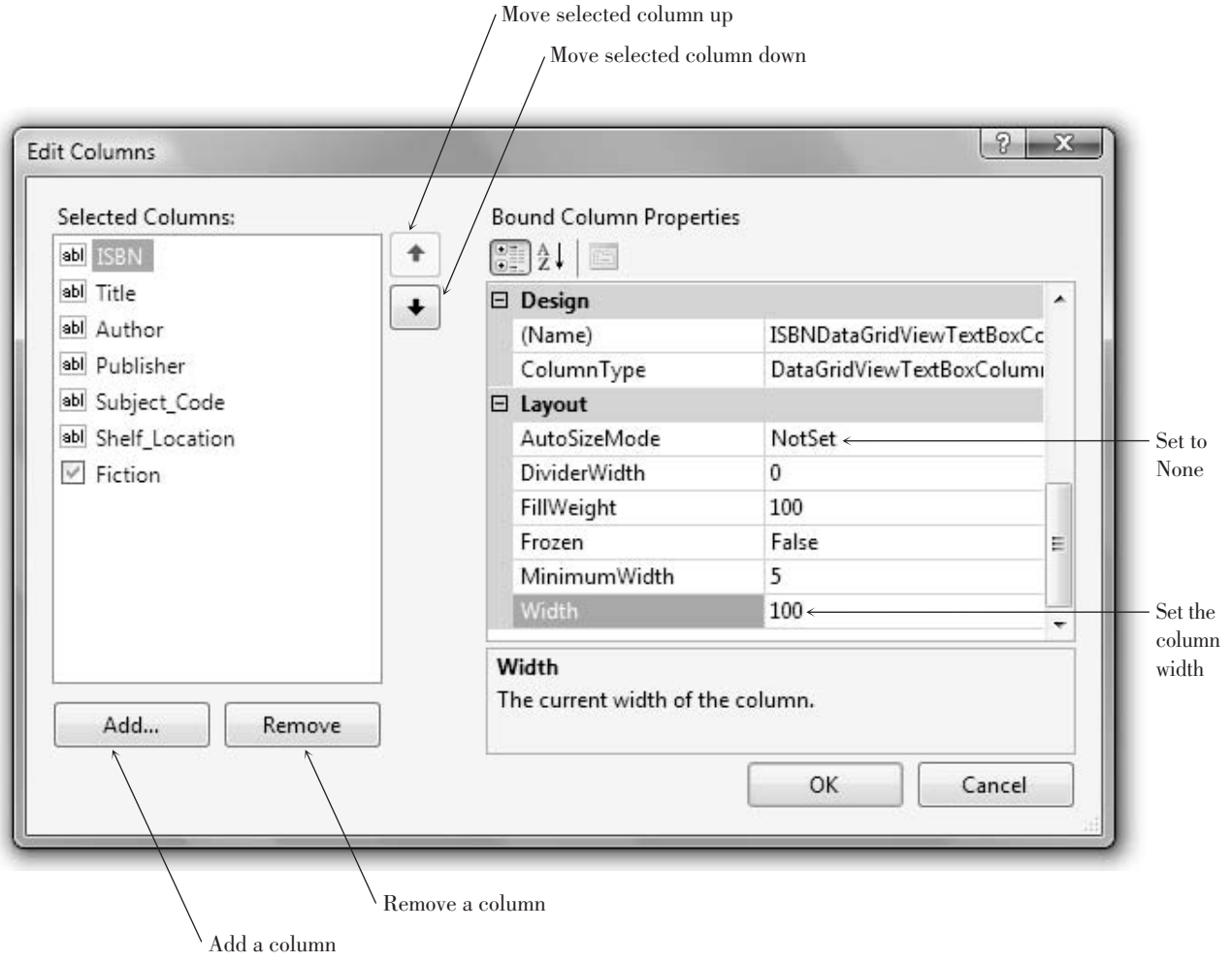


STEP 2: In the *Edit Columns* dialog box (Figure 10.12), you can add, remove, and reorder the columns. You also can select any of the columns on the left side of the dialog box and view or modify its properties on the right side. For example, you can set the width of a column and change its heading text (HeaderText property).

STEP 3: Remove the extra columns so that the grid displays only the title, author, and publisher. For the Title column, change the AutoSizeMode setting to "None" and set the Width to "250 pixels". For the Author column, set AutoSizeMode to "None", Width to "250 pixels", and header text to "Author Name". Set the Publisher column to AutoSize-Mode = "None" and Width = "250 pixels".

Figure 10.12

Format the columns of the grid in the Edit Columns *dialog box. You can set HeaderText, ToolTipText, Width, and many other properties of a column.*



STEP 4: Run the application and make note of any changes that would improve the layout.

STEP 5: Return to design time, make any further modifications, and run the application again.

The Smart Tag

Earlier you used the smart tag to select a data source and to edit the properties of grid columns. You also can use the smart tag to dock the grid in its parent container (the form) and add and edit columns.

The Database Schema File

When you add a new data source to a project, a file with the extension .xsd is added to the Solution Explorer. This file contains the XML schema definition, which has the description and properties of the data. You can double-click on

the .xsd file to open the **Data Designer** (Figure 10.13). The schema shows the names of the table(s) and fields, the primary keys for each table, and the relationships among the tables if more than one table is represented. You can click on the table name or a field name to display the properties in the Properties window.

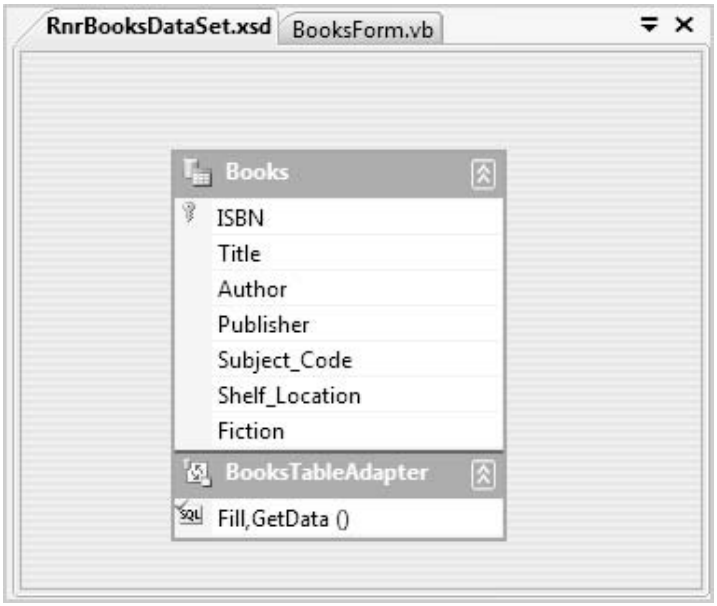


Figure 10.13

The .xsd file holds the schema of the database, where you can view and modify the table elements, relationships, and keys.

TIP

Right-click on the .xsd file in the Solution Explorer, select *Open With*, and select *XML Editor*, to view the actual XML in the Visual Studio XML editor. ■

Notice in Figure 10.13 that at the bottom of the schema appears the TableAdapter for the table. The TableAdapter handles the `Fill` and `GetData` methods for the table. You can click on the *TableAdapter* row to display its properties in the Properties window, or click on the *Fill,GetData()* row to view the properties of the Fill Query.

Binding Individual Data Fields

You can bind table fields from your dataset to many types of controls, such as labels, text boxes, combo boxes, and check boxes. Controls that are connected to fields in the database are referred to as **bound controls** or **data-bound controls**. The easiest way to create bound controls is to use the automatic binding features of the Data Sources window. You can set the data to display as details and then drag the table to the form. This technique creates individual text box controls for each field of data and a navigation control, which allows the user to move from one record to another. Figure 10.14 shows a form with data-bound text boxes; you will create this form in the next section.

The Data Sources Window

You can display the Data Sources window by selecting *Show Data Sources* from the *Data* menu. In a new project, you can use the Data Sources window to add a new data source (Figure 10.15).

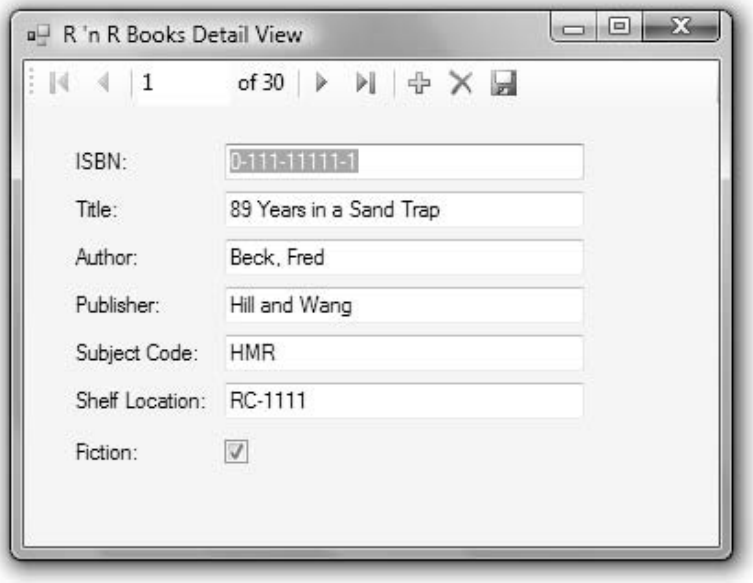


Figure 10.14

Each text box or check box is bound to one field from the table. As the user clicks the navigation buttons, all controls change to display the data for the next record.

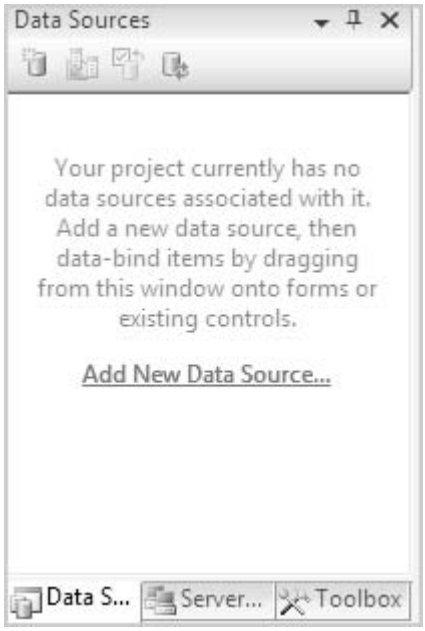


Figure 10.15

Add a new data source in the Data Sources window.

Note: The default location for the Data Sources window is docked with the toolbox, which is a change from VB 2005.

When you select the option to add a new data source, the Data Source Configuration Wizard opens and steps you through selecting the file and table, just as you did in the earlier step-by-step exercise. The new data source appears in the Data Sources window. You can click on the table name to make a drop-down list available, on which you can select *Details* (Figure 10.16). Note that the default view is DataGridView, which is the view that you used in the previous

step-by-step exercise. After you select Details view, the table's icon changes to match the view (Figure 10.17).

Note: The form must be open in the Form Designer for the table's check mark to appear.

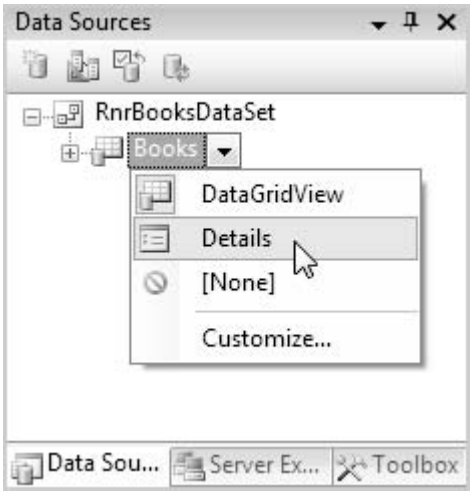


Figure 10.16

Drop down the list for the table name and select Details *to bind each field to its own Text Box control.*

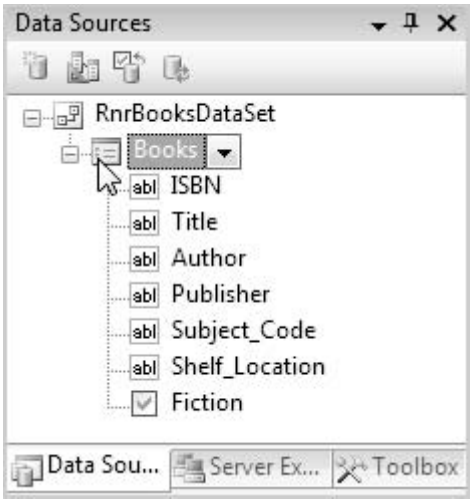


Figure 10.17

The table's icon changes to indicate Details view.

Database Details Program—Step-by-Step

This step-by-step exercise creates the data-bound Details view shown in Figure 10.14.

Begin a New Project

STEP 1: Create a new Windows project called "Ch10DetailsView".

STEP 2: Change the form's filename to "DetailsForm" and the form's Text property to "R 'n R Books Detail View".

STEP 3: Save the project.

Set Up the Data Source

STEP 1: Open the Data Sources window by selecting *Show Data Sources* from the *Data* menu.

STEP 2: Click on *Add New Data Source* in the Data Sources window.

STEP 3: In the Data Source Configuration Wizard, click *Next*, select *Database*, and click *Next* again.

STEP 4: Click on *New Connection* and browse to locate a copy of RnRBooks.mdf database file. This file can be in any other folder or on a CD. Click *Open* and *OK*.

STEP 5: Click *Next*, which pops up the dialog box asking if you want to add the file to your project; click *Yes*, then click *Next* again.

STEP 6: Open the Tables node and click in the box for the Books table. Click *Finish*.

Create the Bound Controls

STEP 1: In the Data Sources window, click on *Books*, which makes a down arrow appear to the right of the name (Figure 10.18). *Warning:* The Form Designer must be open for the down arrow to appear.

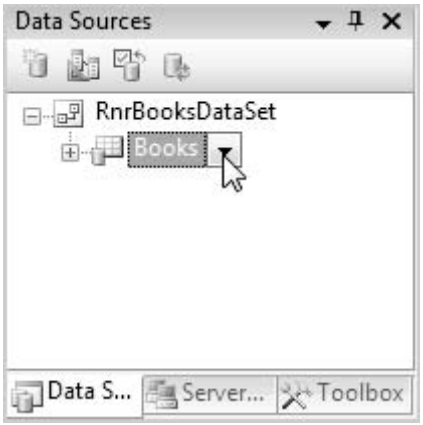


Figure 10.18

Click on the table name to make the drop-down list available.

STEP 2: Click on the down arrow and select *Details* (refer to Figure 10.16).

STEP 3: Point to the Books table name and drag the table to the form to a position about an inch down from the top of the form.

STEP 4: Change the widths of the text boxes and the form as desired and delete the Text property of the check box. Notice in Figure 10.19 that the component tray holds four new components: a DataSet, BindingSource, TableAdapter, and BindingNavigator, which provides the navigation buttons at the top of the form.

Also notice the text of the labels on the form. The new version of Visual Studio is smart enough to figure out multiple-word field names. For example, if your table names contain underscores or multiple capital letters, the smart labels will have the words separated by spaces. The Books table has fields called "Subject_Code" and "Shelf_Location", but the labels say "Subject Code" and "Shelf Location".

STEP 5: Run the project. Try the navigation buttons to step through the records.

Note: Remember that the ADO.NET dataset is loaded into memory and is disconnected from the database, so you can make changes to the records and use the navigation bar buttons for *Add New* (the record is added to the end of

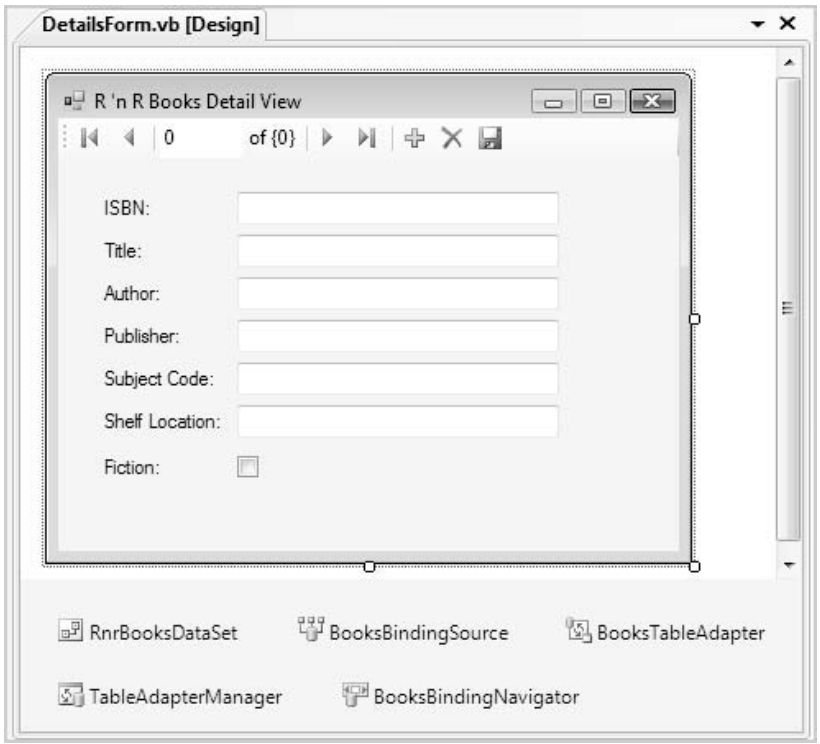


Figure 10.19

Resize the form and controls of the automatically generated controls. The component tray holds the five automatically generated database components.

the dataset), *Delete*, and *Save*. To see any updates from one run to the next, set the database file's "Copy to Output Directory" property to "Copy if newer".

Selecting Records from a List

Many applications allow the user to select an item to display from a list. You can fill a list box or combo box with values from a database. Consider the previous program. A better approach might be to display the list of ISBN numbers in a drop-down list and allow the user to make a selection. Then, after the ISBN is selected, the corresponding data elements fill remaining fields (Figure 10.20).

You can easily select the control type for a bound control in the Data Sources window. The choices are TextBox, ComboBox, Label, LinkLabel, and ListBox.

Converting to Combo Box Selection—Step-by-Step

This step-by-step exercise converts the previous exercise to a selection application. Figure 10.20 shows the output.

Begin the Project

STEP 1: Open your Ch10DetailsView project. It should contain text boxes for the data.

STEP 2: Click on the BindingNavigator component in the component tray and press the *Delete* key to delete the navigation bar from the form.

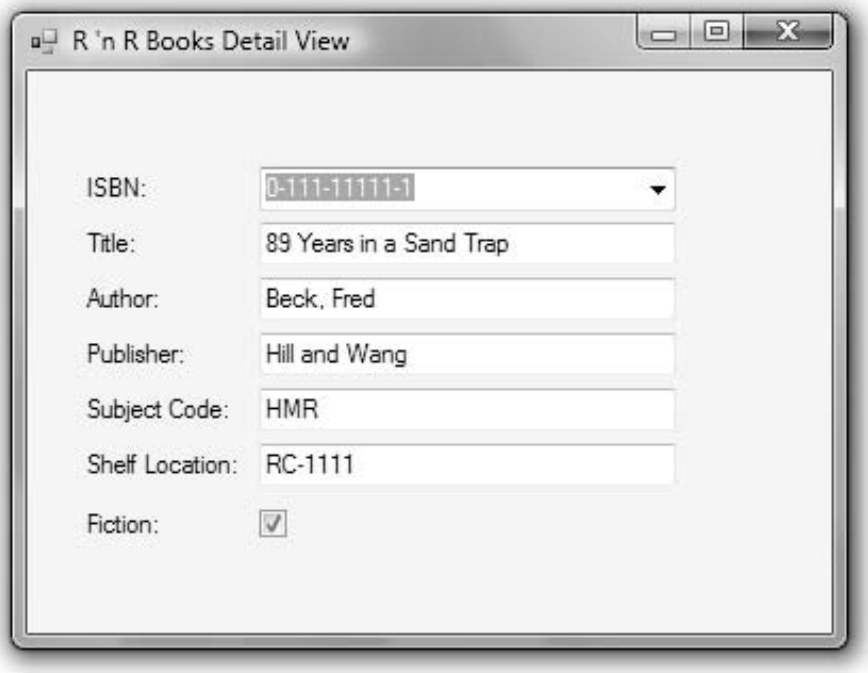


Figure 10.20

The user can select a book from the combo box. The text boxes automatically fill with the field values that correspond to that ISBN.

Set Up a ComboBox Control

STEP 1: Select the ISBN TextBox control and delete it.

STEP 2: In the Data Sources window, click on the ISBN field to make the down arrow appear. Then click on the arrow to drop down the list of possible control types (Figure 10.21). Select *ComboBox*.

STEP 3: Drag the ISBN field from the Data Sources window to the form, which will automatically create a ComboBox control and an extra label for ISBN. Delete the extra label and resize the combo box to match the text boxes (refer to Figure 10.20).

STEP 4: Click on the Smart Tag arrow for the combo box and select *Use data bound items*, which pops up some new fields for *Data Binding Mode* (Figure 10.22). Drop down the list for *Data Source* and select *BooksBindingSource*. Select *ISBN* for *Display Member*. For *Selected Value*, drop down the list and select *None*.

STEP 5: Set the TabIndex of the ISBN combo box to 2, which was the index of the text box that you deleted.

Run the Application

STEP 1: Run the program.

STEP 2: Drop down the combo box and select another ISBN. The other controls automatically fill with the data for the selected book.

Figure 10.21

Select ComboBox for the ISBN field.

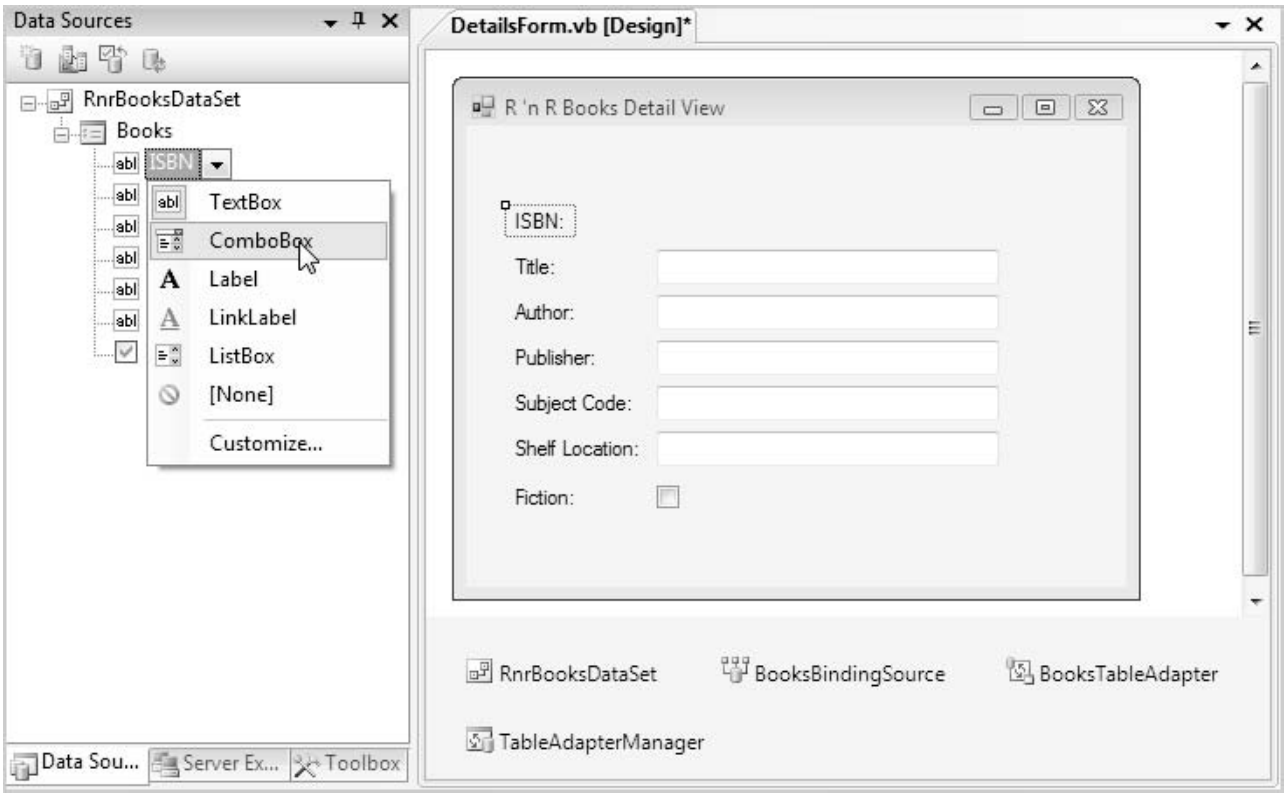
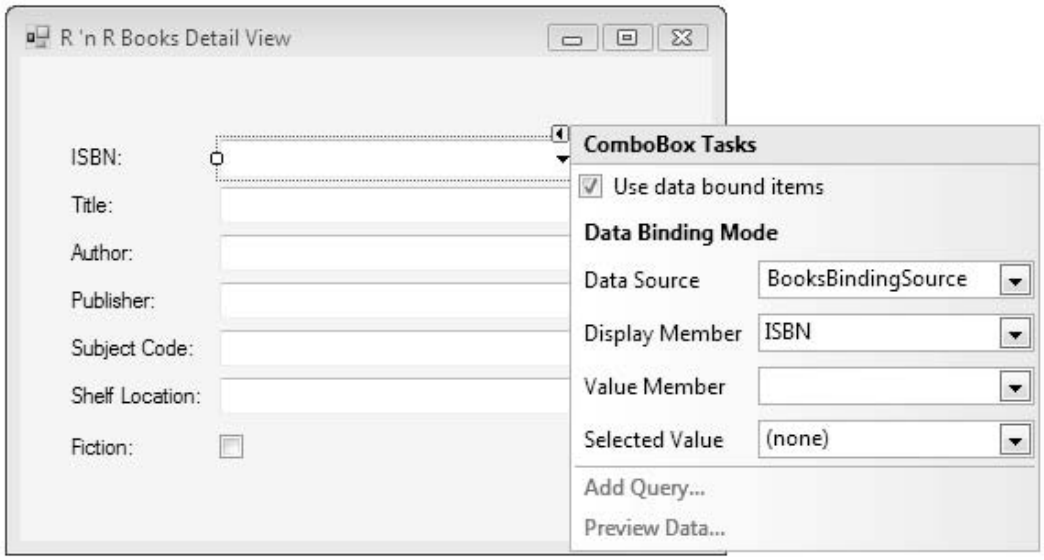


Figure 10.22

Set up the data binding for the ISBN combo box using the smart tag.



Selecting Fields from the Table

Often you only need to display some of the fields from a database table. You can select individual fields when you create the new data source, or select the fields later, after you have created the data source.

Selecting Fields When You Create the Data Source

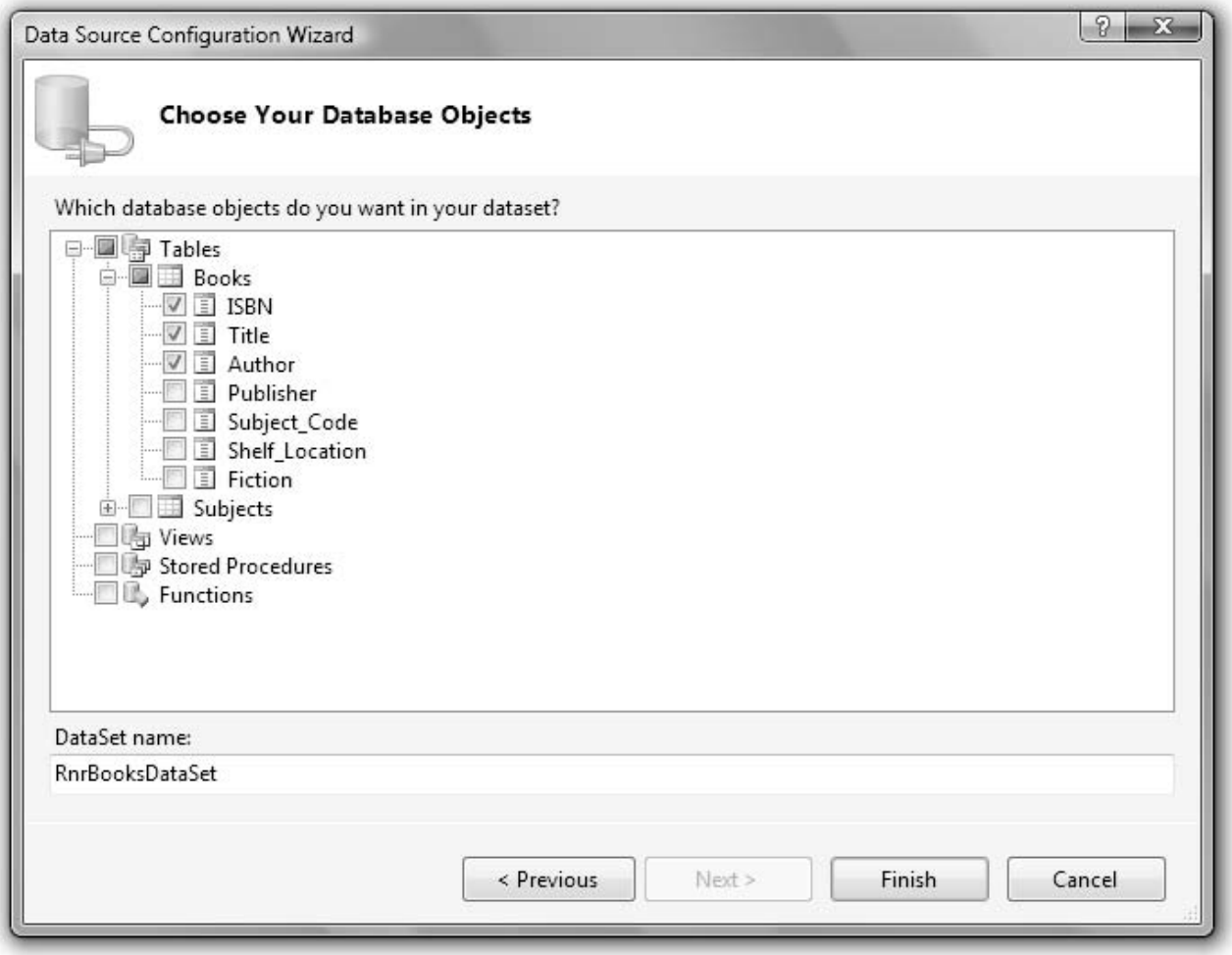
To set up a new dataset with selected fields, choose the *Add New Data Source* option from the *Data* menu or the Data Sources window. The Data Source Configuration Wizard appears as described earlier. When you get to the *Choose Your Database Objects*, expand the Tables node and place a check mark on just the fields that you want (Figure 10.23).

Selecting Fields after the Data Source Is Created

To modify the fields in a dataset after it has been created, select the dataset name in the Data Sources window. You can either click the *Configure DataSet with Wizard* button at the top of the window or right-click and choose the same option. You can make the field selection from the wizard as described in Figure 10.23, which will change the schema for your dataset.

Figure 10.23

Select only the fields that you want to include in the Data Source Configuration Wizard.

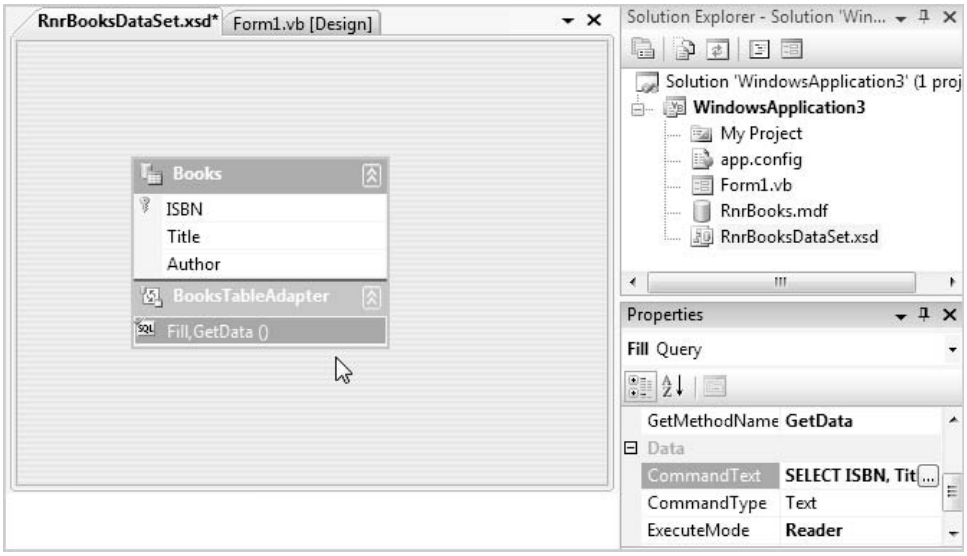


Sorting the List Data

You cannot sort bound data in a combo box or list box using the Sorted property of the control. However, you can sort the records in the query that selects the data for the dataset. Although the SQL `SELECT` statement is generated automatically by the designer, you can find and modify it. In the Solution Explorer, double-click on the dataset's schema file, with the .xsd extension. In the displayed schema (Figure 10.24), click on the *Fill,GetData()* entry at the bottom, which displays the properties of the `Fill` command in the Properties window. Click on the Property button (...) for the CommandText property; the Query Builder window will open. If you have any experience creating queries in Access, this window will look very familiar to you.

Figure 10.24

Click on the Fill,GetData() entry in the dataset schema to display the properties of the `Fill` *command in the Properties window.*



In the Query Builder you can modify the SQL `SELECT` command that selects the data for the dataset. To sort by a field, drop down the *Sort Type* list for the desired field and choose *Ascending* or *Descending*. After you make the selection and press Enter, the SQL statement changes to include an `ORDER BY` clause (Figure 10.25), which sorts the data records as they are retrieved and makes the list items appear in sorted order. You also can type directly into the `SELECT` statement to make modifications, if you wish. Notice at the bottom of the Query Builder window that you can execute the query to preview its output in the lower part of the window.

Choosing the Control Type for Fields

When you drag a Details view to a form, by default text fields are represented by text boxes. You saw earlier that you can select a different type of control in the Data Sources window before dragging a control to the form. In the Data Sources window, click on a field name; a small down arrow appears to the right of the field name. Drop down the list and choose the control type (Figure 10.26). You can choose the control type for all controls and then drag the table to the form to create the Details view.

Note: You must have the form displayed in the Form Designer to select the control type for the field.

Figure 10.25

Select Ascending *for the* Sort Type *to sort the data by the Title field. The SQL statement changes to include an* ORDER BY *clause.*

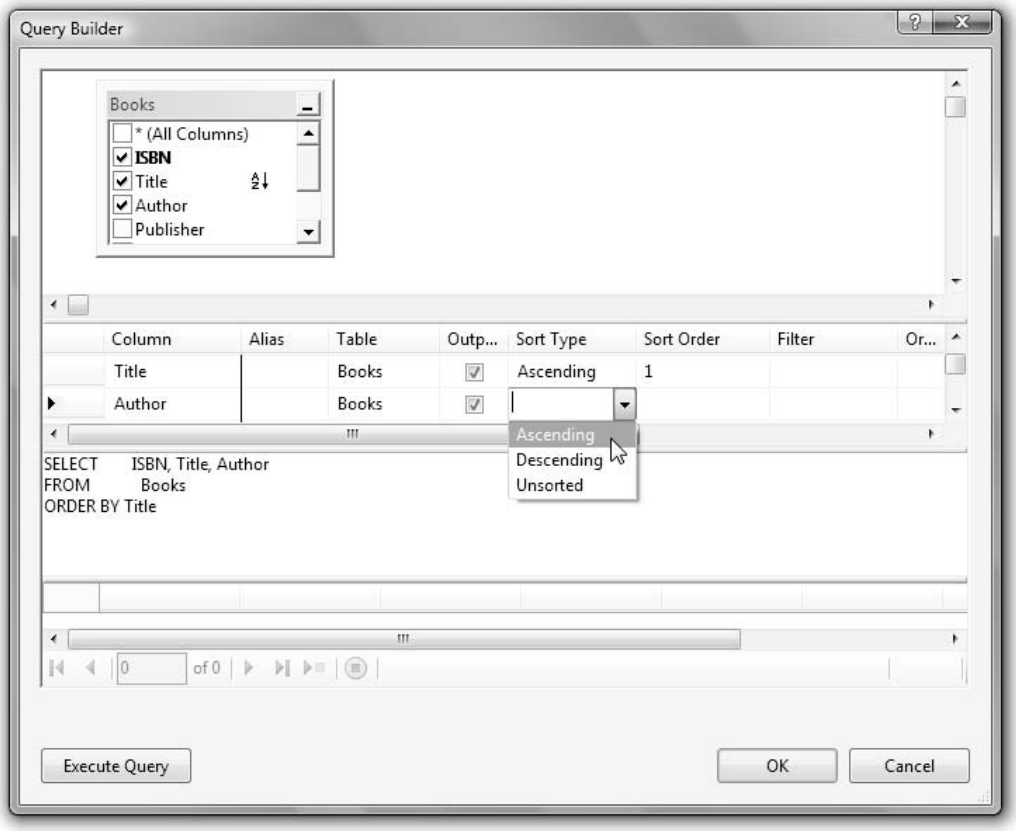
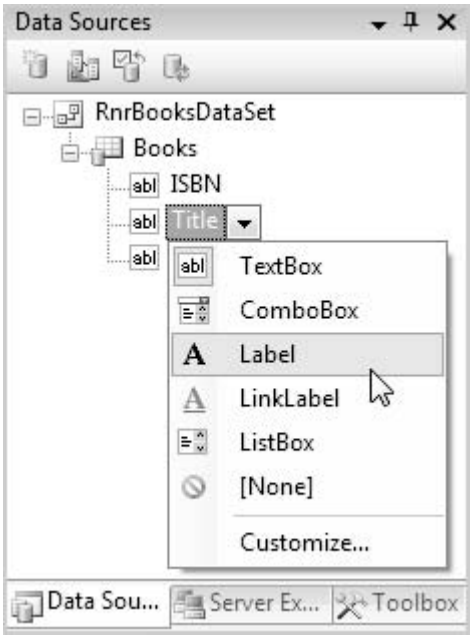


Figure 10.26

Select the control type for each control before creating the Details view.



Feedback 10.3

1. You drag a table name from the Data Sources window onto a form. What determines whether the action produces a bound grid or a set of individual fields?
2. How can you create data-bound text boxes? data-bound labels?
3. What properties of a ComboBox control must you set to bind the control to a data field?
4. How can you make the list items in a data-bound combo box appear in sorted order?

Selecting Records Using Web Forms

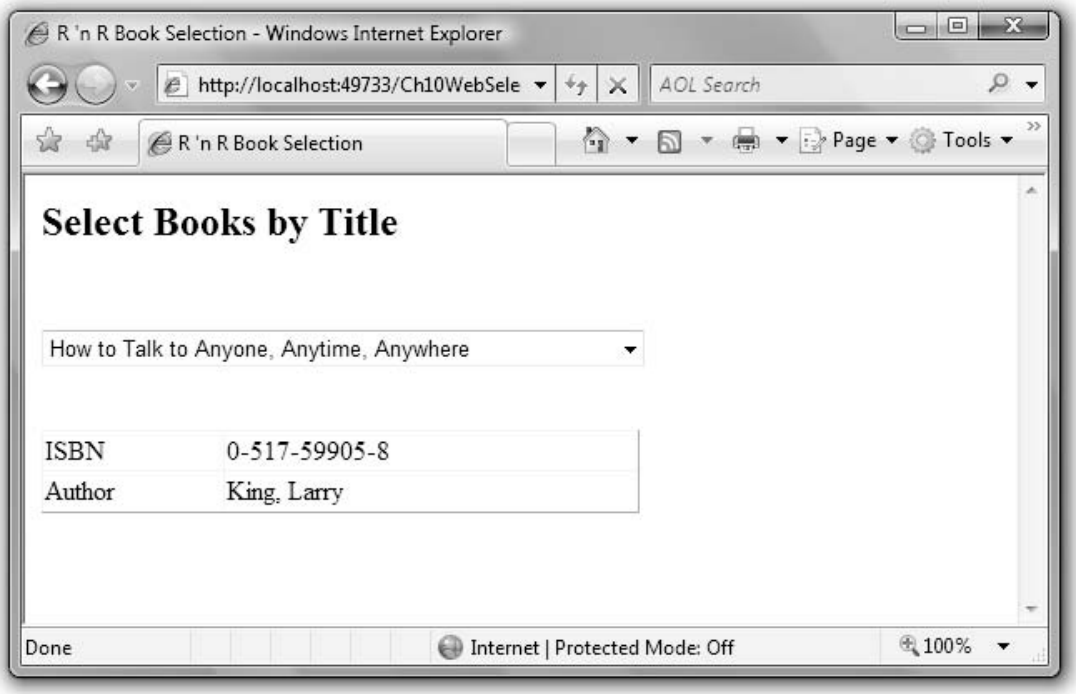
When you write database programs for the Web instead of Windows, you have a few more considerations. You still set up data sources and bind to controls, but the Web controls are considerably different from their Windows counterparts. You also have additional security issues for Web-based database applications.

A Web database application operates somewhat differently than a Windows application due to the nature of Web pages in a client/server environment. Remember that a Web page is stateless. Each time a page displays, it is a "new fresh page."

In the Web version of the list selection program (Figure 10.27), each time the user makes a selection from the list, a **postback** occurs. A postback is a round-trip to the server. After a postback, the Web page redisplays with only the selected data.

Figure 10.27

Allow the user to select a book title from the drop-down list; then display the corresponding Author and ISBN for the selected title.



Security in Web Database Applications

Security is much tighter for Web database applications than for Windows applications. You wouldn't want an unauthorized user to be able to access data from the Web. If you set up a Web application that displays or allows modifications to data, you must require user authentication and set permission levels. Visual Studio integrates security features, which are generally strict by default, so that data will be secure unless you take steps to unprotect your files.

For the programs in this text, which introduce the basic features of Web programming, the challenge is to avoid security restrictions, rather than to secure your database. You will use a SQL Server database file, stored in the Data folder beneath the project folder. This folder has the necessary permissions for the default user of development projects.

Note: If you wish to use a database stored in a folder other than the ProjectName\Data folder, the folder must have read and write permissions for the ComputerName\ASPNET user.

Creating the Web Selection Application—Step-by-Step

This step-by-step exercise develops the Web version of the selection program that you created earlier in Windows. The Web version must use two data sources rather than one. The drop-down list must have a separate data source from the one used for the individual fields of data. The finished application appears in Figure 10.27.

Begin a New Web Site

STEP 1: Select *File / New Web Site* and set the *Location* to the folder of your choice and "Ch10WebSelection" for the name. *Example*: C:\My Documents\WebSites\Ch10WebSelection.

STEP 2: Switch to Windows Explorer or My Computer and copy RnrBooks.mdf into the project's App_Data folder. An easy way to copy the file is to locate the file and press Ctrl + C and then click on the App_Data folder in the Solution Explorer window and paste the file (Ctrl + V). The database appears in the App_Data folder after you click the Solution Explorer's *Refresh* button (Figure 10.28).

STEP 3: Select *Document* in the Properties window *Object* drop-down list and set the Web page's Title property to "R 'n R Book Selection".

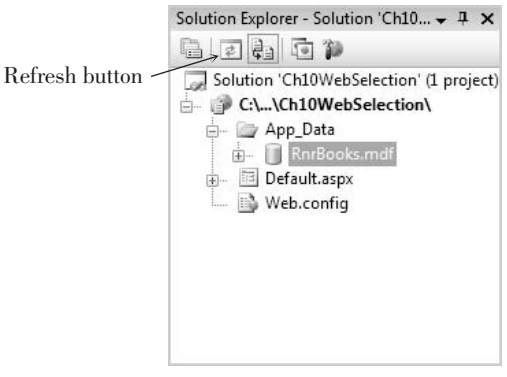


Figure 10.28

Click the Refresh button after you have copied the file into the Data folder to see the changes in the Solution Explorer.

STEP 4: Click at the top of the Web Form and type "Select Books by Title". Select the text and enlarge the font and make it bold. Click after the text and press Enter two or three times to move the insertion point down the page.

Set Up the Drop-Down List

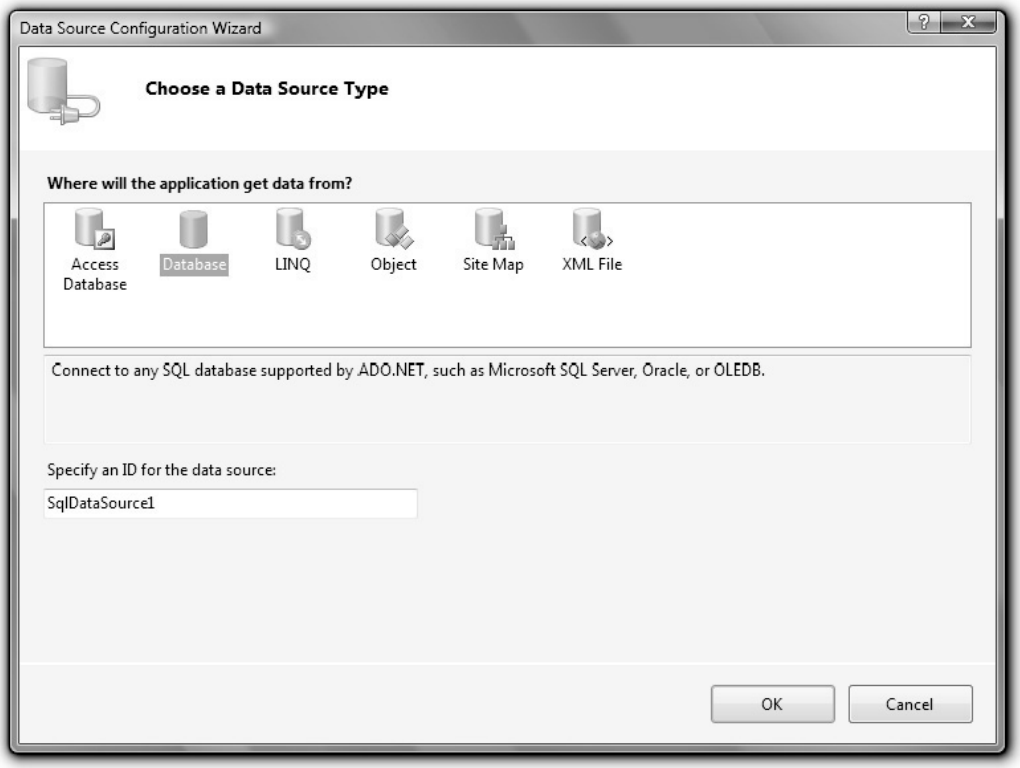
STEP 1: Add a DropDownList control from the Standard tab of the toolbox. In the smart tag select *Choose Data Source*.

STEP 2: In the Data Source Configuration Wizard, drop down the list for *Select a data source* and select *<New data source...>*.

STEP 3: In the next page of the wizard, select *Database* (Figure 10.29). You can leave the ID of the data source set to SqlDataSource1. Click *OK*.

Figure 10.29

Set the data source to an SQL database.



STEP 4: Next you set up the connection: Click on the *New Connection* button. If the data source does not say "Microsoft SQL Server Database File (SqlClient)", click on the *Change* button and make that selection.

STEP 5: In the *Add Connection* dialog box, browse to select the RnrBooks.mdf file in the App_Data folder beneath the project folder. Click *Open*, *OK*, and *Next*. Click *Next* again.

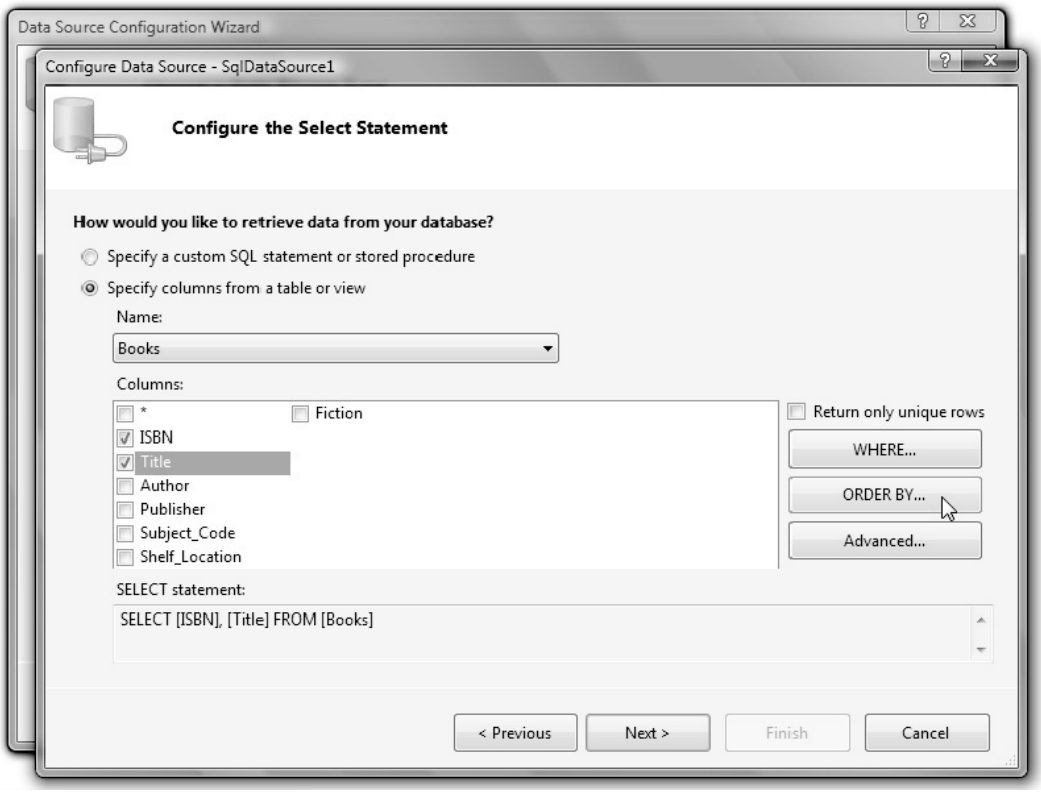
STEP 6: On the Configure the Select Statement page, you will select the data fields for the dataset for the drop-down list. Click on (check) *ISBN* and *Title*. You need the ISBN because it is the table's primary key.

STEP 7: Click on the *ORDER BY* button (Figure 10.30).

STEP 8: In the *Add ORDER BY Clause* dialog box, drop down the *Sort by* list and select *Title*. Click *OK*.

Figure 10.30

Select the Title and ISBN fields and click on the ORDER BY button to set the sort order for the data.



STEP 9: Back on the Configure the Select Statement page of the wizard, you can see the new `ORDER BY` clause added to the SQL `SELECT` statement (Figure 10.31).

STEP 10: Click *Next*. Before you click *Finish*, you can click on the *Test Query* button if you would like to see the records returned from the query you just created. Click *Finish*.

The Data Source Configuration Wizard reappears.

STEP 11: Choose *Title* for *Select a data field to display in the DropDownList*. Keep *ISBN* as the value of the DropDownList (Figure 10.32). Click *OK*.

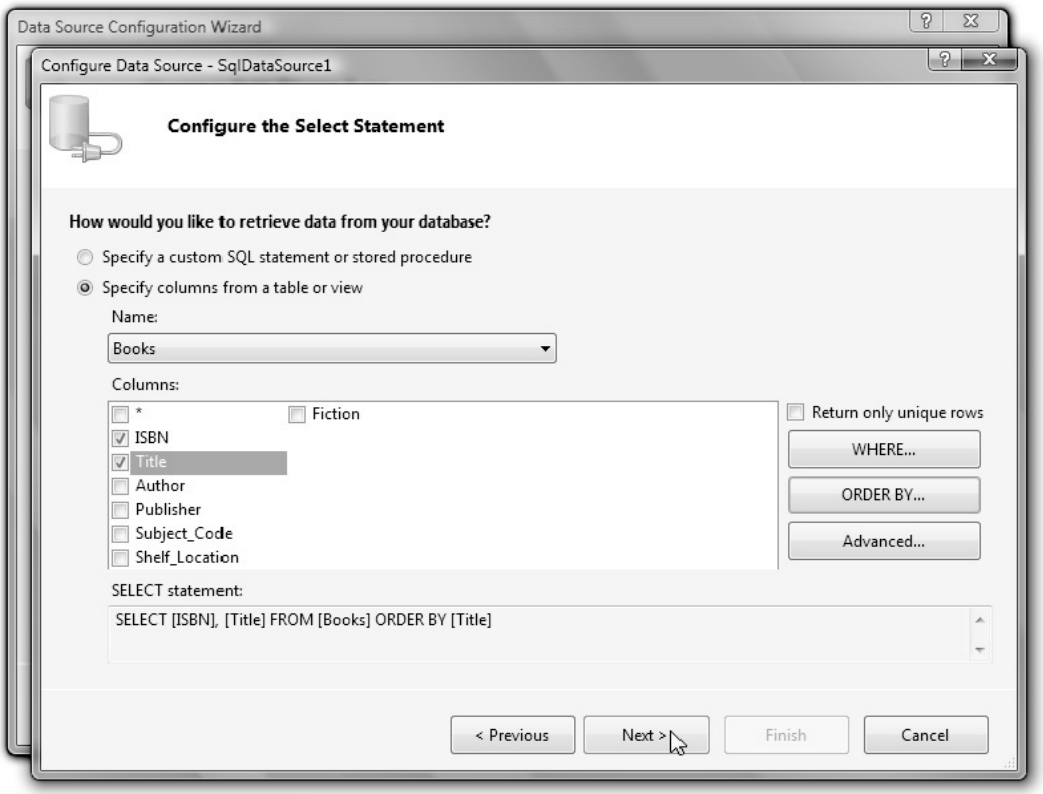
STEP 12: Display the smart tag for the drop-down list again and select *Enable AutoPostBack* (Figure 10.33). This important step specifies that each time the user makes a new selection from the list, the page should be sent back to the server. This step is necessary to select and display the data for the selected book.

STEP 13: Widen the DropDownList control so that it is wide enough to hold a book title.

STEP 14: Click after the SqlDataSource component (which will not appear at run time) and press Enter two or three times.

Figure 10.31

An ORDER BY *clause is added to the SQL* SELECT *statement.*



Set Up the Additional Fields

STEP 1: In the toolbox, open the Data tab and click to view the available controls and components.

You can see tools for data sources, which is another way to add a new data source. The controls near the top of the list are those that can be bound to data.

STEP 2: Add a DetailsView control to the Web page. In the smart tag, drop down the *Choose a Data Source* list and select *<New data source...>*. Do *not* choose *SqlDataSource1*, which you just created. The data for the DetailsView must be different from the data for the list.

STEP 3: Select *Database* and click *OK*. Then drop down the list and select the connection for RnrBooks.mdf that you already created. The two data sources will share the same connection since they both refer to the same database file. Click *Next* and *Next* again.

STEP 4: On the Configure the Select Statement page of the wizard, select *ISBN* and *Author* for the fields. Then click on the *WHERE* button.

STEP 5: In the *Add WHERE Clause* dialog box, you will set up the parameter used to select the correct data for the individual fields. Drop down the

Figure 10.32

Set the display field and value field in the Choose a Data Source page.

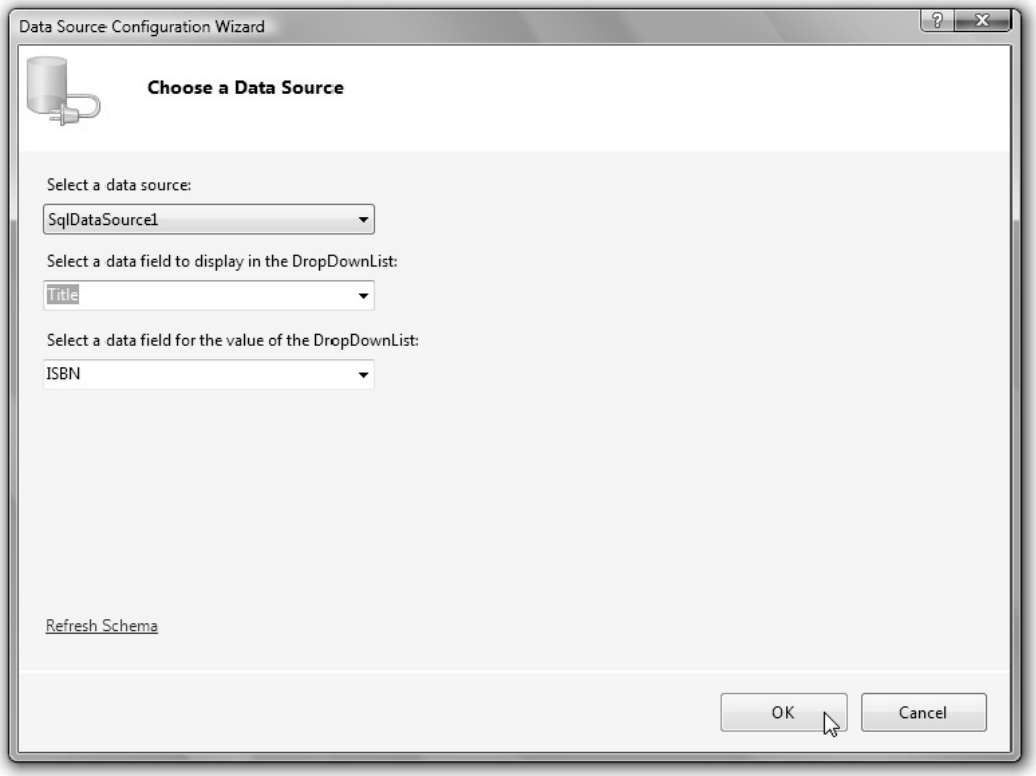
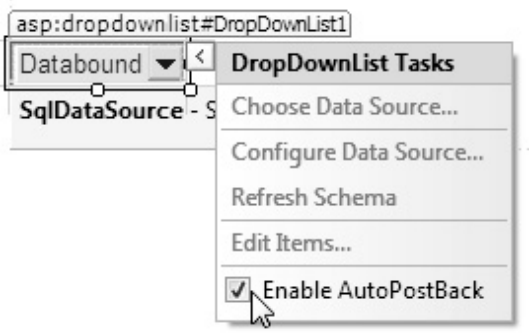


Figure 10.33

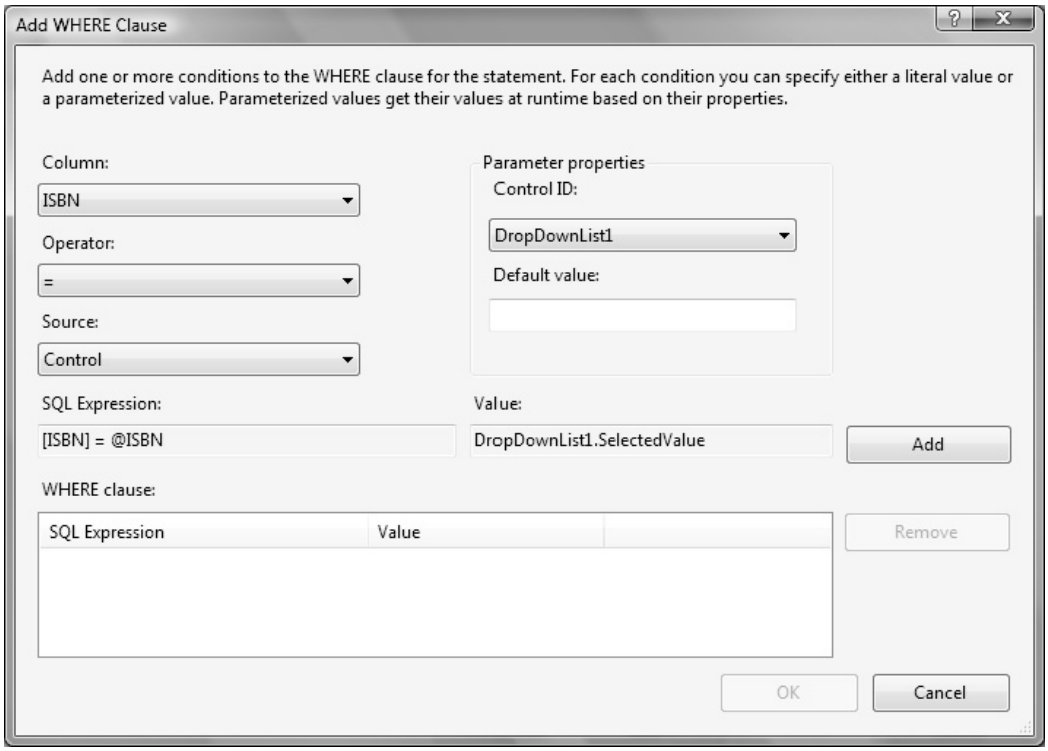
Select Enable AutoPostBack from the smart tag so that the user's selection will be sent to the server.



Column list and select *ISBN*; leave the *Operator* drop-down as "=", then drop down the list for *Source* and select *Control*. The *Parameter properties* group box pops up on the right side of the dialog box. For *Control ID* select *DropDownList1* and notice the SQL Expression (`[ISBN] = @ISBN`) (Figure 10.34). This type of query is called a *parameterized query*.

Figure 10.34

Set up the selection parameter in the Add WHERE Clause dialog box.



STEP 6: Click on *Add* and view the `WHERE` clause at the bottom of the dialog box. It should say `[ISBN] = @ISBN  DropDownList1.SelectedValue`. If it isn't correct, you can click *Remove* and repeat step 5. Click *OK*.

Back in the wizard, the `SELECT` statement should read:

```
SELECT [ISBN], [Author] FROM [Books] WHERE ([ISBN] = @ISBN)
```

STEP 7: Click *Next* and *Finish*.

Note: Don't bother with *Test Query* this time because you must supply an existing ISBN number—the parameter—to make the query work.

STEP 8: Resize the DetailsView control to be approximately the same width as the DropDownList control (Figure 10.35). *Note*: If your grid does not look like the figure, select *Refresh Schema* from the SqlDataSource's smart tag.

STEP 9: Click *Save All* (or press Ctrl + Shift + S).

Run the Application

STEP 1: Press Ctrl + F5 (or *Debug / Start without Debugging*) to test the application.

STEP 2: Make new selections from the list; the data fields below should change to match the selection.

Make the Project Portable

This optional step will make your Web application portable. The web.config file has a hard-coded path for the connection to the database file. If you move or rename the Web site folder, the connection fails due to the path. You can modify the connection entry to make the project portable.

Figure 10.35

Widen the DetailsView control.

STEP 1: Open the web.config file from the Solution Explorer and scroll to find the entry for the connection string. The path for AttachDbFilename will show the current folder where you created the Web site.

```
<appSettings/>
    <connectionStrings>
        <add name="RnrBooksConnectionString" connectionString="Data
Source=.\SQLEXPRESS;AttachDbFilename=&quot;C:\Users\UserName\Documents\Visual
Studio 2008\WebSites\Ch10WebSelection\App_Data\RnrBooks.mdf&quot;;Integrated
Security=True;Connect Timeout=30;User Instance=True"
            providerName="System.Data.SqlClient" />
    </connectionStrings>
```

STEP 2: Very carefully select the text that shows the path (but not the filename). Replace the highlighted text with "|DataDirectory|". (That is "DataDirectory" with a vertical bar before and after, with no spaces.)

The completed entry should look like this:

```
AttachDbFilename=&quot;|DataDirectory|RnrBooks.mdf&quot;;
```

STEP 3: Save and close the project.

After you have changed the web.config file, you can rename your project folder and move it to another location. The portable connection string will always point to the database file in the Web site's App_Data folder.

Make sure that the project is not open in the IDE and copy the complete folder from one computer or location to another. For Web projects, you must first open the IDE, select *Open Web Site*, and browse to the folder.

LINQ

In this optional section we will examine and demonstrate **Language Integrated Query (LINQ)**, which is a recent addition to Visual Basic. LINQ is a general-purpose query language that can ask a question of any data that is defined as an object, as a database, or as XML. The source of the data may be a database but could also be any collection, such as the collection for a list box. VB contains a LINQ to SQL component to convert database items to objects and a LINQ to XML component for converting XML document collections to objects. Arrays, which you learned about in Chapter 8, are also objects that contain a collection of items.

Querying Operating System Data

For an example, we will use the collection of processes that are currently running on your operating system. Yes, it's easy to access operating system information with VB. To make it obvious that we are treating the operating system information as data, we will use the DataGridView control for displaying the data.

The key operators in the query are `From`, `In`, and `Select`.

The LINQ Query—General Form

General Form

```
Dim VariableName = From ItemName In Object Select ListOfFields/Items
```

The *VariableName* in the format does not have a data type assigned. In Visual Studio 2008, if the data type is not specified, the compiler can assign a type in a process called *type inference*. If you were to type `Dim Amount = 5`, move to another line, and then hover the mouse over the variable, it would show you that through type inference, Amount is presumed to be Integer. Change the value to 5.5 and hover over Amount and the type will be Double. Although, it is not wise to use type inference when the type is known, the feature was introduced to allow some of the operators in LINQ (`Order By`, `Where`) to be used in a different order.

The LINQ Query—Example

Example

```
Dim MyQuery = From AnItem in Process.GetProcesses _
  Select AnItem.ProcessName, AnItem.StartTime
```

Creating a LINQ Project—Step-by-Step

In our operating system example, you will see a new method of an enumerable collection called the `ToList`, which works much like a `ToString` but returns a list of items.

STEP 1: Open a new Windows application project called CH10LINQ.
STEP 2: Add a DataGridView control, naming it ProcessesDataGridView.

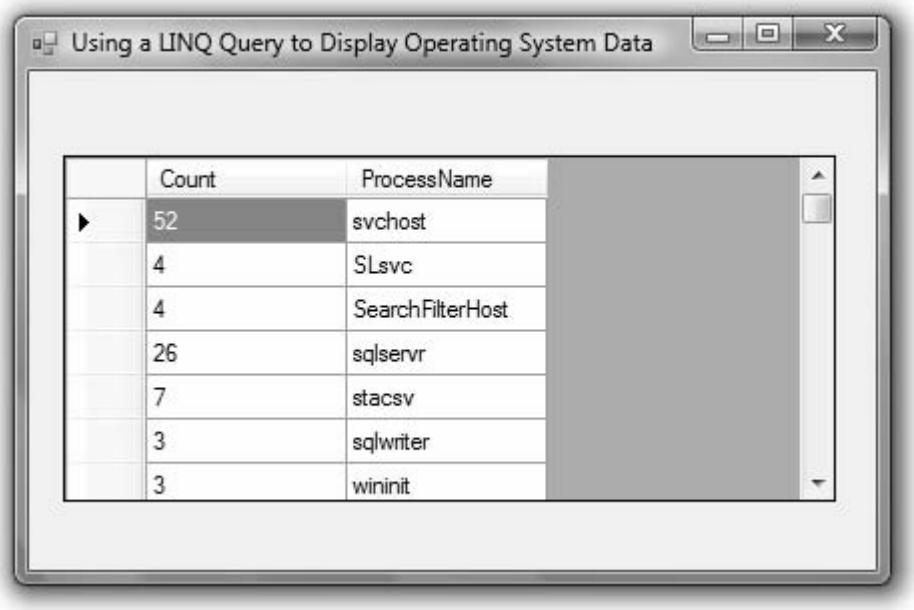
STEP 3: Double-click on the form to access the Form_Load event.
STEP 4: Type in the following code:

```
' Display the current system processes.

Dim MyQuery = From AnItem In Process.GetProcesses _
  Select AnItem.ProcessName, AnItem.Threads.Count

ProcessesDataGridView.DataSource = MyQuery.ToList
```

STEP 5: Run the program. It should retrieve the system processes, convert them to an object, and assign the object as the data source of the data grid view (Figure 10.36)

Figure 10.36

Using a LINQ query to fill a DataGridView control.



A FileSystem LINQ Example

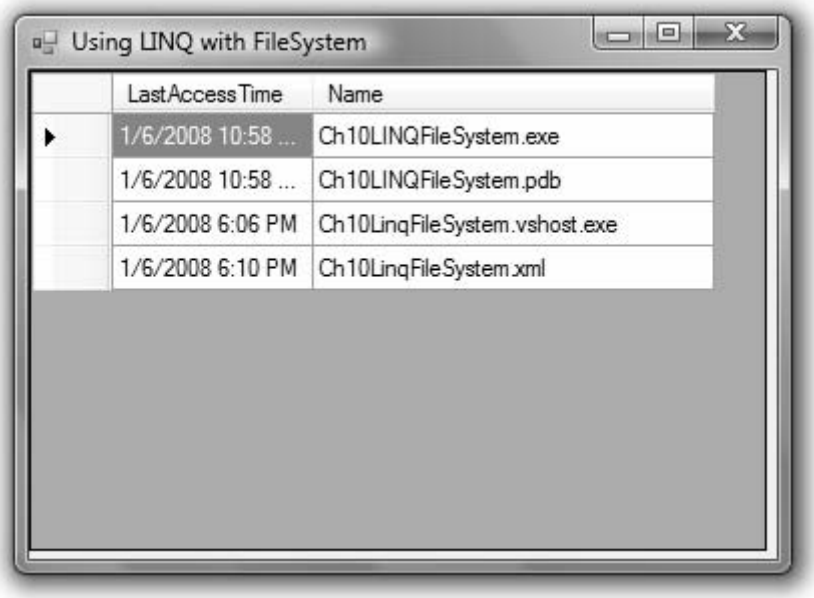
A very useful object that belongs to the My object is My.FileSystem, which can return information about files and directories on the computer system. This example will perform three LINQ queries, each on the results of the previous query. First, we will get the collection of files in the current directory. Then, for each file we will retrieve a collection of the file information. The final query selects the name and last access time for each file in the directory. Figure 10.37 shows the output of the queries in a DataGridView control.

```
'Project:              Ch10LinqFileSystem
'Date:                 June 2008
'Programmer:           Bradley/Millspaugh
'Description:          Demonstrates a LINQ query to fill a DataGridView
'                      with system information.
```

```
Public Class FileSystemForm

    Private Sub FileSystemForm_Load(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles MyBase.Load
        ' Use a LINQ query to get information on system files _
        ' and directories.

        ' Select all the files in the current directory.
        Dim MyQuery = From file In My.Computer.FileSystem.GetFiles(CurDir()) _
                      Select file

        ' For each file, get the file info.
        Dim NextQuery = From file In MyQuery _
          Select My.Computer.FileSystem.GetFileInfo(file)

        ' For each file in the file info collection, find the file name and _
        ' the last access date.
        Dim FileInfoQuery = From file In NextQuery _
            Select file.Name, file.LastAccessTime

        FileDataGridView.DataSource = FileInfoQuery.ToList
        FileDataGridView.Columns(1).Width = 200
    End Sub
End Class
```

Figure 10.37

Using a LINQ query to retrieve and display FileSystem data in a DataGridView control.



Feedback 10.4

1. What is LINQ?
2. What can be queried with LINQ?
3. Explain what is meant by type inference.

Your Hands-On Programming Example

Create a Windows application that contains a drop-down list of titles from the RnrBooks.mdf database file. When the user selects a title, display the corresponding ISBN, author, and publisher in labels. Include additional labels to identify the contents of the list box and the data fields.

Planning the Project

Sketch the form (Figure 10.38), which your users sign off as meeting their needs. Figure 10.39 shows the form in Design mode.

Select the control types for the controls in the Data Sources window before dragging the Details view to the form.

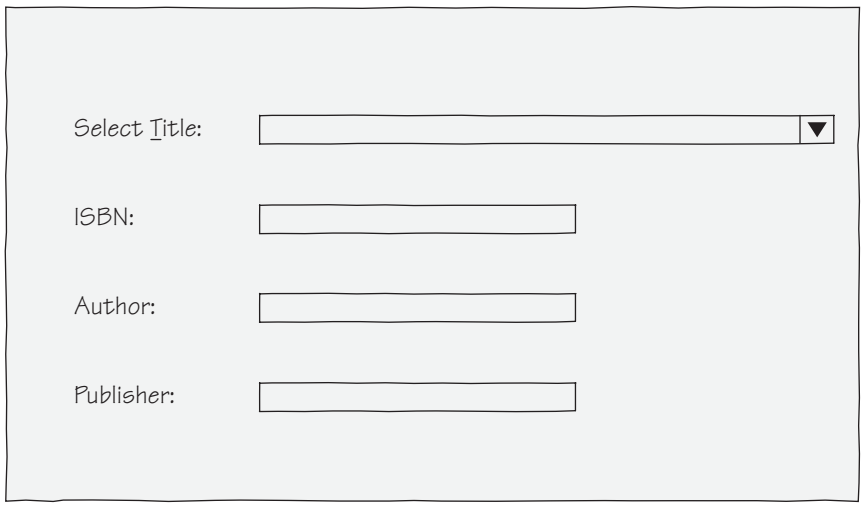


Figure 10.38

A planning sketch of the Windows form for the hands-on programming example.

Plan the Objects and Properties

Object	Property	Setting
BooksBindingSource	Name	BooksBindingSource
RnrBooksDataset	Name	RnrBooksDataset
BooksTableAdapter	Name	BooksTableAdapter
TitleComboBox	Name	TitleComboBox
	BindingSource	BooksBindingSource
	DisplayMember	Title
Labels	Name	Keep default names

Plan the Procedures No code is required if all properties are correctly set.

Write the Project

- Create a new Windows project.
- Create the new SQL Server data source based on the RnrBooks.mdf data file. Include only those fields that appear on the finished form.

- Set the control types to a combo box and labels for the fields.
- Drag a Details view of the data to the form and rearrange the controls to match the sketch in Figure 10.38. Figures 10.39 and 10.40 show the completed form.
- Set the properties of the combo box according to your plan.
- Thoroughly test the project.

The Project Code

Isn't it amazing that so powerful a program doesn't require any code at all?

Figure 10.39

The form for the hands-on programming example in Design mode, showing the component tray.

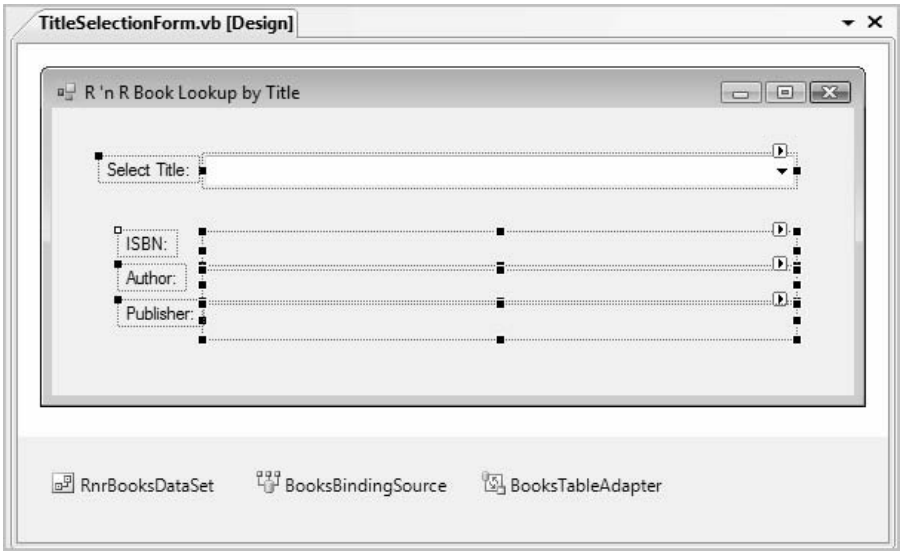
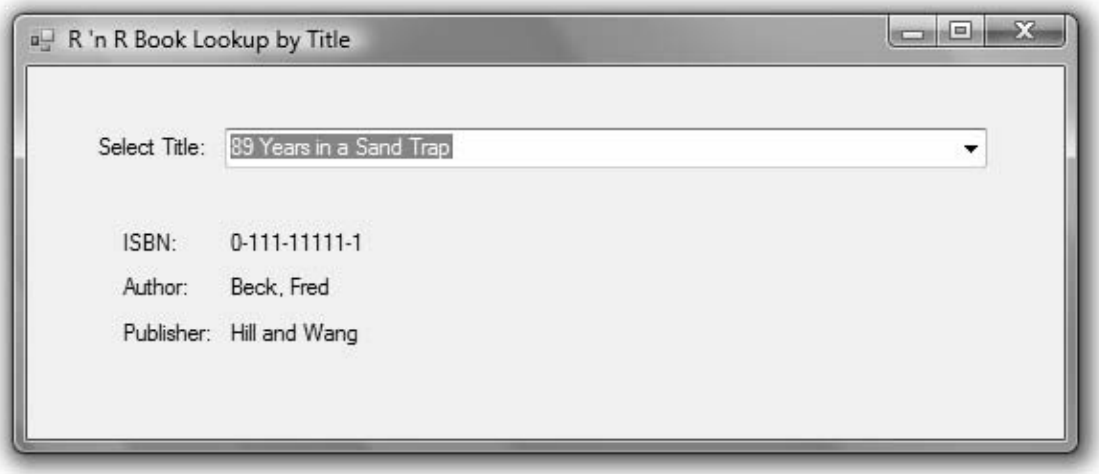


Figure 10.40

The form for the hands-on programming example.



Summary

1. Visual Studio uses Microsoft's ADO.NET technology to access databases in many different formats.
2. ADO.NET provides several types of connections for databases: OleDb, SQL Server, Odbc, and Oracle.
3. Databases are composed of tables of related information. Each table is organized into rows representing records and columns containing fields of data.
4. The primary key field uniquely identifies a row or record.
5. ADO.NET stores and transfers data using a format called XML (Extensible Markup Language), which can be used by many different platforms.
6. Many controls can be bound to a database including labels, text boxes, list boxes, or a DataGridView.
7. A binding source establishes a link to a data source, which is a specific data file or server.
8. A table adapter handles the transfer of data between a data source and a dataset.
9. A dataset stores information from the database in the memory of the computer. A dataset can contain multiple tables and their relationships.
10. You can create datasets by dragging tables from the Data Sources window or by using the Configuration Wizard that displays when *Add New Data Source* is selected from the *Data* menu.
11. A table adapter uses an SQL `SELECT` statement to specify the data to retrieve.
12. You can add a DataGridView to a form and automatically bind the grid to a data source.
13. The dataset's schema is defined in the .xsd file that appears in the project folder.
14. To bind individual controls to data fields, select *Details* for the table in the Data Sources window and drag the table to the form.
15. You can change the type of control used to display bound data in the control's smart tag.
16. It is common to allow the user to select a value from a list and then display the data values for the selected item in bound labels.
17. To use a bound combo box for selection, you must set its DataSource and DisplayMember properties.
18. You can select a subset of the fields in a table for a dataset.
19. In a Web database application, you must be very aware of the security requirements.
20. Each selection from a list requires a postback to the server to fill the bound controls. You must set the AutoPostBack property of the drop-down list to True to make the postback occur.
21. A Web selection program requires a parameterized query to retrieve the data matching the list selection. The Windows program does not have the same requirement.
22. LINQ is a query language that works on object data types.

Key Terms

binding source *406*
bound controls *413*
column *402*
data binding *405*
Data Designer *413*
data source *406*
data-bound controls *413*
DataGridView control *407*
dataset *406*
field *402*
LINQ *431*
postback *423*
primary key field *402*
record *402*
row *402*
table *402*
table adapter *406*
XML *403*

Review Questions

1. Explain the purpose of a binding source.
2. Explain the purpose of the table adapter control.
3. What is a dataset?
4. How is a DataGridView control used?
5. Explain the steps to change a data source from DataGridView to Details.
6. What options are available for styles of a bound control?
7. What is the purpose of the Data Source window?
8. How do a Windows and a Web version of a list selection program vary? Why?
9. What is a parameterized query? When would it be used?
10. What is a postback? When does it occur?
11. What is the purpose of LINQ? Name three operators.

Programming Exercises

Note: Each of these exercises can be written as a Windows application or as a Web application.

10.1 The Rnrbooks.mdf database file holds two tables: the Books table used in this chapter and the Subjects table. The Subjects table has only two fields: the Subject Code (the key) and the Subject Name. Write a project that displays the Subjects table in a grid. *Hint*: For a Web application, use a DataList control for the grid.

10.2 Write a project to display a list of the subject names in the Subjects table described in Programming Exercise 10.1. Use a drop-down combo box. Display in a label the subject code for the name selected from the list.

10.3 Write a project to display the Publishers table from the Contacts.mdf database from your StudentData\DatabaseFiles folder on the text Web site. The Publishers table has the following fields: PubID (the key field), Name, Company Name, Address, City, State, ZIP, Telephone, and Fax.

Allow the user to select the publisher name from a sorted drop-down list; display the rest of the fields in labels.

Case Studies

VB Mail Order

1. Create a Windows application to display the VB Mail Order Customer table from the VbMail.mdf database from the StudentData folder on the text Web site. Use the navigation bar to move from record to record.
2. Create a Web application to display the Customer table in a grid on a Web Form. *Hint*: Use a DataList control for the grid.

   The Customers table holds these fields:

CustomerID

LastName

FirstName

Address

City

State

ZipCode

VB Auto Center

Create a Windows application or a Web application to display the VB Auto Center Vehicle table from the VBAuto.mdf database from the StudentData folder on the text Web site. Display the InventoryID in a sorted combo box. Display the remaining fields in individual controls.

The table holds these fields:

InventoryID

Manufacturer

ModelName

Year

VehicleID

CostValue

Video Bonanza

1. Create a Windows application to display the information from the Studio table in the VBVideo.mdf database file from the StudentData folder on the text Web site. Allow the user to select the studio name from a sorted drop-down list and display the rest of the fields in labels.
2. Create a Windows or Web application to display the Studio table in a grid. *Hint*: For a Web application, use a DataList control for the grid.

The Studio table contains these fields:

StudioID

StudioName

ContactPerson

Phone

Very Very Boards

1. Create a Windows application to display the Product table from the VeryBoards.mdf database file from the StudentData folder on the text Web site. Allow the user to select the product ID from a sorted drop-down list and display the rest of the fields in labels.
2. Create a Windows or a Web application to display the Product table in a grid. *Hint*: For a Web application, use a DataList control for the grid.

   The Product table contains these fields:

ProductID

Description

MfgID

Unit

Cost

LastOrderDate

LastOrderQuantity

CHAPTER

11

Data Files

at the completion of this chapter, you will be able to . . .

1. Store and retrieve data in files using streams.
2. Save the values from a list box and reload for the next program run.
3. Check for the end of file.
4. Test whether a file exists.
5. Display the standard *Open File* and *Save File* dialog boxes to allow the user to choose or name the file.

Data Files

Many computer applications require that data be saved from one run to the next. Although the most common technique is to use a database, many times a database is overkill. Perhaps you just need to store a small amount of data, such as the date of the last program run, the highest ID number assigned, a user preference, or the property values of an object to transfer to another application. This chapter deals with techniques to store and retrieve **data files** on disk.

Note that the default security policy for the Internet and for intranets does not allow access to disk files. This chapter presents only basic file input and output (I/O) for Windows applications.

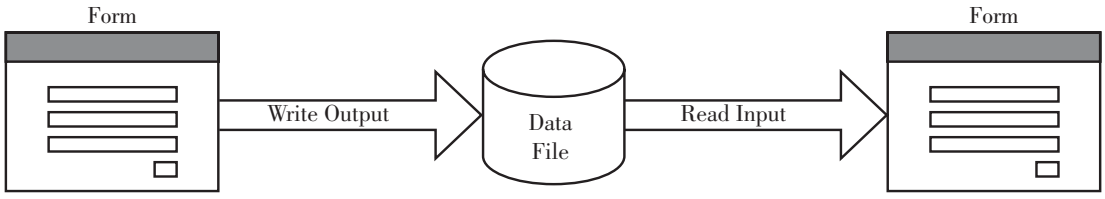
In computer terminology, any data/information that you store on disk is given its own unique name and is called a *file*. In other words, a file is a collection of related data stored together and assigned a name so that it can be accessed later. Each of your Visual Basic projects requires multiple files—for the forms, other classes, assembly information, and project information. However, the files you will create now are different; they contain actual data, such as names and addresses, inventory amounts, account balances, or even the contents of a list box.

File I/O

You can read and write data in a disk file. You may have the user enter data into text boxes that you want to store in a file; that is called *writing* or *output*. At a later time, when you want to retrieve the data from the file, that is *reading* or *input* (Figure 11.1).

Figure 11.1

Write output from a program to a file; read input from the file into a program.



Simple VB File I/O

Visual Studio includes a library of simplified data file input and output (I/O) objects. You can use the methods of these objects to quickly and easily write and read data files. But be aware that these objects are not the standard .NET objects that are used by the other .NET programming languages, such as C# and C++. Although a C# programmer *could* add the Microsoft.VisualBasic.FileIO library to a program, that is extremely unlikely. If you want to use the more universal and robust file-handling objects of .NET, see ".NET Standard File Handling" later in this chapter.

Writing and Reading Text Files

The quickest and easiest way to write text files in VB is to use the **`WriteAllText` method** of **My.Computer.FileSystem**. This method specifies the file name and the text string to write to the file. You also can choose whether the data will replace the existing file or will be added to the end of the file (appended).

The WriteAllText Method—General Form

General Form

```
My.Computer.FileSystem.WriteAllText(FileName, StringToWrite, AppendBoolean)
```

If the AppendBoolean argument is set to True, the new data are written to the end of the file; if it is set to False, any old file is replaced by the new data.

When you use this method, there is no need to open or close a file. The statement creates a file if one does not already exist. You also can specify a complete path for the file.

The WriteAllText Method—Examples

Examples

```
My.Computer.FileSystem.WriteAllText("Names.txt", NameString, True)
My.Computer.FileSystem.WriteAllText("C:\FinalCount.txt", CountInteger.ToString(), _
  False)
```

To read the string back in, you can use the **`ReadAllText` method**, which reads the entire file into a single string.

The ReadAllText Method—General Form

General Form

```
My.Computer.FileSystem.ReadAllText(FilePath)
```

The `ReadAllText` method fails if the file or path does not exist, so you should code the method in a `Try/Catch` block.

The ReadAllText Method—Example

Example

```
Try
   NameString = My.Computer.FileSystem.ReadAllText("Names.txt")
Catch
   MessageBox.Show("File or path not found or invalid")
End Try
```

The `ReadAllText` and `WriteAllText` methods are handy when you need to read or write a single string. To write multiple fields of data, you will want to write and read delimited files.

Writing and Reading Delimited Files

The term ***delimited file*** refers to a file that consists of multiple fields of data, with the fields separated by some predefined character. The most common

character used as a delimiter (separator) is the comma, but you can specify some other character, such as a tab or carriage return, if you wish.

Writing a Delimited File

In the following program example, the user enters a name and phone number into a form (Figure 11.2) and clicks the *Save* button. In the SaveButton_Click event procedure, the `WriteAllText` appends the name and phone number to the end of the file, with the fields delimited by commas and the end of each record delimited with a carriage return.

Figure 11.2

The user enters data into the text boxes and clicks the Save button, which writes these fields of data into the file.

You can insert delimiters in your text file by concatenating the fields when you write the file:

```
My.Computer.FileSystem.WriteAllText("Names.txt", _
  NameTextBox.Text & "," & PhoneTextBox.Text & vbCrLf, True)
```

The preceding line of code writes the names and phone numbers from text boxes, delimited with a comma, and uses the VB intrinsic constant for a carriage return (technically it's a carriage return and line feed). The final argument is set to True so that new data will be appended to the end of the existing file. Note that for the carriage return character, you can use the .NET `Environment.NewLine`, or `ControlChar.NewLine`, as you have used in the past, or the VB-only `vbCrLf` intrinsic constant.

Delimited Data File Output from the Program

```
Ann,714-555-4444
Dennis,805-555-7777
Richard,626-555-5678
Katie,909-555-6789
Ally,626-555-9999
Danny,909-555-3333
```

The Simple Delimited File Write Program

```
'Program:        Ch11SimpleDelimitedFileWrite
'Programmer:     Bradley/Millspaugh
'Date:           June 2008
'Description:    Allow the user to enter names and phone numbers and
'                save them in a delimited file.
'                Each record holds two fields, separated by commas.
'                Uses the simplified VB file access methods.
'Folder:         Ch11SimpleFileWrite

Public Class EntryForm

    Private Sub SaveButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles SaveButton.Click
        ' Save the record to the end of the file.

        Dim FileString As String = "TextFile.txt"
        Dim RecordString As String = NameTextBox.Text & "," _
          & PhoneTextBox.Text & vbCrLf

        ' This line opens the file, appends delimited text to the end of the file,
        ' and closes it.
        My.Computer.FileSystem.WriteAllText(FileString, RecordString, True)

        With NameTextBox
            .Clear()
            .Focus()
        End With
        PhoneTextBox.Clear()
    End Sub

    Private Sub ExitToolStripMenuItem_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles ExitToolStripMenuItem.Click
        ' Close the file and the form.

        Me.Close()
    End Sub
End Class
```

Viewing the Contents of a File

After you run your project, you can view the new file using a text editor such as Notepad. You also can view the file in the Visual Studio IDE. Unless you specified a path to a folder in a different location, by default your new file is created in the bin\Debug folder in your project folder.

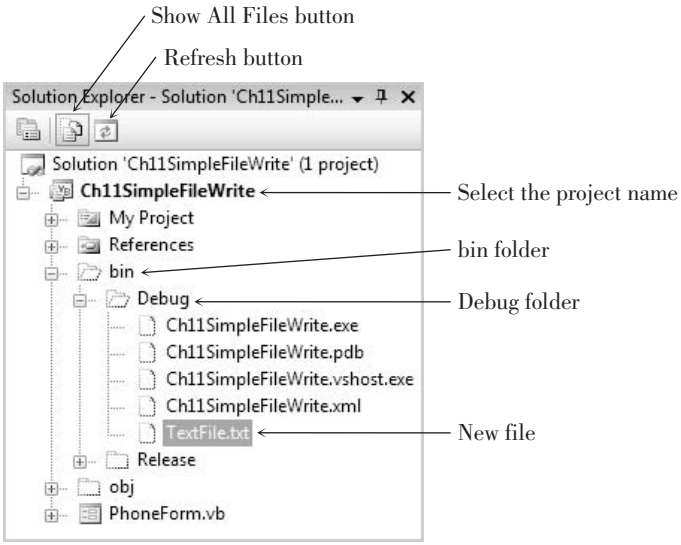
To view the file, select the project name in the Solution Explorer. If you don't see the bin and obj folders listed, click on the *Show All Files* button at the top of the window. Then you can expand the bin folder and the Debug folder, find the data file's name (Figure 11.3), and open it. The contents of the file should appear in the Editor window. If the filename does not appear when you open the bin\Debug folder, click on the *Refresh* button at the top of the Solution Explorer.

Reading a Delimited File

To read a delimited file using the simplified VB objects, you will need a **TextFieldParser** object, which comes from the Microsoft.VisualBasic.FileIO namespace. Include an `Imports` statement at the top of the code to use the library objects.

Figure 11.3

View the contents of your new file in the Visual Studio IDE.




```
' Top of code file:
Imports Microsoft.VisualBasic.FileIO

' Module-level variable:
Private NamePhoneTextFieldParser As TextFieldParser
```

Specifying a Delimiter A VB TextFieldParser object can read delimited files as well as fixed-width fields. When you declare a TextFieldParser, you must specify that the file is delimited and which character(s) to use as the delimiter.

The TextFieldType property of the TextFieldParser specifies whether you are using a delimited or fixed-width file. Assuming that the TextFieldParser is declared at the module level, the following lines of code instantiate the TextFieldParser object, set the file, indicate a delimited file, and specify that the delimiter is a comma. A good location for this code is the form's Load event procedure.

```
Private Sub DisplayForm_Load(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles MyBase.Load
    ' Instantiate the TextFieldParser and set the delimiters
    Dim FileString As String = "TextFile.txt"

    Try
        NamePhoneTextFieldParser = New TextFieldParser(FileString)
        NamePhoneTextFieldParser.TextFieldType = FieldType.Delimited
        NamePhoneTextFieldParser.SetDelimiters(",")
    Catch
        MessageBox.Show("Unable to read the file: " & FileString, "File Error")
    End Try
End Sub
```

Notice that you create a TextFieldParser object using the `New` keyword and indicate the filename associated with the parser.

Note: To specify delimiters such as a tab, the TextFieldParser uses the VB intrinsic constants. Example:

```
MyTextFieldParser.SetDelimiters(vbTab)
```

The TextFieldParser.ReadFields Method—General Form

Read from a delimited file with the `ReadFields` method. This method reads one record of the file into a string array. The end of the line or record is determined by a carriage return.

General Form

```
StringArray = TextFieldParser.ReadFields()
```

The TextFieldParser.ReadFields Method—Example

Example

```
Dim InfoString() As String = NamePhoneTextFieldParser.ReadFields()
```

Once you have retrieved the fields into the array, you can use the subscripts as you learned in Chapter 8. Remember that an array begins with subscript 0. If we know that each record contains two strings, the first field will have a subscript of 0, and the second subscript is 1. Notice that you can check for the end of the file using the `EndOfData` method.

```
Private Sub NextButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles NextButton.Click
    ' Read a name and phone number from the file.
    Dim FieldString() As String ' Must be a string array for delimited fields.

    If Not NamePhoneTextFieldParser.EndOfData Then
        FieldString = NamePhoneTextFieldParser.ReadFields()
        ' First field.
        NameTextBox.Text = FieldString(0)
        ' Second field.
        PhoneTextBox.Text = FieldString(1)
    Else
        MessageBox.Show("No more records to display.", "End of Data")
    End If
End Sub
```

The Simple Delimited File Read Program

Here is the completed program that reads the names and phone numbers from a delimited file and displays them on the form (Figure 11.4). Each time the user clicks *Next*, the program reads and displays the next record. Note that for this example program, we copied the TextFile.txt file from the bin\Debug folder of the previous program—the Simple Delimited File Write program.

```
'Program:        Ch11SimpleDelimitedFileRead
'Programmer:     Bradley/Millspaugh
'Date:           June 2008
'Description:    Uses a TextFieldParser object to read delimited fields from
'                a file.
'                Uses the simplified VB file access methods.
'                By default, the data file is expected to be in the
'                project's bin\Debug folder.

Imports Microsoft.VisualBasic.FileIO
```

```
Public Class DisplayForm
    ' Declare module-level variable.
    Private NamePhoneTextFieldParser As TextFieldParser

    Private Sub DisplayForm_Load(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles MyBase.Load
        ' Instantiate the TextFieldParser and set the delimiters
        Dim FileString As String = "TextFile.txt"

        Try
            NamePhoneTextFieldParser = New TextFieldParser(FileString)
            NamePhoneTextFieldParser.TextFieldType = FieldType.Delimited
            NamePhoneTextFieldParser.SetDelimiters(",")
        Catch
            MessageBox.Show("Unable to read the file: " & FileString, "File Error")
        End Try
    End Sub

    Private Sub NextButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles NextButton.Click
        ' Read a name and phone number from the file.
        Dim FieldString() As String ' Must be a string array for delimited fields.

        If Not NamePhoneTextFieldParser.EndOfData Then
            FieldString = NamePhoneTextFieldParser.ReadFields()
            ' First field.
            NameTextBox.Text = FieldString(0)
            ' Second field.
            PhoneTextBox.Text = FieldString(1)
        Else
            MessageBox.Show("No more records to display.", "End of Data")
        End If
    End Sub

    Private Sub ExitButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ExitButton.Click
        ' Close the form.

        Me.Close()
    End Sub
End Class
```

Figure 11.4

Each time the user clicks **Next**, *the next record is read from the file and displayed in the labels.*

.NET File Handling

The simple file handling that you saw in the previous section can work well for small amounts of data in a VB program. But for more robust and universal file handling, which is the same for all .NET languages, you will want to use streams.

File Handling Using Streams

.NET uses streams for file input and output. A **stream** is designed to transfer a series of bytes from one location to another. Streams are objects that have methods and properties, just like any other object. The stream objects are found in the **System.IO namespace**. You can save the trouble of fully qualifying references by including an `Imports` statement at the top of the file, before the statement declaring the form's class.

```
Imports System.IO

Public Class FileIOForm
```

The most straightforward way to read and write small amounts of data is to use the **StreamReader** and **StreamWriter** objects. Generally, you write the StreamWriter code first, to create the data file. Then you can write the StreamReader code to read the file that you just created.

Writing Data in a File Using a StreamWriter

To write data to a file, you first have the user input the data into text boxes and then write the data to the disk. The steps for writing data are

- Declare a new StreamWriter object, which also declares the name of the data file.
- Use the StreamWriter's `WriteLine` method to copy the data to a buffer in memory. (A buffer is just a temporary storage location.)
- Call the StreamWriter's `Close` method, which transfers the data from the buffer to the file and releases the system resources used by the stream.

Instantiating a StreamWriter Object—General Forms

General Forms

```
Dim ObjectName As New StreamWriter("FileName")
Dim ObjectName As New StreamWriter("FileName", BooleanAppend)
```

You declare a new StreamWriter object for writing data to a file. The first argument in the constructor specifies the name of the file. The default location for the file is where the program executable (.exe) is placed, which is the bin\Debug folder beneath the folder for the current project. You also can specify the complete path of the file.

In the second version of the StreamWriter constructor, you can specify that you want to append data to an existing file. Specify True to append. By default,

the option is set to False, and the old data file is deleted and a new data file is created, in effect overwriting any existing data.

Declaring a new StreamWriter object opens the file. The file must be open before you can write in the file. If the file does not already exist, a new one is created. If you don't use a full qualifying path, then the file is opened or created in the project's bin\Debug folder where the program executable is located. Because no exception occurs whether or not the file exists, you can declare the StreamWriter object in the declarations section of your program or in a procedure. If you do use a full path in the filename, then you should instantiate the StreamWriter object in a `Try/Catch` block in case the path does not exist.

TIP

Use .txt as your extension to allow for easy viewing of the file in Notepad or the Visual Studio IDE. ■

Declaring a StreamWriter Object—Examples

Examples

```
Dim PhoneStreamWriter As New StreamWriter("Phone.txt")
Private NamesStreamWriter As New StreamWriter("C:\MyFiles\Names.txt") ' Could throw
    ' an exception if the path doesn't exist.
Friend LogFileStreamWriter As New StreamWriter("LogFile.txt", True)
```

The StreamWriter object has both a **`Write`** and a **`WriteLine` method**. The difference between the two is a carriage-return character. The `Write` method places items consecutively in the file with no delimiter (separator). The `WriteLine` method places an Enter (carriage return) between items. We will use the `WriteLine` in this chapter because we want to easily retrieve the individual data elements later.

The WriteLine Method—General Form

General Form

```
ObjectName.WriteLine(DataToWrite)
```

The DataToWrite argument may be string or numeric. The `WriteLine` method converts any numeric data to string and actually writes string data in the file.

The WriteLine Method—Examples

Examples

```
PhoneStreamWriter.WriteLine(NameTextBox.Text)
PhoneStreamWriter.WriteLine(PhoneTextBox.Text)

NamesStreamWriter.WriteLine("Sammy")

BankBalanceStreamWriter.WriteLine(BalanceDecimal.ToString())
```

If you are inputting data from the user and writing in a file, you generally place the `WriteLine` in a button click event procedure. The following phone list example is similar to the earlier file writing program, but uses a StreamWriter object, rather than the VB WriteAllText method. You can refer to Figure 11.2 to see the data entry form.

```
Private Sub SaveButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles SaveButton.Click
    ' Save the record to the file.
```

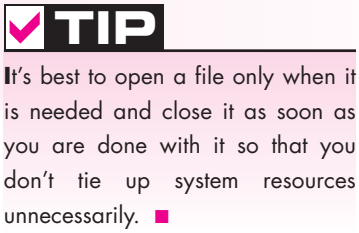
```
    ' Write to the already-open stream.
    PhoneStreamWriter.WriteLine(NameTextBox.Text)
    PhoneStreamWriter.WriteLine(PhoneTextBox.Text)
    With NameTextBox
       .Clear()
       .Focus()
    End With
    PhoneTextBox.Clear()
End Sub
```

The *Save* button writes the data from the screen to the StreamWriter object and then clears the screen.

Closing a File

After you finish writing data in a file, you must close the file. Closing a file is good housekeeping; it finishes writing all data from the stream's buffer to the disk and releases the system resources. Use the StreamWriter's **`Close` method**, which is similar to closing a form. A common location for the `Close` method is in your program's Exit command or the form's FormClosing event procedure (see page 459).

```
Private Sub ExitButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles ExitButton.Click
    ' Close the file and the form.

    PhoneStreamWriter.Close()
    Me.Close()
End Sub
```



If you fail to close a file when you are finished with it, the file may remain open for an indefinite time and sometimes may become unusable. See "The FormClosing Event Procedure" section later in this chapter.

Reading Data from a File Using a StreamReader

You use the StreamReader class to read the data from a file that you created with a StreamWriter.

The steps for reading the data from a file are the following:

- Declare an object of the StreamReader class. The constructor declares the filename and optional path. This statement opens the file so that you can read from it.
- Use the `ReadLine` method to read the data. You may need to use a loop to retrieve multiple records.
- When finished, close the stream using the StreamReader's `Close` method.

Declaring and Instantiating a StreamReader Object—General Forms

General Forms

```
' Declare a module-level variable.
Private ObjectName As StreamReader

' Inside a procedure.
ObjectName = New StreamReader("FileName")
```

The StreamReader class works in much the same way as the StreamWriter. However, the file must exist in the location where the application expects it. If no such file exists, an exception occurs. For this reason, you must instantiate the StreamReader object in a procedure so that you can enclose it in a `Try/Catch` block.

Declaring and Instantiating a StreamReader Object—Examples

Examples

```
Try
     Dim NamesStreamReader As New StreamReader("C:\MyFiles\Names.txt")
Catch
     MessageBox.Show("File does not exist.")
End Try

' In declarations section, to create a module-level variable name.
Private PhoneStreamReader As StreamReader
...
' In a Procedure, to catch an exception for a missing file.
Try
     PhoneStreamReader = New StreamReader("Phone.txt")
Catch
     MessageBox.Show("File does not exist.")
End Try
```

Using the ReadLine Method

Use the StreamReader's **`ReadLine` method** to read the previously saved data. Each time you execute the method, it reads the next line from the file. Assign the value from the read to the desired location, such as a label, a text box, or a string variable. The `ReadLine` method has no arguments.

```
NameTextBox.Text = PhoneStreamReader.ReadLine()
```

Checking for the End of the File

Use the StreamReader's **`Peek` method** to check for end of file. The `Peek` method looks at the next element without really reading it. The value returned when you peek beyond the last element is negative 1 (–1).

```
If PhoneStreamReader.Peek <> –1 Then
    NameTextBox.Text = PhoneStreamReader.ReadLine()
    PhoneTextBox.Text = PhoneStreamReader.ReadLine()
End If
```

Note that the `ReadLine` method does not throw an exception when you attempt to read past the end of the file.

You must always make sure to read the data elements in the same order in which they were written. Otherwise your output will display the wrong values. For example, if you reversed the two lines in the program segment above, the phone number would display for the name and vice versa. The `ReadLine` method just reads the next line and assigns it to the variable or property that you specify.

The File Read Program

Here is the completed program that reads the name and phone numbers from a file and displays them on the form. Each time the user clicks *Next*, the program reads and displays the next record. Note that for this example program, we copied the PhoneList.txt file from the bin\Debug folder of the Write File project, to the bin\Debug folder of this project. You also could specify the exact path of the file.

```
'Program:         Ch11StreamReaderReadFile
'Programmer:      Bradley/Millspaugh
'Date:            June 2008
'Description:     Retrieve the information stored in a data file
'                 and display it on the screen.
'                 Uses a StreamReader.

Imports System.IO

Public Class DisplayForm
    ' Declare a module-level variable.
    Private PhoneStreamReader As StreamReader

    Private Sub DisplayForm_Load(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles MyBase.Load
        ' Open the input file and display the first record.

        Try
            PhoneStreamReader = New StreamReader("PhoneList.txt")
            DisplayRecord()
        Catch ex As Exception
            MessageBox.Show("File not found or is invalid.", "Data Error")
        End Try
    End Sub

    Private Sub NextButton_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles NextButton.Click
        ' Display the next record.

        DisplayRecord()
    End Sub

    Private Sub DisplayRecord()
        ' Read and display the next record.

        If PhoneStreamReader.Peek <> -1 Then
            NameTextBox.Text = PhoneStreamReader.ReadLine()
            PhoneTextBox.Text = PhoneStreamReader.ReadLine()
        Else
            MessageBox.Show("No more records to display.", "End of File")
        End If
    End Sub

    Private Sub ExitToolStripMenuItem_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles ExitToolStripMenuItem.Click
        ' End the project.

        If Not PhoneStreamReader Is Nothing Then
            ' Close the file, only if it is open.
            PhoneStreamReader.Close()
        End If
        Me.Close()
    End Sub
End Class
```

Feedback 11.1

1. Write the statement to create an inventory StreamWriter object that will write data to a file called "Inventory.txt".
2. Code the statement to write the contents of DescriptionTextBox into the inventory stream.
3. Why should the declaration statement for a StreamReader object be in a `Try/Catch` block? Does the declaration statement for a StreamWriter object need to be in a `Try/Catch` block? Why or why not?
4. Write the statement(s) to read a description and a product number from InventoryStreamReader assuming it has been opened as a StreamReader object. Make sure to test for the end of the file.

Using the File Common Dialog Box

In the preceding file read and write programs, the filenames are hard-coded into the programs. You may prefer to allow the user to browse and enter the filename at run time. You can display the standard Windows *Open File* dialog box, in which the user can browse for a folder and filename and/or enter a new filename. Use the **OpenFileDialog** common dialog component to display the dialog box, and then use the object's FileName property to open the selected file.

OpenFileDialog Component Properties

You will find the following properties of the OpenFileDialog component very useful:

Property	Description
Name	Name of the component. You can use the default OpenFileDialog1.
CheckFileExists	Display an error message if the file does not exist. Set to False for saving a file, since you want to create a new file if the file does not exist. Leave at the default True to read an existing file.
CheckPathExists	Display an error message if the path does not exist. Set to False for saving a file, since you want it to create the new folder if necessary.
FileName	The name of the file selected or entered by the user, which includes the file path. Use this property after displaying the dialog box to determine which file to open. You also can give this property an initial value, which places a default filename in the dialog box when it appears.
Filter	Filter file extensions to display. Example: `Text Files (*.txt)|*.txt|All files (*.*)|*.*`
InitialDirectory	Directory to display when the dialog box opens. Set this in code to Directory.GetCurrentDirectory( ) to begin in the current directory.
SafeFileName	The name of the file selected or entered by the user, which does not include the file path.
Title	Title bar of the dialog box.

Displaying the Open File Dialog Box

To display an *Open File* dialog box (Figure 11.5), you must first add an OpenFileDialog component to your form. The component appears in the component tray. At design time, set initial properties for Name, CheckFileExists, CheckPathExists, Filter, and Title (see the preceding table for the values). In code, set the InitialDirectory property to `Directory.GetCurrentDirectory()`, display the dialog box using the `ShowDialog` method, and retrieve the FileName property.

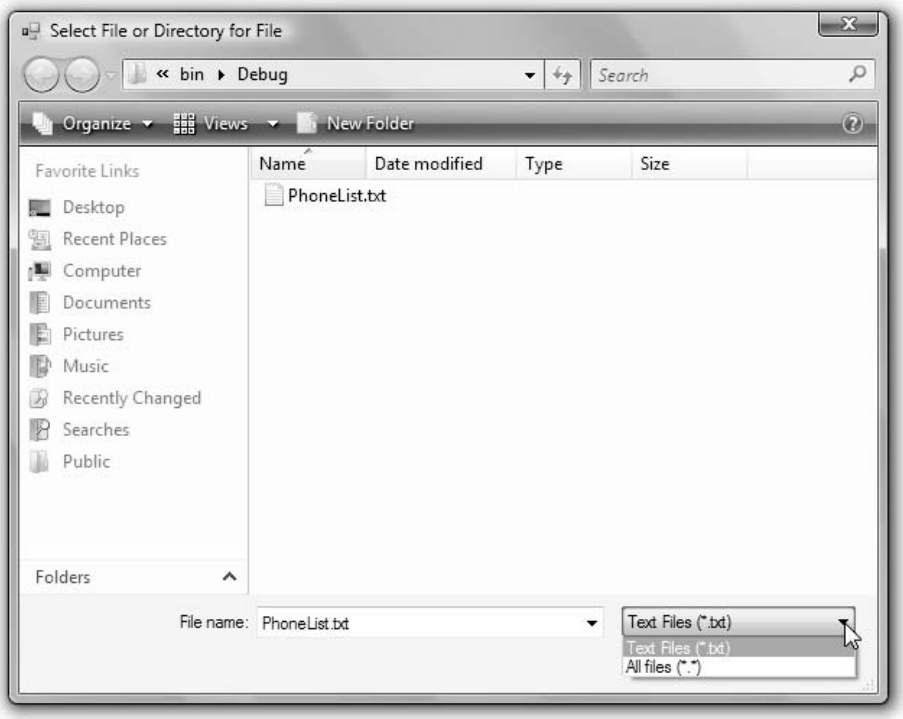


Figure 11.5

Display the Windows Open File dialog box using the OpenFileDialog component. The Filter property determines the entries that display in the drop-down box.

```
Private Sub OpenToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles OpenFileToolStripMenuItem.Click
    ' Open the file.
    Dim ResponseDialogResult As DialogResult

    ' Is the file already open?
    If PhoneStreamWriter IsNot Nothing Then
        PhoneStreamWriter.Close()
    End If

    ' Set up and display the Open File dialog.
    With OpenFileDialog1
        ' Begin in the current folder.
        .InitialDirectory = Directory.GetCurrentDirectory
        .FileName = "PhoneList.txt"
        .Title = "Select File or Directory for File"
        ' Display the Open File dialog box.
        ResponseDialogResult = .ShowDialog()
    End With
```

```
    ' Make sure that the user didn't click the Cancel button.
    If ResponseDialogResult <> DialogResult.Cancel Then
        ' Open the output file.
        PhoneStreamWriter = New StreamWriter(OpenFileDialog1.FileName)
    End If
End Sub
```

Notice that the user may click on the *Cancel* button of the *Open File* dialog box. Check the DialogResult for *Cancel*. And if the user *does* click *Cancel*, that presents one more task for the program: You cannot close a StreamWriter object that isn't open.

Checking for Successful File Open

In the preceding file-open procedure, the statement

```
PhoneStreamWriter = New StreamWriter(OpenFileDialog1.FileName)
```

may not execute. In that case, the StreamWriter is not instantiated. You can verify the object's instantiation using the VB keyword **`Nothing`**. An object variable that has not been instantiated has a value of `Nothing`. Notice the syntax: You must use the keyword `IsNot` rather than the not equal operator (<>).

```
' Is the file already open?
If PhoneStreamWriter IsNot Nothing Then
    PhoneStreamWriter.Close()
End If
```

Place this code in the form's FormClosing event procedure.

Checking for Already Open File

It's possible that the user may select the *File / Open* menu item twice, which can cause a problem. A second open instantiates another file stream, and the `Close` method never executes for the first file. It's best to check for an active instance of the file stream before instantiating a new one.

```
Private Sub OpenToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles OpenFileToolStripMenuItem.Click
    ' Open the file.
    Dim ResponseDialogResult As DialogResult

    ' Is the file already open?
    If PhoneStreamWriter IsNot Nothing Then
        PhoneStreamWriter.Close()
    End If

    ' Set up and display the Open File dialog.
    With OpenFileDialog1
        ' Begin in the current folder.
        .InitialDirectory = Directory.GetCurrentDirectory
        .FileName = "PhoneList.txt"
        .Title = "Select File or Directory for File"
        ' Display the Open File dialog box.
        ResponseDialogResult = .ShowDialog()
    End With
```

```
    ' Make sure that the user didn't click the Cancel button.
    If ResponseDialogResult <> DialogResult.Cancel Then
        ' Open the output file.
        PhoneStreamWriter = New StreamWriter(OpenFileDialog1.FileName)
    End If
End Sub
```

Using the Save File Dialog Component

In addition to the OpenFileDialog, you also can choose to display a SaveFileDialog component, which displays the standard system *Save As* dialog box. The SaveFileDialog allows the user to browse and enter a filename to save; it has most of the same properties as the OpenFileDialog component. By default, the SaveFileDialog component checks for an already existing file and displays a dialog box asking the user whether to replace the existing file.

The Open and Write File Program

Here is the complete listing of the Open and Write File program, which allows the user to select the filename. The user can select the *Open* command from the *File* menu. But if the *Save* button is clicked and the file is not yet open, the *Open File* dialog box displays automatically.

```
'Program:         Ch11 StreamWriter Open and Write File
'Programmer:      Bradley/Millspaugh
'Date:            June 2008
'Description:     Allow the user to enter names and phone numbers and
'                 save them in a file.
'                 Display the File Open dialog box for the user to
'                 enter the file and path.
'Folder:          Ch11StreamWriterOpenAndWriteFile

Imports System.IO

Public Class PhoneForm
  ' Declare module-level variable.
  Private PhoneStreamWriter As StreamWriter

  Private Sub SaveButton_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles SaveButton.Click
      ' Save the record to the file.

      If PhoneStreamWriter IsNot Nothing Then ' Is the file open?
          PhoneStreamWriter.WriteLine(NameTextBox.Text)
          PhoneStreamWriter.WriteLine(PhoneTextBox.Text)
          With NameTextBox
              .Clear()
              .Focus()
          End With
          PhoneTextBox.Clear()
      Else          ' File is not open.
          MessageBox.Show("You must open the file before you can save a record.", _
            "File Not Open", MessageBoxButtons.OK, MessageBoxIcon.Information)
          ' Display the File Open dialog box.
          OpenToolStripMenuItem_Click(sender, e)
      End If
  End Sub
```

```
  Private Sub OpenToolStripMenuItem_Click(ByVal sender As System.Object, _
    ByVal e As System.EventArgs) Handles OpenFileToolStripMenuItem.Click
      ' Open the file.
      Dim ResponseDialogResult As DialogResult

      ' Is the file already open?
      If PhoneStreamWriter IsNot Nothing Then
          PhoneStreamWriter.Close()
      End If

      ' Set up and display the Open File dialog.
      With OpenFileDialog1
          ' Begin in the current folder.
          .InitialDirectory = Directory.GetCurrentDirectory
          .FileName = "PhoneList.txt"
          .Title = "Select File or Directory for File"
          ' Display the Open File dialog box.
          ResponseDialogResult =.ShowDialog()
      End With

      ' Make sure that the user didn't click the Cancel button.
      If ResponseDialogResult <> DialogResult.Cancel Then
          ' Open the output file.
          PhoneStreamWriter = New StreamWriter(OpenFileDialog1.FileName)
      End If
  End Sub

  Private Sub ExitToolStripMenuItem_Click(ByVal sender As Object, _
    ByVal e As System.EventArgs) Handles ExitToolStripMenuItem.Click
      ' Close the file and the form.

      If PhoneStreamWriter IsNot Nothing Then ' Is the file open?
          PhoneStreamWriter.Close()
      End If
      Me.Close()
  End Sub
End Class
```

Feedback 11.2

1. What is the Filter property setting to display only .txt files?
2. Write the statement to set OpenFileDialog1 to begin in the current directory.
3. Write the statement to close PhoneStreamWriter; make sure to allow for the possibility that the file is not open.

Saving the Contents of a List Box

In Chapter 7 you wrote a program to maintain a list. The user was allowed to add items and remove items, but the next time the program ran, the list changes were gone. The changes were not saved from one execution to the next.

Now that you know how to save data in a file, you can save the contents of a list when the program exits and reload the list when the program reopens. Use the following techniques for this project:

- Do not give any values to the list's Items collection at design time. Instead, when the program begins, open the data file and read the items into the Items collection.
- If the user makes any changes to the list, ask whether to save the list when the program ends.
- Include a menu option to save the list.
- If the file holding the list elements does not exist when the program begins, give the user the option of creating a new list by adding items.

The examples in this section use the hands-on example from Chapter 7, which allows the user to make changes to the Coffee Flavor list (Figure 11.6). We will load the list from a file in the Form_Load procedure and query the user to save the list if any changes are made.

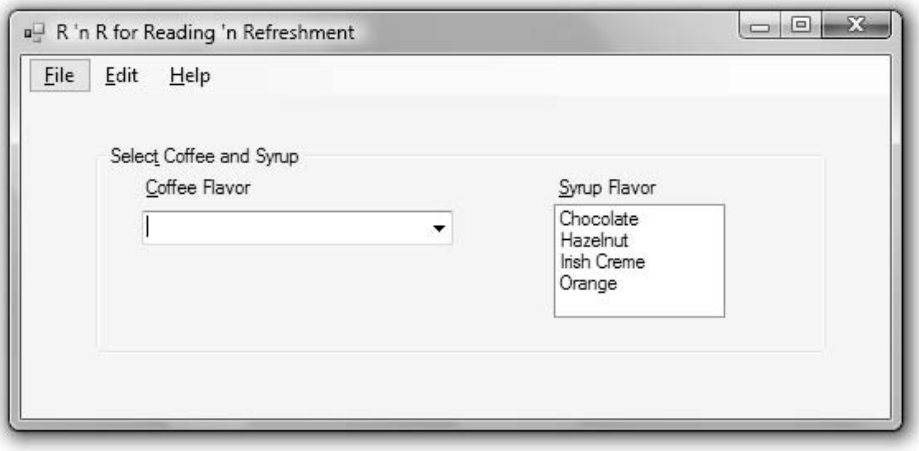


Figure 11.6

The form for the list save program, taken from Chapter 7.

Loading the List Box

Assuming that the list items are stored in a data file, you can read the file into the list in the Form_Load procedure. Loop through the file until all elements are read, placing each item in the list with the `Items.Add` method.

```
Dim CoffeeFlavorString As String

' Read all elements into the list.
Do Until FlavorsStreamReader.Peek = -1
     CoffeeFlavorString = FlavorsStreamReader.ReadLine()
     CoffeeComboBox.Items.Add(CoffeeFlavorString)
Loop
```

Checking for Existence of the File

When you create a StreamReader object, the constructor checks to make sure the file exists. If the file does not exist, what do you want to do? Maybe the user

wants to exit the program, locate the file, and try again. Or maybe the user prefers to begin with an empty list, add the list items, and create a new file. This technique is a good way to create the file in the first place.

You can catch the exception for a missing file and display a message box asking if the user wants to create a new file.

```
ResponseDialogResult = MessageBox.Show("Create a new file?", "File not Found", _
  MessageBoxButtons.YesNo, MessageBoxIcon.Question)
```

If the user says Yes, allow the program to begin running with an empty list; the file will be created when the program exits or the user saves the list. If the user says No, exit the program immediately.

```
Private Sub FlavorsForm_Load(ByVal sender As Object, _
  ByVal e As System.EventArgs) Handles Me.Load
    ' Load the items in the coffeeComboBox list.
    Dim ResponseDialogResult As DialogResult
    Dim CoffeeFlavorString As String

    Try
        ' Open the file.
        Dim FlavorsStreamReader As StreamReader = _
          My.Computer.FileSystem.OpenTextFileReader("Coffees.txt")
        ' Read all elements into the list.
        Do Until FlavorsStreamReader.Peek = -1
            CoffeeFlavorString = FlavorsStreamReader.ReadLine()
            CoffeeComboBox.Items.Add(CoffeeFlavorString)
        Loop
        ' Close the file.
        FlavorsStreamReader.Close()
    Catch ex As Exception
        ' File missing.
        ResponseDialogResult = MessageBox.Show("Create a new file?", _
          "File Not Found", MessageBoxButtons.YesNo, _
          MessageBoxIcon.Question)
        If ResponseDialogResult = DialogResult.No Then
            ' Exit the program.
            Me.Close()
        End If
    End Try
End Sub
```

Saving the File

In this program the user can choose a menu option to save the file. Open a StreamWriter object and loop through the Items collection of the list box, saving each element with a `WriteLine` method.

```
Private Sub SaveFlavorListToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles SaveFlavorListToolStripMenuItem.Click
    ' Save the flavor list in a file.
    Dim NumberItemsInteger As Integer
```

```
    ' Open the file.
    Dim FlavorsStreamWriter As StreamWriter = _
      My.Computer.FileSystem.OpenTextFileWriter("Coffees.txt", False)
    ' Save the items in the file.
    NumberItemsInteger = CoffeeComboBox.Items.Count - 1
    For IndexInteger As Integer = 0 To NumberItemsInteger
        FlavorsStreamWriter.WriteLine(CoffeeComboBox.Items(IndexInteger))
    Next IndexInteger
    ' Close the file.
    FlavorsStreamWriter.Close()
    IsDirtyBoolean = False
End Sub
```

The last line in this procedure needs some explanation. The next section explains the reason for `IsDirtyBoolean = False`.

Querying the User to Save

If your program allows users to make changes to data during program execution, it's a good idea to ask them if they want to save the changes before the program ends. This is similar to working in a word processing program or the VB editor. If you close the file after making changes, you receive a message asking if you want to save the file. But if you haven't made any changes since the last save, no message appears.

To keep track of data changes during execution, you need a module-level Boolean variable. Because the standard practice in programming is to refer to the data as "dirty" if changes have been made, we will call the variable IsDirtyBoolean. In each procedure that allows changes (Add, Remove, Clear), you must set IsDirtyBoolean to True. After saving the file, set the variable to False. (The code for this appears in the preceding section.)

Just before the project ends, you must check the value of IsDirtyBoolean; if True, ask the user if he or she wants to save; if False, you can just exit without a message.

The FormClosing Event Procedure

If you want to do something before the project ends, such as ask the user to save the file, the best location is the form's **FormClosing event** procedure. This is a much better place for such a question than your exit procedure because the user can quit the program in more than one way. The Form_ FormClosing event procedure executes before the form closes when the user clicks on your Exit button or menu command, clicks on the window's Close button, or even exits Windows.

```
Private Sub FlavorsForm_FormClosing(ByVal sender As Object, _
  ByVal e As System.Windows.Forms.FormClosingEventArgs) Handles Me.FormClosing
    ' Ask the user to save the file.
    Dim ResponseDialogResult As DialogResult
    Dim MessageString As String = "Coffee list has changed. Save the list?"

    If IsDirtyBoolean Then
        ResponseDialogResult = MessageBox.Show(MessageString, "Coffee List Changed", _
          MessageBoxButtons.YesNo, MessageBoxIcon.Question)

        If ResponseDialogResult = DialogResult.Yes Then
            SaveFlavorListToolStripMenuItem_Click(sender, e)
        End If
    End If
End Sub
```

Feedback 11.3

1. Write the loop to save all of the elements from NamesListBox using NamesStreamWriter, which is a StreamWriter already opened and connected to Names.txt.
2. In what procedure should the code from Question 1 be placed?
3. Write the statements in the Form_Load event procedure to load the list of names into NamesListBox.

XML Files

An increasingly important topic, XML files, is covered in Chapter 14. See "XML Data Files" for terminology and examples, including the new XML Literals, XDocument and XElement objects, and LINQ to XML.

Your Hands-On Programming Example

Modify the hands-on programming example from Chapter 7 to save the list changes from one run of the program to the next. The user can add items to the Coffee Flavor list, remove items, and clear the list. If there are any changes to the list, allow the user to save the list. When the program begins, load the list from the disk file, so that it displays the list as it appeared during the last run.

Do not give the Coffee Flavor list initial values; if the user has not entered any flavors, the list should be blank. If the file holding coffee flavors is not found, allow the user to enter the new flavors at run time.

Add a *Save Flavors List* menu item on the *File* menu. Also query the user to save the file if the list has changed when the program closes.

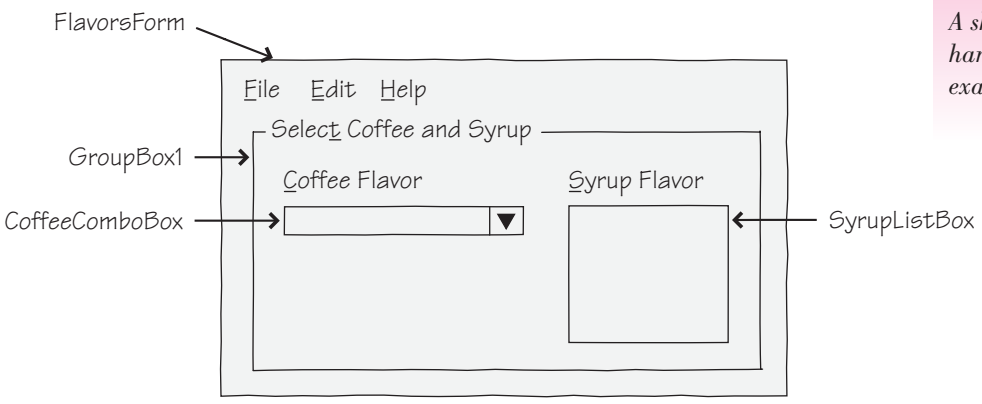
Note: We have removed the printing routines from the Ch07HandsOn program to better focus on the file-handling routines.

Planning the Project

Sketch the form (Figure 11.7), which your users sign off as meeting their needs.

Figure 11.7

A sketch of the form for the hands-on programming example.



Plan the Objects and Properties See the planning for the Chapter 7 hands-on programming example and make the following addition:

Object	Property	Setting
SaveFlavorListToolStripMenuItem	Name	SaveFlavorListToolStripMenuItem
	Text	&Save Flavor List

Plan the Procedures Refer to the planning for the Chapter 7 hands-on programming example and make the following changes. You can remove the controls and procedures for printing.

Procedure	Actions
SaveFlavorListToolStripMenuItem_Click	Open the file. Save the list items in the file. Close the file. Set IsDirtyBoolean to False.

Form_Load	Try
	  Open the file.
	  Read the file contents into the Flavors list.
	  Close the file.
	Catch (File is missing)
	  Query the user to create the new file.
	  If answer is No
	  Exit the program.
	  End If
	End Try

Form_FormClosing	If list has changed (is dirty)
	  Query the user to save the list data.
	  If Yes
	  Call SaveFlavorListToolStripMenuItem_Click.

Write the Project Begin with the Chapter 7 hands-on programming example. See "Basing a New Project on an Existing Project" in Chapter 5 (page 237) for help. Figure 11.7 shows the sketch and Figure 11.8 shows the completed form.

- Add the menu item and set the properties according to your plan.
- Make sure to add the new `Imports` statement:

```
Imports System.IO
```

- Add the module-level variable IsDirtyBoolean.
- Write the code for the new menu item based on the pseudocode.
- Write the new code for the Form_Load and Form_FormClosing event procedures, based on the pseudocode.
- When you complete the code, thoroughly test the project. Fill the list, save the list, and rerun the program multiple times. Make sure that you can modify the list and have the changes appear in the next program run. Also test the option to not save changes and make sure that it works correctly.

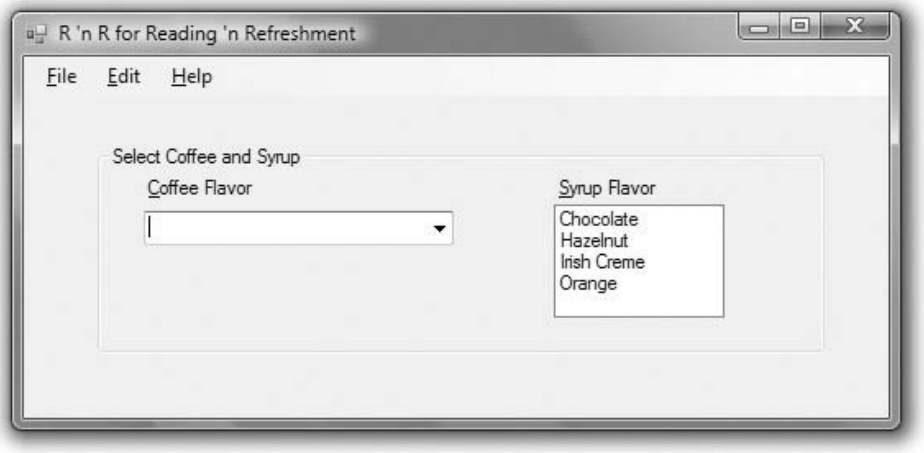


Figure 11.8

The completed form for the hands-on programming example.

The Project Coding Solution

```
'Project:          Ch11HandsOn
'Programmer:       Bradley/Millspaugh
'Date:             June 2008
'Description:      Maintain a list of coffee flavors.

'                  Note: This program extends Ch07HandsOn to save the modified list
'                  in a file. The printing has been removed for clarity.
'Folder:           Ch11HandsOn

Imports System.IO

Public Class FlavorsForm

  ' Declare module-level variable.
  Private IsDirtyBoolean As Boolean

  Private Sub FlavorsForm_Load(ByVal sender As Object, _
    ByVal e As System.EventArgs) Handles Me.Load
      ' Load the items in the CoffeeComboBox list.
      Dim ResponseDialogResult As DialogResult
      Dim CoffeeFlavorString As String

      Try
        ' Open the file.
        Dim FlavorsStreamReader As StreamReader = _
          New StreamReader("Coffees.txt")
        ' Read all elements into the list.
        Do Until FlavorsStreamReader.Peek = -1
            CoffeeFlavorString = FlavorsStreamReader.ReadLine()
            CoffeeComboBox.Items.Add(CoffeeFlavorString)
        Loop
        ' Close the file.
        FlavorsStreamReader.Close()
```

```
    Catch ex As Exception
      ' File missing.
      ResponseDialogResult = MessageBox.Show("Create a new file?", _
        "File Not Found", MessageBoxButtons.YesNo, _
        MessageBoxIcon.Question)
      If ResponseDialogResult = DialogResult.No Then
          ' Exit the program.
          Me.Close()
      End If
    End Try
End Sub

Private Sub FlavorsForm_FormClosing(ByVal sender As Object, _
  ByVal e As System.Windows.Forms.FormClosingEventArgs) Handles Me.FormClosing
    ' Ask the user to save the file.
    Dim ResponseDialogResult As DialogResult
    Dim MessageString As String = "Coffee list has changed. Save the list?"

    If IsDirtyBoolean Then
        ResponseDialogResult = MessageBox.Show(MessageString, "Coffee List Changed", _
          MessageBoxButtons.YesNo, MessageBoxIcon.Question)

        If ResponseDialogResult = DialogResult.Yes Then
            SaveFlavorListToolStripMenuItem_Click(sender, e)
        End If
    End If
End Sub

Private Sub SaveFlavorListToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles SaveFlavorListToolStripMenuItem.Click
    ' Save the flavor list in a file.
    Dim NumberItemsInteger As Integer

    ' Open the file.
    Dim FlavorsStreamWriter As StreamWriter = New StreamWriter("Coffees.txt", False)
    ' Save the items in the file.
    NumberItemsInteger = CoffeeComboBox.Items.Count - 1
    For IndexInteger As Integer = 0 To NumberItemsInteger
        FlavorsStreamWriter.WriteLine(CoffeeComboBox.Items(IndexInteger))
    Next IndexInteger
    ' Close the file.
    FlavorsStreamWriter.Close()
    IsDirtyBoolean = False
End Sub

Private Sub ExitToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles ExitToolStripMenuItem.Click
    ' End the program.

    Me.Close()
End Sub

Private Sub AddCoffeeFlavorToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles AddCoffeeFlavorToolStripMenuItem.Click
    ' Add a new coffee flavor to the coffee list.
```

```
        With CoffeeComboBox
            ' Test for blank input.
            If .Text <> "" Then
                ' Make sure item is not already on the list.
                Dim ItemFoundBoolean As Boolean
                Dim ItemIndexInteger As Integer
                Do Until ItemFoundBoolean Or ItemIndexInteger = .Items.Count
                    If .Text = .Items(ItemIndexInteger).ToString() Then
                        ItemFoundBoolean = True
                        Exit Do
                    Else
                        ItemIndexInteger += 1
                    End If
                Loop
                If ItemFoundBoolean Then
                    MessageBox.Show("Duplicate item.", "Add Failed", _
                      MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
                Else
                    ' If it's not in the list, add it.
                    .Items.Add(.Text)
                    .Text = ""
                    IsDirtyBoolean = True
                End If
            Else
                MessageBox.Show("Enter a coffee flavor to add", _
                  "Missing Data", MessageBoxButtons.OK, _
                  MessageBoxIcon.Exclamation)
            End If
            .Focus()
        End With
    End Sub

    Private Sub ClearCoffeeListToolStripMenuItem_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles ClearCoffeeListToolStripMenuItem.Click
        ' Clear the coffee list.
        Dim ResponseDialogResult As DialogResult

        ResponseDialogResult = MessageBox.Show("Clear the coffee flavor list?", _
          "Clear Coffee List", MessageBoxButtons.YesNo, MessageBoxIcon.Question)
        If ResponseDialogResult = DialogResult.Yes Then
            CoffeeComboBox.Items.Clear()
            IsDirtyBoolean = True
        End If
    End Sub

    Private Sub RemoveCoffeeFlavorToolStripMenuItem_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles RemoveCoffeeFlavorToolStripMenuItem.Click
        ' Remove the selected coffee from list.

        With CoffeeComboBox
            If .SelectedIndex <> -1 Then
                .Items.RemoveAt(.SelectedIndex)
                IsDirtyBoolean = True
            Else
                MessageBox.Show("First select the coffee to remove.", _
                  "No selection made", MessageBoxButtons.OK, _
                  MessageBoxIcon.Exclamation)
            End If
        End With
    End Sub
```

```
  Private Sub DisplayCoffeeCountToolStripMenuItem_Click(ByVal sender As Object, _
    ByVal e As System.EventArgs) _
    Handles DisplayCoffeeCountToolStripMenuItem.Click
      ' Display a count of the coffee list.

      MessageBox.Show("The number of coffee types is " & _
        CoffeeComboBox.Items.Count, "R 'n R Coffee Type Count", _
        MessageBoxButtons.OK, MessageBoxIcon.Information)
  End Sub

  Private Sub AboutToolStripMenuItem_Click(ByVal sender As Object, _
    ByVal e As System.EventArgs) Handles AboutToolStripMenuItem.Click
      ' Display the About form.

      AboutForm.Show()
  End Sub
End Class
```

Summary

1. The My.Computer.FileSystem makes it easier to work with data.
2. A stream object is used to transfer data to and from a data file. The StreamWriter outputs (writes) the data and the StreamReader inputs (reads) data.
3. The constructors for a StreamWriter and StreamReader take the name of the file, with an optional path, as a parameter.
4. The `WriteLine` method writes a data line to disk.
5. A `Close` method should be used as soon as you are done with the stream. Make sure the stream is closed prior to the termination of a program that uses streams.
6. The `Peek` method looks at the next element, which allows testing for the end of the file. The `Peek` method returns –1 at the end of file.
7. List box data may be saved to a file. The Items collection should be filled in the Form_Load if the file exists. Any changes are saved back to the file when the program terminates.
8. A Boolean variable is used to track whether changes are made to the data.
9. The form's FormClosing event procedure is a good location for the code to prompt the users if they wish to save any changes.
10. The OpenFileDialog and SaveFileDialog components can be used to display the *Open File* and *Save As* dialog boxes and allow the user to select the filename.

Key Terms

`Close` method *449*
data file *440*
delimited file *441*
FormClosing event *459*
My.Computer.FileSystem *441*
`Nothing` *454*
OpenFileDialog *452*
`Peek` method *450*
`ReadAllText` method *441*
`ReadLine` method *450*
stream *447*
StreamReader *447*

StreamWriter *447*
System.IO namespace *447*
TextFieldParser *443*
`Write` method *448*
`WriteAllText` method *441*
`WriteLine` method *448*

Review Questions

1. Explain how to create a new object that should have module-level scope and be instantiated in a `Try/Catch` block.
2. Explain what occurs when a stream object is instantiated.
3. Name two types of stream classes. What is the difference between the two?
4. What is the difference between a `Write` method and a `WriteLine` method?
5. What steps are necessary for storing the list items from a list box into a disk file?
6. What is the format for the statements to read and write streams?
7. What method can be used to determine the end of file?
8. When is exception handling necessary for stream handling?
9. Explain when a form's FormClosing event occurs and what code might be included in the FormClosing event procedure.

Programming Exercises

11.1 Rewrite Programming Exercise 8.4 using a file to store the state names and abbreviations. You need two projects: The first will allow the typist to enter the state name and the abbreviation in text boxes and store them in a file. The second project will perform the lookup functions specified in Programming Exercise 8.4.

Note: Unless you include *Open File* dialog boxes, copy the file created in bin\Debug for the first project into the bin\Debug folder for the second project.

Note: For help in basing a new project on an existing project, see "Basing a New Project on an Existing Project" in Chapter 5.

Optional extra: Allow the user to select the file to open using the *Open File* dialog box.

11.2 Create a file for employee information and call it Employee.txt. Each record will contain fields for first name, last name, employee number, and hourly pay rate.

Write a second project to process payroll. The application will load the employee data into an array of structures from the file with an extra field for the pay. The form will contain labels for the information from the array (display one record at a time) and a text box for the hours worked.

A button called *FindPay* will use a `For/Next` loop to process the array. You will calculate the pay and add the pay to the totals. Then display the labels for the next employee. (Place the pay into the extra field in the array.)

The *Exit* button will print a report on the printer and terminate the project. (Print the array.)

Processing: Hours over 40 receive time-and-a-half pay. Accumulate the total number of hours worked, the total number of hours of overtime, and the total amount of pay.

Sample Report

Ace Industries

Employee Name	Hours Worked	Hours Overtime	Pay Rate	Amount Earned
Janice Jones	40	0	5.25	210.00
Chris O'Connel	35	0	5.35	187.25
Karen Fisk	45	5	6.00	285.00
Tom Winn	42	2	5.75	247.25
Totals	162	7		929.50

Note: Unless you include an *Open File* dialog, copy the file created in the bin\Debug folder for the first folder into the bin\Debug folder for the second folder.

Optional Extra: Allow the user to select the file to open using the *Open File* dialog box.

11.3 Modify Programming Exercise 7.6 to store the list box for Bradley's Bagels in a data file. Load the list during the Form_Load event procedure and then close the file. Be sure to use error checking in case the file does not exist.

In the FormClosing procedure, prompt the user to save the bagel list back to the disk.

Note: For help in basing a new project on an existing project, see "Basing a New Project on an Existing Project" in Chapter 5.

Optional Extra: Allow the user to select the file to open using the *Open File* dialog box.

11.4 Create a simple text editor that has one large text box (with its Multiline property set to True) or a RichTextBox control. Set the text control to fill the form and set its Anchor property to all four edges, so that the control fills the form even when it is resized.

Allow the user to save the contents of the text box in a data file and load a data file into the text box using the *Open File* dialog box.

Use a StreamWriter and StreamReader or *My.Computer.FileSystem.WriteAllText* and *My.Computer.FileSystem.ReadAllText*.

Hint: You will need to save multiple lines.

11.5 Create a project that stores personal information for a little electronic "black book." The fields in the file should include name, phone number, pager number, cell phone number, voice mail number, and e-mail address. Allow the user to enter the data into text boxes.

Create a second project to load the names into a list box. Perform a "look up" and display the appropriate information for the selected name.

Note: Unless you include an *Open File* dialog, copy the file created in the bin\Debug folder for the first folder into the bin\Debug folder for the second folder.

Optional Extra: Allow the user to select the file to open using the *Open File* dialog box.

Case Studies

Note: For help in basing a new project on an existing project, see "Basing a New Project on an Existing Project" in Chapter 5.

VB Mail Order

Modify your project from Chapter 7 to save the changes to the catalog name combo box from one run to the next. When the program begins, load the list from the data file. If the file does not exist, display a message asking if the user wants to create it.

Allow the user to save changes from a *Save* menu item. When the program terminates, check to see if there are any unsaved changes. If so, prompt the user to save the changes.

Optional extra: Allow the user to select the file to open using the *Open File* dialog box.

VB Auto Center

Write a project to store vehicle information including model, manufacturer, year, and VIN number.

Create a second project that loads the data from the file into memory and loads a drop-down combo box with the VIN numbers. When a number is selected from the combo box, display the appropriate information regarding the vehicle in labels.

Note: Unless you include an *Open File* dialog, copy the file created in the bin\Debug folder for the first folder into the bin\Debug folder for the second folder.

Optional extra: Allow the user to select the file to open using the *Open File* dialog box.

Video Bonanza

Modify your project from Chapter 7 to save the changes to the movie combo box from one run to the next. When the program begins, load the list from the data file. If the file does not exist, display a message asking if the user wants to create it.

Allow the user to save changes from a *Save* menu item. When the program terminates, check to see if there are any unsaved changes. If so, prompt the user to save the changes.

Optional extra: Allow the user to select the file to open using the *Open File* dialog box.

Very Very Boards

Modify your project from Chapter 7 to save the changes to the shirt style combo box from one run to the next. When the program begins, load the list from the data file. If the file does not exist, display a message asking if the user wants to create it.

Allow the user to save changes from a *Save* menu item. When the program terminates, check to see if there are any unsaved changes. If so, prompt the user to save the changes.

Optional extra: Allow the user to select the file to open using the *Open File* dialog box.

CHAPTER

12

OOP: Creating Object-Oriented Programs

at the completion of this chapter, you will be able to . . .

1. Use object-oriented terminology correctly.
2. Create a two-tier application that separates the user interface from the business logic.
3. Differentiate between a class and an object.
4. Create a class that has properties and methods.
5. Declare object variables and use property procedures to set and retrieve properties of a class.
6. Assign values to the properties with a constructor.
7. Instantiate an object in a project using your class.
8. Differentiate between shared members and instance members.
9. Understand the purpose of the constructor and destructor methods.
10. Inherit a new class from your own class.
11. Use visual inheritance by deriving a form from another form.

Object-Oriented Programming

You have been using objects since Chapter 1. As you know quite well by now, **objects** have properties and methods and generate events that you can respond to (or ignore) if you choose. Up until now, the classes for all objects in your projects have been predefined; that is, you could choose to create a new object of the form class, a button class, a text box class, or any other class of control in the toolbox. In this chapter you will learn to define your own new class and create objects based on that class.

Object-oriented programming (OOP) is currently the most accepted style of programming. Some computer languages, such as Java, C#, and SmallTalk, were designed to be object oriented (OO) from their inception. Other languages, such as Visual Basic, have been modified over recent years to accommodate OOP. Visual Basic .NET was the first version of Visual Basic to be truly object oriented.

Writing object-oriented programs is a mind-set—a different way of looking at a problem and requires an understanding of Object Oriented Design. You must think in terms of using objects. As your projects become more complex, using objects becomes increasingly important.

Objects

Beyond the many built-in choices you have for objects to include in your projects, Visual Basic allows you to create your own new object type by creating a **class**. Just like other object types, your class may have both properties and methods. Your class can have events too, just like the Click event for the Button class. So remember: Properties are characteristics, and methods are actions that can be performed by a class of objects.

An object is a *thing* such as a button. You create a button object from the button tool in the toolbox. In other words, *button* is a class but *ExitButton* is an actual occurrence or **instance** of the class; the instance is the object. Just as you may have multiple buttons in a project, you may have many objects of a new class type.

Defining your own class is like creating a new tool for the toolbox; the process does not create the object, only a definition of what that type of object looks like and how it behaves. You may then create as many instances of the class as you need using the `New` keyword. Your class may be a student, an employee, a product, or any other type of object that would be useful in a project.

Many people use a cookie analogy to describe the relationship of a class and an object. The cookie cutter is the class. You can't eat a cookie cutter, but you can use it to make cookies; the cookie is the object. When you make a cookie using a cookie cutter, you **instantiate** an object of the cookie class. You can use the same cookie cutter to make various kinds of cookies. Although all the cookies made will have the same shape, some may be chocolate, others are lemon, or vanilla; some may be frosted or have colored sprinkles on top. The characteristics of the cookie, such as flavor and topping, are the properties of the object. You could refer to the properties of your cookie object as

```
Cookie1.Flavor = "Lemon"
Cookie1.Topping = "Cream Frosting"
```

What about methods? Recall that a method is an action or behavior—something the object can do or have done to it, such as Move, Clear, or Print. Possible methods for our cookie object might be Eat, Bake, or Crumble. Using object terminology, you can refer to Object.Method:

```
Cookie1.Crumble
```

Sometimes the distinction between a method and an event is somewhat fuzzy. Generally, anything you tell the object to do is a method; if the object does an action and needs to inform you, that's an event. So if you tell the cookie to crumble, that is a method; if the cookie crumbles on its own and needs to inform you of the fact, that's an event.

Object-Oriented Terminology

Key features of an object-oriented language are encapsulation, inheritance, and polymorphism.

Encapsulation

Encapsulation refers to the combination of characteristics of an object along with its behaviors. You have one "package" that holds the definition of all properties, methods, and events. For example, when you create a button, you can set or retrieve its properties, such as Text, Name, or BackColor. You can execute its methods, such as `Focus`, `Hide`, or `Show`, and you can write code for its events, such as Click or Double-click. But you cannot make up new properties or tell it to do anything that it doesn't already know how to do. It is a complete package; you can think of all of the parts of the package as being in a capsule.

You can witness encapsulation by looking at any program. The form is actually a class. All of the methods and events that you code are enclosed within the `Class` and `End Class` statements. The variables that you place in your code are actually properties of the specific form class that you are generating.

When you understand and use encapsulation successfully, you can implement *data hiding*. Each object can keep its data (properties) and procedures (methods) hidden. Through use of the `Public`, `Private`, `Protected`, and `Friend` keywords, an object can "expose" only those data elements and procedures that it wishes to allow the outside world to see.

Inheritance

Inheritance is the ability to create a new class from an existing class. You can add enhancements to an existing class without modifying the original. By creating a new class that inherits from an existing class, you can add or modify class variables and methods. For example, each of the forms that you create is inherited from, or derived from, the existing Form class. The original class is known as the **base class**, **superclass**, or **parent class**. The inherited class is called a **subclass**, **derived class**, or **child class**. Of course, a new class can inherit from a subclass—that subclass becomes a superclass as well as a subclass.

Look closely at the first lines of the *FormName*.Designer.vb code file for a form:

```
Partial Public Class Form1
  Inherits System.Windows.Forms.Form
```

The base class is System.Windows.Forms.Form, and Form1 is the derived class. Inherited classes have an "is a" relationship with the base class. In the form example, the new Form1 "is a" Form.

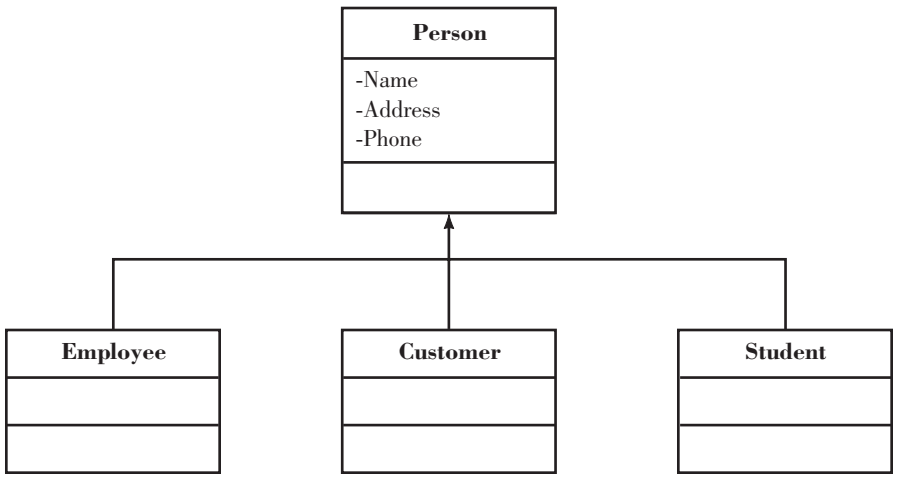
The real purpose of inheritance is **reusability**. You may need to reuse or obtain the functionality from one class or object when you have another similar situation. The new Form1 class that you create has all of the characteristics and actions of the base class, System.Windows.Forms.Form. From there you can add the functionality for your own new form. Other classes that you have reused multiple times are the Button class and the TextBox class.

You can create your own hierarchy of classes. You place the code you want to be common in a base class. You then create other classes from it, which inherit the base class methods. This concept is very helpful if you have features that are similar in two classes. Rather than writing two classes that are almost identical, you can create a base class that contains the similar procedures.

An example of reusing classes could be a Person class, where you might have properties for name, address, and phone number. The Person class can be a base class from which you derive an Employee class, a Customer class, or a Student class (Figure 12.1). The derived classes could call shared procedures from the base class and contain any procedures that are unique to the derived class. In inheritance, typically the classes go from general to the more specific.

Figure 12.1

The derived classes inherit from the base class.



Polymorphism

The term ***polymorphism*** actually means the ability to take on many shapes or forms. As applied to OOP, polymorphism refers to methods that have identical names but different implementations, depending on the situation. For example, radio buttons, check boxes, and list boxes all have a `Select` method. In each case, the `Select` method operates appropriately for its class.

Polymorphism also allows a single class to have more than one method with the same name. When the method is called, the argument type determines which version of the method to use. Each of the identically named methods should perform the same task in a slightly different manner, depending on the arguments.

Later in this chapter you will use both **overloading** a method and **overriding** a method to implement polymorphism. You have already seen examples

of *overloading*, such as the `MessageBox.Show` method that gives you several argument lists for calling the method. *Overriding* refers to a method that has the same signature (name and parameter list) as a method in its base class. The method in the subclass, or derived class, takes precedence over, or overrides, the identically named method in the base class.

Reusable Classes

A big advantage of object-oriented programming over traditional programming is the ability to reuse classes. When you create a new class, you can then use that class in multiple projects. Each object that you create from the class has its own set of properties. This process works just like the built-in VB controls you have been using all along. For example, you can create two PictureBox objects: PictureBox1 and PictureBox2. Each has its own Visible property and Image property, which will probably be set differently from each other.

As you begin creating classes in your projects, you will find many situations in which classes are useful. You might want to create your own class to provide database access. You could include methods for adding and deleting data members. If you work frequently with sales, you might create a Product class. The Product class would likely have properties such as description, quantity, and cost. The methods would probably include finding the current value of the product.

Multitier Applications

A common practice for writing professional applications is to write independent components that work in multiple "tiers" or layers. Each of the functions of a **multitier application** can be coded in a separate component, and the components may be stored and run on different machines.

One of the most popular approaches is a three-tier application. The tiers in this model are the Presentation tier, Business tier, and Data tier (Figure 12.2). You also hear the term "n-tier" application, which is an expansion of the three-tier model. The middle tier, which contains all of the business logic, may be written in multiple classes that can be stored and run from multiple locations.

Presentation Tier	Business Tier	Data Tier
User Interface Forms, controls, menus	**Business Objects** Validation Calculations Business logic Business rules	**Data Retrieval** Data storage

Figure 12.2

The three-tier model for application design.

In a multitier application, the goal is to create components that can be combined and replaced. If one part of an application needs to change, such as a redesign of the user interface or a new database format, the other components do not need to be replaced. A developer can simply "plug in" a new user interface and continue using the rest of the components of the application.

The Presentation tier refers to the user interface, which in VB is the form. Consider that in the future the user interface could be redesigned or even converted to a Web page.

The Business tier is a class or classes that handle the data. This layer can include validation to enforce business rules as well as the calculations.

The Data tier includes retrieving and storing the data in a database. Occasionally an organization will decide to change database vendors or will need to retrieve data from several different sources. The Data tier retrieves the data and passes the results to the Business tier, or takes data from the Business tier and writes them in the appropriate location.

Classes

The classes that you have worked with up until now have generated visual objects such as text boxes and labels. These were easily created from the toolbox at design time. You also can create objects at run time. In Chapter 11 you instantiated objects of the StreamWriter and StreamReader classes, and in Chapter 7 you instantiated objects of the Font class in your printing routines. In both cases you used the `New` keyword to instantiate the objects.

TIP

Before you can refer to most properties and methods of a class, you must instantiate an object of the class. The exception is shared members, which you will see later in this chapter. ■

Designing Your Own Class

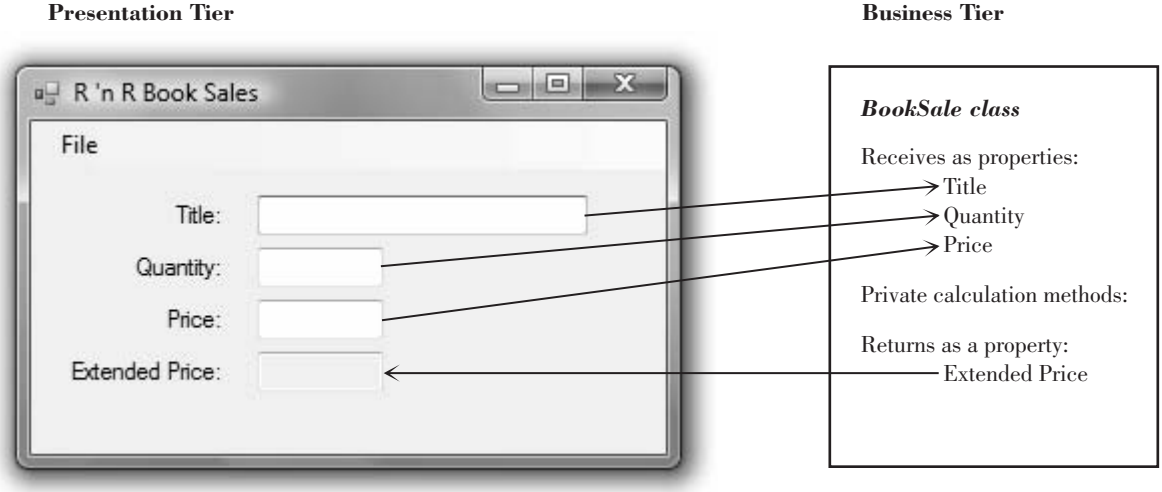
To design your own class, you need to analyze the characteristics and behaviors that your object needs. The characteristics or properties are defined as variables, and the behaviors (methods) are sub procedures or function procedures.

For a simple example, assume that you have a user interface (form) that gathers the unit price and the quantity of a product. You can design a class to perform the calculations. For the class to calculate the extended price, it must know the unit price and the quantity. The form needs to retrieve the extended price. The price, quantity, and extended price are stored in private variables in the class; those variables are accessed through property procedures.

The form will instantiate the class, pass the price and quantity to it through property procedures, call a method to calculate the extended price, and then display the extended price on the form by retrieving it from a property procedure (Figure 12.3).

Figure 12.3

A Presentation tier and a Business tier. The data are entered and displayed in the Presentation tier; calculations are performed in the Business tier. Pass in the Title, Quantity, and Unit Price, and then you can retrieve the Extended Price.



Creating Properties in a Class

Inside your class you define private member variables, which store the values for the properties of the class. Theoretically, you could declare all variables as `Public` so that all other project code could set and retrieve their values. However, this approach violates the rules of encapsulation that require each object to be in charge of its own data. Remember that encapsulation can be used for *data hiding*. To accomplish data hiding, you will declare all variables in a class as `Private` or `Protected`. Protected variables behave as private but are available in any class that inherits from this class. As a private or protected variable, the value is available only to procedures within the class, the same way that private module-level variables are available only to procedures within a form's class code.

When your program creates objects from your class, you will need to assign values to the properties. Because the properties are private variables, you will use special property procedures to pass the values to the fields in an instance of the class and to return field values from the instance.

Property Procedures

The way that your class allows its properties to be accessed is with **accessor methods** in a **property procedure**. The procedure may contain a `Get` accessor method to retrieve a property value and/or a `Set` accessor method to assign a value to the property. The name that you use for the `Property` procedure becomes the name of the property to the outside world. Create "friendly" property names that describe the property, such as LastName or EmployeeNumber. You do not include the data type as part of a property name.

The Property Procedure—General Form

General Form

```
{Private | Protected} ClassVariable As DataType

[Public] Property PropertyName() As DataType
     Get
          Return ClassVariable [| PropertyName = ClassVariable ]
     End Get
     Set(ByVal value As DataType)
          [statements, such as validation]
          ClassVariable = value
     End Set
End Property
```

The `Set` statement uses the **`value` keyword** to refer to the incoming value for the property. Property procedures are public by default, so you can omit the optional `Public` keyword. `Get` blocks are similar to function procedures in at least one respect: Somewhere inside the procedure, before the `End Get`, you must assign a return value to the procedure name or use a `Return` statement to return a value. The data type of the incoming value for a `Set` must match the type of the return value of the corresponding `Get`.

The Property Procedure—Example

Example

```
Private LastNameString As String

Property LastName() As String
     Get
          Return LastNameString
     End Get
     Set(ByVal value As String)
          LastNameString = value
     End Set
End Property
```

Remember, the private module-level variable holds the value of the property. The `Property` `Get` and `Set` retrieve the current value and assign a new value to the property.

Note: If you do not specify an access modifier, the default is `Public`.

Read-Only Properties

In some instances, you may wish to have a property that can be retrieved by an object but not changed. You can write a property procedure to create a read-only property: Use the **`ReadOnly`** modifier and write only the `Get` portion of the property procedure.

```
' Define the property at the module level.
Private TotalPayDecimal As Decimal

' The property procedure for a read-only property.
ReadOnly Property TotalPay() As Decimal
    Get
         Return TotalPayDecimal
    End Get
End Property
```

Write-Only Properties

At times you may need to have a property that can be assigned by an object but not retrieved. You can create a property block that contains only a `Set` to create a write-only property.

```
' Private module-level variable to hold the property value.
Private PriceDecimal As Decimal

Public WriteOnly Property Price() As Decimal
    Set(ByVal value As Decimal)
      If value >= 0 Then
           PriceDecimal = value
      End If
    End Set
End Property
```

Class Methods

You create methods of the new class by coding public methods within the class. Any methods that you declare with the `Private` keyword are available only

within the class. Any methods that you declare with the `Public` keyword are available to external objects created from this class or other classes.

```
' Private method used for internal calculations.

Private Sub CalculateExtendedPrice()
    ' Calculate the extended price.

    ExtendedPriceDecimal = QuantityInteger * PriceDecimal
End Sub
```

Constructors and Destructors

A **constructor** is a method that executes automatically when an object is instantiated. A **destructor** is a method that executes automatically when an object is destroyed. In VB, the name of a constructor method is `New`.

Constructors

The constructor executes automatically when you instantiate an object of the class. Because the constructor method executes before any other code in the class, the constructor is an ideal location for any initialization tasks that you need to do, such as setting the initial values of variables and properties.

The constructor must be public or protected because the objects that you create must execute this method.

Note: If a class does not contain a constructor, the compiler creates an implicit method called the *default constructor*. The default constructor has an empty argument list.

Overloading the Constructor

Recall from Chapter 3 that *overloading* means that two methods have the same name but a different list of arguments (the signature). You can create overloaded methods in your class by giving the same name to multiple procedures, each with a different argument list. The following example shows an empty constructor (one without arguments) and a constructor that passes arguments to the class.

```
Sub New()

  ' Empty constructor.

End Sub


Sub New(ByVal Title As String, ByVal Quantity As Integer, _
  ByVal Price As Decimal)

      ' Code statements to assign property values.

End Sub
```

Parameterized Constructor

The term ***parameterized constructor*** refers to a constructor that requires arguments. This popular technique allows you to pass arguments as you create the new object.

```
' Instantiate the object and set the properties.
TheBookSale = New BookSale(TitleTextBox.Text, _
  Integer.Parse(QuantityTextBox.Text), _
  Decimal.Parse(PriceTextBox.Text))
```

Within the class code, assign the values passed as arguments to the class constructor to the properties of the class. This technique is preferable to just assigning the passed argument to the class-level property variables, since validation is often performed in the `Set` methods.

```
Sub New(ByVal TitleIn As String, ByVal QuantityIn As Integer, _
  ByVal PriceIn As Decimal)
    ' Assign property values.

    Title = TitleIn
    Quantity = QuantityIn
    Price = PriceIn
    CalculateExtendedPrice()
End Sub
```

Creating a New Class—Step-by-Step

In this step-by-step exercise, you will create a new class to hold book sale information for R 'n R.

Begin the Project

A class file is part of a Visual Basic project, so the first step is to create a new project.

STEP 1: Create a new Windows project called "Ch12SBS" (for *step-by-step*).

Begin a New Class

STEP 1: Select *Add Class* from the *Project* menu. The *Add New Item* dialog box will appear (Figure 12.4) with the Class template already selected.

STEP 2: In the *Add New Item* dialog box, type "BookSale.vb" for the class name and click on *Add*. You will see a new tab in the Document window for the new class.

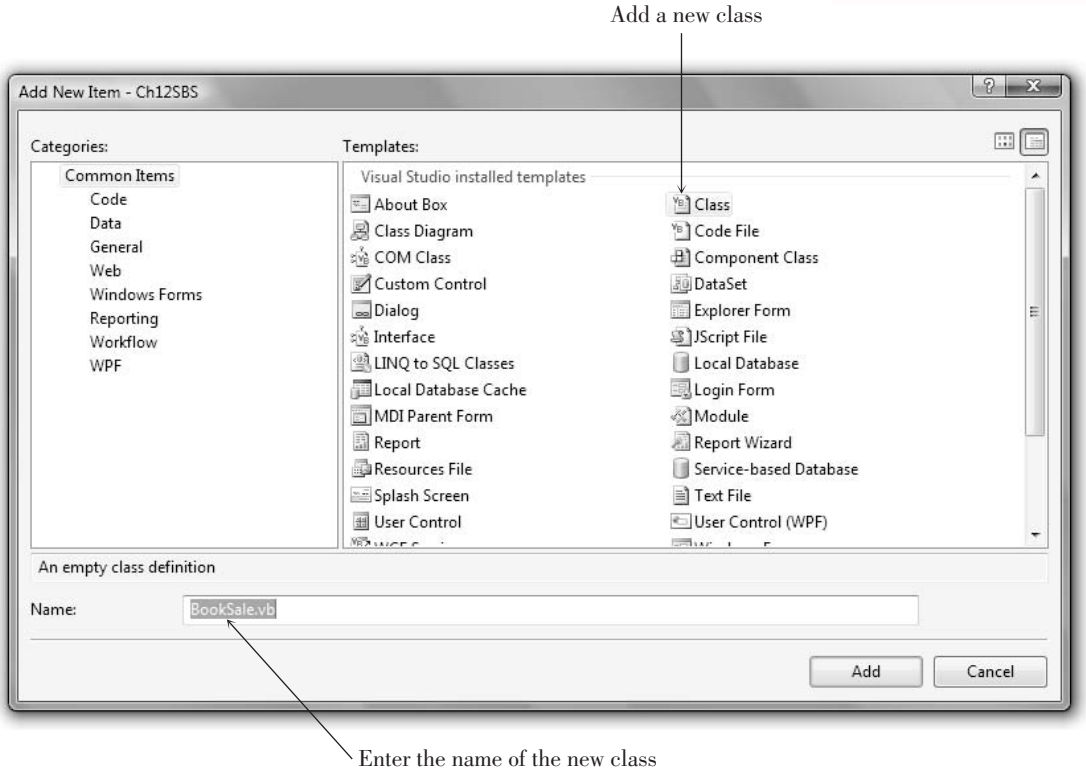
Define the Class Properties

STEP 1: In the Code Editor window, in the line after the `Class` statement, declare the `Private` variables. These module-level variables will hold the values for the properties of your new class.

```
    Private TitleString As String
    Private QuantityInteger As Integer
    Private PriceDecimal, ExtendedPriceDecimal As Decimal
```

Figure 12.4

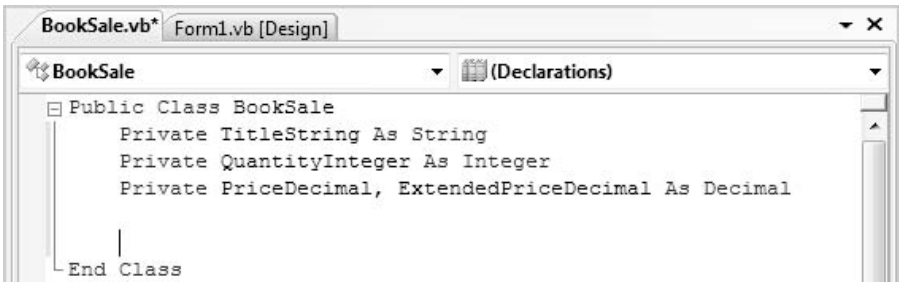
Add a new class to a project in the Add New Item dialog box.



This class has private module-level variables: TitleString, QuantityInteger, PriceDecimal, and ExtendedPriceDecimal (Figure 12.5). Because the variables are declared as `Private`, they can be accessed only by procedures within the class module. To allow access from outside the class module, you must add property procedures.

Figure 12.5

Declare module-level variables for the class properties.



Add the Title Property Procedure

STEP 1: In the Code Editor window, after the property declarations, type "Property Title As String". Press Enter.

The `Get` and `Set` blocks will appear, as well as the parentheses on the property name.

Note: The smart editor takes care of the capitalization of keywords. However, the new property name that you declare will be capitalized

TIP

Follow variable naming conventions for the module-level variable to hold the property value; use a friendly name for the property name in the Property procedure. ■

exactly as you enter it. You can save a little time by typing the line "property Title as string".

STEP 2: Write the code for the Property procedures.

```
Property Title() As String
    Get
        Return TitleString
    End Get
    Set(ByVal value As String)
        TitleString = value
    End Set
End Property
```

Add the Quantity Property Procedure

STEP 1: On a new line after the `End Property` for Title, type "Property Quantity As Integer" and press Enter.
The `Get` and `Set` blocks will appear.

STEP 2: Write the code for the Property procedure.

```
Property Quantity() As Integer
    Get
        Return QuantityInteger
    End Get
    Set(ByVal value As Integer)
        If value >= 0 Then
            QuantityInteger = value
        End If
    End Set
End Property
```

Notice the code to validate the incoming `value` in the `Set`.

Add the Price Property Procedure

STEP 1: After the `End Property` for Quantity, add the property procedure for Price.

STEP 2: Write the code.

```
Property Price() As Decimal
    Get
        Return PriceDecimal
    End Get
    Set(ByVal value As Decimal)
        If value >= 0 Then
            PriceDecimal = value
        End If
    End Set
End Property
```

Add the ExtendedPrice Property Procedure

STEP 1: After the `End Property` for Price, add the property procedure for ExtendedPrice.

STEP 2: Write the code.

```
Property ExtendedPrice() As Decimal
     Get
          Return ExtendedPriceDecimal
     End Get
     Set(ByVal value As Decimal)
          If value >= 0 Then
               ExtendedPriceDecimal = value
          End If
     End Set
End Property
```

Write the Constructor

STEP 1: Following the Private module-level variables and above the property procedures, type in "Public Sub New(TitleIn As String, QuantityIn As Integer, PriceIn As Decimal)" and press Enter.

Notice that the editor adds the `ByVal` before each argument.

The constructor can actually appear anywhere in the code, as long as it's inside the class and not inside another procedure. A good convention is to place the constructors near the top of the class, right after the module-level declarations.

STEP 2: Type the code for the procedure.

```
Public Sub New(ByVal TitleIn As String, ByVal QuantityIn As Integer, _
  ByVal PriceIn As Decimal)
     ' Assign the property values.

     Title = TitleIn
     Quantity = QuantityIn
     Price = PriceIn
     CalculateExtendedPrice()
End Sub
```

The call to `CalculateExtendedPrice` is flagged as an error. You will code that procedure next.

Code a Method

You can create methods by adding sub procedures and functions for the behaviors needed by the class. For this class, you will add a sub procedure to calculate the extended price, which is the price per book multiplied by the quantity. Note that if you declare sub procedures and functions with the `Public` keyword, the methods are public; if you use the `Protected` keyword, the methods can be executed from the current class or any inherited classes; if you use the `Private` keyword, the methods are private and can be executed only from inside the class.

STEP 1: After the property procedures, type
"Protected Sub CalculateExtendedPrice" and press Enter.
Notice that the editor adds the parentheses after the procedure name.

STEP 2: Type the code for the procedure.

```
Protected Sub CalculateExtendedPrice()
     ' Calculate the extended price.

     ExtendedPriceDecimal = QuantityInteger * PriceDecimal
End Sub
```

Add General Remarks

STEP 1: Type the remarks at the top of the file, before the Class declaration line.

```
'Class Name:        BookSale
'Programmer:        Your Name
'Date:              Today's Date
'Description:       Handle book sale information.
'Folder:            Ch12SBS
```

STEP 2: Save your project.

The Complete Class Code

```
'Class Name:      BookSale
'Programmer:      Your Name
'Date:            Today's Date
'Description:     Handle book sale information.
'Folder:          Ch12SBS

Public Class BookSale
    Private TitleString As String
    Private QuantityInteger As Integer
    Private PriceDecimal, ExtendedPriceDecimal As Decimal

    Public Sub New(ByVal TitleIn As String, ByVal QuantityIn As Integer, _
      ByVal PriceIn As Decimal)
        ' Assign the property values.

        ' Assign the input parameters to the properties by using their
        ' property procedures.
        Title = TitleIn
        Quantity = QuantityIn
        Price = PriceIn
        CalculateExtendedPrice()
    End Sub

    Property Title() As String
        Get
            Return TitleString
        End Get
        Set(ByVal Value As String)
            TitleString = Value
        End Set
    End Property

    Property Quantity() As Integer
        Get
            Return QuantityInteger
        End Get
        Set(ByVal Value As Integer)
            If Value >= 0 Then
                QuantityInteger = Value
            End If
        End Set
    End Property

    Property Price() As Decimal
        Get
            Return PriceDecimal
        End Get
```

```
        Set(ByVal Value As Decimal)
            If Value >= 0 Then
                PriceDecimal = Value
            End If
        End Set
    End Property

    Property ExtendedPrice() As Decimal
        Get
            Return ExtendedPriceDecimal
        End Get
        Set(ByVal Value As Decimal)
            If Value >= 0 Then
                ExtendedPriceDecimal = Value
            End If
        End Set
    End Property

    Protected Sub CalculateExtendedPrice()
        ' Calculate the extended price.

        ExtendedPriceDecimal = QuantityInteger * PriceDecimal
    End Sub

End Class
```

Property Procedures with Mixed Access Levels

It is possible to set the `Property` statement as `Public` and then to assign either the `Get` or the `Set` procedure to a more restrictive level such as `Friend` or `Private`. This mixed-level access was a welcome addition to VB 2005.

```
Private TitleString As String

Public Property Title() As String
    Get
        Return TitleString
    End Get
    Private Set(ByVal value As String)
        TitleString = value
    End Set
End Property
```

This code allows public access to the `Get` procedure, but the `Set` procedure is private. This would work well with our programs where we call the `Set` only from the constructor. Remember, if you do not specify the access, it defaults to `Public`.

Feedback 12.1

1. What is the difference between an object and a class?
2. Given the statement

```
Private TheProduct As Product
```

   Is TheProduct an object or class? What about Product?
3. What actions are performed by the following statement?

```
TheProduct.Quantity = Integer.Parse(QuantityTextBox.Text)
```

4. Write the property declarations for a class module for a Student class that will contain the properties LastName, FirstName, StudentIDNumber, and GPA. Where will these statements appear?
5. Code the Property procedure to set and retrieve the value of the LastName property.
6. Code the Property procedure to retrieve the value of the read-only GPA property.

Creating a New Object Using a Class

Creating a new class defines a new type; it does not create any objects. This is similar to creating a new tool for the toolbox but not yet creating an instance of the class.

Generally you will create new objects of your class in a two-step operation: first declare a variable for the new object and then instantiate the object using the `New` keyword. Use `Dim`, `Public`, or `Private` to declare the identifier that refers to the object of the class.

```
Private TheBookSale As BookSale
```

This line merely states that the name TheBookSale is associated with the BookSale class, but it does not create an instance of the object. You must use the `New` keyword to actually create the object.

```
TheBookSale = New BookSale()
```

In Visual Basic it is legal to declare and instantiate an object at the same time:

```
Dim TheBookSale As New BookSale()
```

If you will need to use the object variable in multiple procedures, you should declare the object at the module level. But when you instantiate an object, you may need to include the `New` statement in a `Try/Catch` block to allow error checking, and a `Try/Catch` block *must* be inside a procedure. Make sure to enclose the instantiation in a `Try/Catch` block if you are converting and passing values that a user enters in a text box so that you catch any bad input data.

The preferred technique is to include the `New` statement inside of a procedure at the time the object is needed. And if the object is never needed, it won't be created needlessly.

If you *do* choose to declare the variable and instantiate it at the same time, these two statements are equivalent:

```
Private TheBookSale As BookSale = New BookSale()
Private TheBookSale as New BookSale()
```

The second statement is a coding shortcut for the first (more complete) statement.

If you are using a parameterized constructor, you must pass the values for the arguments when you instantiate the object.

```
Private TheBookSale As BookSale

' Instantiate the BookSale object and set the properties.
TheBookSale = New BookSale(TitleTextBox.Text, _
  Integer.Parse(QuantityTextBox.Text), _
  Decimal.Parse(PriceTextBox.Text))
```

Defining and Using a New Object—Step-by-Step

To continue the step-by-step tutorial for the BookSale class, the next step is to design the form for the user interface. The form has text boxes for the user to enter the title, quantity, and price; a menu choice to calculate the sale (the extended price); and another menu item to exit.

In the Calculate Sale event procedure, you will create an instance of the BookSale class and assign the input values for title, quantity, and price to the properties of the BookSale object. The ExtendedPrice property in the BookSale class retrieves the amount of the sale, which appears in a ReadOnly text box on the form. Figure 12.6 shows the completed form.

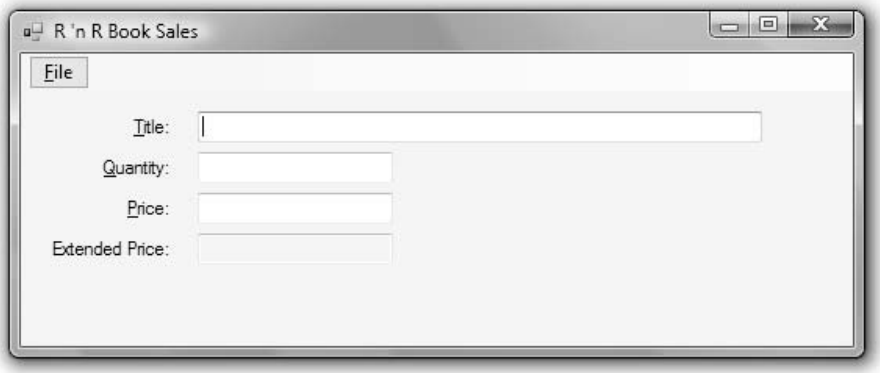


Figure 12.6

The user interface that uses the new BookSale class; the completed form for the step-by-step exercise.

Placing all calculations in a separate class is a good thing. You are seeing your first example of dividing a program into a Presentation tier and a Business tier.

Create the Form

This is a continuation of the step-by-step tutorial for this chapter. If the project is not still open, open it now.

STEP 1: Open the Form Designer for Form1. Referring to Figure 12.6, create the user interface with text boxes for the title, quantity, and price, and a ReadOnly text box for the extended price. Set appropriate properties for the form and the controls.

STEP 2: Change the form name to "SalesForm".

STEP 3: Create menu items on the *File* menu for *Calculate Sale*, *Clear*, and *Exit*. You may want to create keyboard shortcuts for the menu items to simplify testing.

Add General Remarks

STEP 1: Type the remarks at the top of the form's code.

```
'Program:      Chapter 12 BookSale Step-by-Step
'Programmer:   Your Name
'Date:         Today's Date
'Description:  Calculate sales price using the BookSale class.
'              Instantiate TheBookSale as a new object of the BookSale class.
'Folder:       Ch12SBS
```

Declare the New Object

STEP 1: Declare the object variable in the Declarations section, right under the `Public Class SalesForm` statement.

```
' Declare the new object.
Private TheBookSale As BookSale
```

Write the Code

STEP 1: In the CalculateSaleToolStripMenuItem_Click event procedure, write the code to instantiate the BookSale object, assign the values to the properties, calculate the extended price, and assign the result to extendedPriceTextBox. Notice that IntelliSense pops up with the properties and method of your new BookSale class.

```
Private Sub CalculateSaleToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles CalculateSaleToolStripMenuItem.Click
    ' Calculate the extended price for the sale.

    Try
        ' Instantiate the object and set the properties.
        TheBookSale = New BookSale(TitleTextBox.Text, _
          Integer.Parse(QuantityTextBox.Text), Decimal.Parse(PriceTextBox.Text))
        ' Calculate and format the result.
        ExtendedPriceTextBox.Text = TheBookSale.ExtendedPrice.ToString("N")
    Catch ex As Exception
        MessageBox.Show("Enter numeric data.", "R 'n R Book Sales", _
          MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
    End Try
End Sub
```

STEP 2: Code the ClearToolStripMenuItem_Click procedure.

```
Private Sub ClearToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles ClearToolStripMenuItem.Click
    ' Clear the screen controls.

    QuantityTextBox.Clear()
    PriceTextBox.Clear()
    ExtendedPriceTextBox.Clear()
    With TitleTextBox
        .Clear()
        .Focus()
    End With
End Sub
```

STEP 3: Code the ExitToolStripMenuItem_Click procedure.

```
Private Sub ExitToolStripMenuItem_Click(ByVal sender As Object, _
  ByVal e As System.EventArgs) Handles ExitToolStripMenuItem.Click
    ' Exit the program.

    Me.Close()
End Sub
```

Save Your Work

STEP 1: Click the *Save All* toolbar button to save the project, class, and form.

Run the Project

The next step is to watch the project run—hopefully without errors.

STEP 1: Run the program; your form should appear.

STEP 2: Fill in test values for the title, quantity, and price. Select the *Calculate Sale* menu item. What did you get for the extended price? Is it correct? Try putting in something other than a number for Quantity. What happened when you calculated the sale?

STEP 3: Stop program execution using the *File / Exit* menu item.

Single-Step the Execution

If you get an error message or an incorrect answer in the output, you will need to debug the project. The quickest and easiest way to debug is to single-step program execution. Single-stepping is an interesting exercise, even if you *did* get the right answer.

To single-step, you need to be in break time. Place a breakpoint on the first line in the CalculateSaleToolStripMenuItem_Click procedure (the `Try` statement). Run the program, enter test values for quantity and price, and select *File / Calculate Sale*. When the program stops at the breakpoint, press the F8 key repeatedly and watch each step; you will see execution transfer to the code for the BookSale class for each property and for the `CalculateExtendedPrice` method. If an error message halts program execution, point to the variable names and property names on the screen to see their current values.

When the Click event procedure finishes, if the form does not reappear, you can click on your project's Taskbar button.

Instance Variables versus Shared Variables

The class properties that you have created up to this point belong to each instance of the class. Therefore, if you create two BookSale objects, each object has its own set of properties. This is exactly what you want for properties such as quantity and price, but what if you need to find a total or count for all of the BookSale objects? You don't want each new object to have its own count property; there would be nothing to increment.

The variables and properties that we have declared thus far are called ***instance variables***, or **instance properties**. A separate memory location exists for each instance of the object. Now we will create **shared variables**, also called ***shared properties***. A shared property is a single variable that exists, or is available, for all objects of a class.

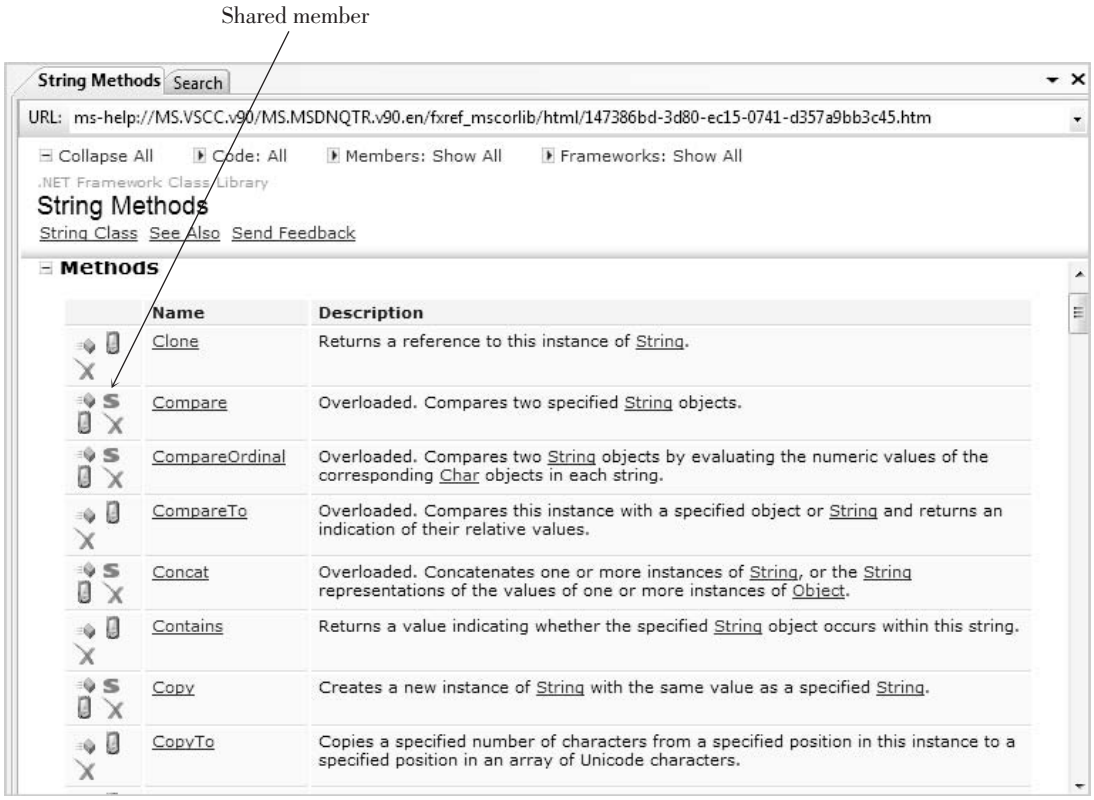
Terminology varies from one OOP language to another. In some languages, shared members are called *class variables* or *static variables*. Microsoft documentation refers to *instance members* and *shared members*, which include both

properties and methods. In general, a shared member has one copy for *all* objects of the class, and an instance member has one copy for *each* instance or object of the class. Methods also can be declared as shared and are considered shared members.

Another important point is that you can access shared members without instantiating an object of the class. When you display class documentation in MSDN Help, shared members display with a yellow *S* next to the name (Figure 12.7). You must reference these shared members with `ClassName.Property` or `ClassName.Method()`, whether or not you have instantiated an object from the class.

Figure 12.7

Shared members display in MSDN Help with a yellow S.



Creating Shared Members

Use the `Shared` keyword to create a shared member.

```
[Public | Protected | Private] Shared VariableName As Datatype
[Public | Protected | Private] Shared Function FunctionName(ArgumentList) As Datatype
```

If we want to accumulate a total of all sales and a count of the number of sales for our BookSale class, we need shared properties:

```
Private Shared SalesTotalDecimal As Decimal
Private Shared SalesCountInteger As Integer
```

You will want to make these shared properties read-only, so that their values can be retrieved but not set directly. The values of the properties are accumulated inside the class; each time a new sale is calculated, the extended price is added to the total sales and the sales count is incremented by one.

```
Shared ReadOnly Property SalesTotal() As Decimal
    Get
        Return SalesTotalDecimal
    End Get
End Property

Shared ReadOnly Property SalesCount() As Integer
    Get
        Return SalesCountInteger
    End Get
End Property
```

Note that the `Shared` keyword on the `Private` module-level variable makes it a shared member and is required; the `Shared` keyword on the property procedure is optional. You need to use it if you plan to retrieve the property without first creating an instance of the class.

Adding Shared Properties to the Step-by-Step Exercise

You will now make the BookSale class calculate the total of all sales and a count of the number of sales. You will need shared properties for the sales total and sales count in the class. Then, on the form, you will add a menu option for *Summary* that displays the totals in a message box.

Add Shared Properties to the Class

If the chapter step-by-step exercise is not still open, open it now.

STEP 1: In the BookSale class, add the private module-level declarations for SalesTotalDecimal and SalesCountInteger.

```
Private Shared SalesTotalDecimal As Decimal
Private Shared SalesCountInteger As Integer
```

STEP 2: Add the property procedures for these two shared read-only properties.

```
Shared ReadOnly Property SalesTotal() As Decimal
    Get
        Return SalesTotalDecimal
    End Get
End Property

Shared ReadOnly Property SalesCount() As Integer
    Get
        Return SalesCountInteger
    End Get
End Property
```

Modify the Code to Calculate the Totals

STEP 1: Add a protected procedure for calculating the totals. This method will be called inside the class (or any classes that inherit from this class) but cannot be called from an object outside the class.

```
Protected Sub AddToTotals()
    ' Add to summary information.

    SalesTotalDecimal += ExtendedPriceDecimal
    SalesCountInteger += 1
End Sub
```

STEP 2: Modify the constructor procedure to call the `AddToTotals` procedure.

```
Public Sub New(ByVal TitleIn As String, ByVal QuantityIn As Integer, _
  ByVal PriceIn As Decimal)
    ' Assign property values.

    Title = TitleIn
    Quantity = QuantityIn
    Price = PriceIn
    CalculateExtendedPrice()
    AddToTotals()
End Sub
```

Modify the Form

STEP 1: Add a menu item for *File / Summary* to the form.

STEP 2: Write the event procedure for SummaryToolStripMenuItem_Click to display the sales total and sales count from the properties of the class. Use a message box and format the sales total to display dollars and cents. Note that you retrieve the shared members of the BookSale class without using an instance of the class: `BookSale.SalesTotal`.

```
Private Sub SummaryToolStripMenuItem_Click(ByVal sender As Object, _
  ByVal e As System.EventArgs) Handles SummaryToolStripMenuItem.Click
    ' Display the sales summary information.
    Dim MessageString As String

    MessageString = "Sales Total: " & BookSale.SalesTotal.ToString("C") & _
      Environment.NewLine & "Sales Count: " & BookSale.SalesCount.ToString()
    MessageBox.Show(MessageString, "R 'n R Book Sales Summary", _
      MessageBoxButtons.OK, MessageBoxIcon.Information)
End Sub
```

STEP 3: Test the program. Try entering several sales and checking the totals. Also try selecting *Summary* without first calculating a sale. If the program throws an exception, it means that you probably left the `Shared` modifier off the property procedures for the two shared properties.

Destructors

If there is special processing that you need to do when an object goes out of scope, you can write a `Finalize` procedure, which is also called a *destructor*. However, Microsoft recommends against writing `Finalize` procedures unless you need to do something special that the system doesn't know how to handle, such as closing some types of database connections.

Garbage Collection

The **garbage collection** feature of the .NET Common Language Runtime cleans up unused components. Periodically the garbage collector checks for unreferenced objects and releases all memory and system resources used by the objects. If you have written a `Finalize` procedure, it executes during garbage collection. Microsoft recommends that you rely on garbage collection to release resources and not try to finalize objects yourself. Using this technique, you don't know exactly when your objects will be finalized, since the CLR performs garbage collection on its own schedule, when it needs to recover the resources or has spare time.

Inheritance

When you create a class, the new class can be based on another class. You can make the new class inherit from one of the existing .NET classes or from one of your own classes. Recall that a form uses inheritance using the statement

```
Partial Public Class Form1
  Inherits System.Windows.Forms.Form
```

The `Inherits` statement must follow the class header prior to any comments.

```
Public Class NewClass
  Inherits BaseClass
```

Inheriting Properties and Methods

All public and protected data members and methods of the base class are inherited in the derived class. If you want the derived class to have a different implementation for a base-class method, you must write the method in the derived class that overrides the base-class method.

In the past you have used the `Public`, `Private`, and `Friend` keywords. You also can declare elements with the **`Protected`** keyword, which specifies that the element is accessible only within its own class or any class derived from that class.

Constructors in Inheritance

Although a derived class can inherit all public and protected methods, there is one exception: A subclass cannot inherit constructors from the base class. Each class must have its own constructors, unless the only constructor needed is an empty constructor. (Visual Basic automatically creates an empty constructor for all classes, so you don't need to write one if that's the only constructor that you need.)

Calling the Base-Class Constructor

Often an inherited class needs to make sure that the constructor for the base class executes as well as the constructor for the inherited class. You can call the base-class constructor with the statement

```
MyBase.New()
```

You generally place this code in the constructor for the inherited class, before any additional statements.

```
Sub New(ByVal TitleIn As String, ByVal QuantityIn As Integer, ByVal PriceIn As Decimal)
  ' Assign property values.

  ' Call the base-class constructor.
  MyBase.New(TitleIn, QuantityIn, PriceIn)
End Sub
```

Overriding Methods

You can create a method with the same name and the same argument list as a method in the base class. The new method is said to override the base-class method. The derived class will use the new method rather than the method in the base class.

To override a method in Visual Basic, you must declare the original method with the `Overridable` keyword and declare the new method with the `Overrides` keyword. The access modifier for the base-class procedure can be `Private` or `Protected` (not `Public`).

Base Class

```
Protected Overridable Sub CalculateExtendedPrice()
```

Inherited Class

```
Protected Overrides Sub CalculateExtendedPrice()
```

In a base class, you can actually use the `Overridable`, `Overrides`, or **`MustOverride`** keyword on a method that can be overridden. Use `Overridable` when you are writing a new method that has code. Use `MustOverride` for an **abstract method**, which is an empty method. Abstract methods are designed to be overridden by subclasses and have no implementation of their own. The only time that you declare a base-class method with the `Overrides` keyword is when the method is overriding a method in *its* base class.

When you use the keyword `Overridable` for a base-class method, in the derived class you have the option of using the base-class implementation for the method or overriding the method by supplying new code. However, if you use the `MustOverride` keyword on a base-class method, the method does not have any code; the derived class *must* provide its own code for the method. A class that has any method declared as `MustOverride` is considered an **abstract class**, which can be used only for inheritance. You cannot instantiate objects from a class that contains abstract methods.

Accessing Properties

Your derived class can set and retrieve the properties of the base class by using the property accessor methods. Usually your derived class needs to make use of properties and methods of the base class. You can call the base class constructor from the derived class constructor, which allows you to use the property values from the base class. In the following example, the derived StudentBookSale class inherits from BookSale. Notice the constructor, which uses the `MyBase.New()` statement to call the constructor of the base class. If the constructor requires arguments, you can pass the argument values when you call the constructor:

```
Sub New(ByVal TitleIn As String, ByVal QuantityIn As Integer, _
  ByVal PriceIn As Decimal)
    ' Assign property values.

    ' Call base-class constructor and pass the property values.
    MyBase.New(TitleIn, QuantityIn, PriceIn)
End Sub
```

After you have assigned values to the properties of the base class, you can refer to the properties in methods in the derived class. In the following example, the `CalculateExtendedPrice` method in the derived class uses properties of the base class by property name.

```
' Procedure in the derived class that overrides the procedure in the base class:
Protected Overrides Sub CalculateExtendedPrice()
    ' Calculate the extended price and add to the totals.

    DiscountDecimal = Quantity * Price * DISCOUNT_RATE_Decimal
    ExtendedPrice = Quantity * Price - DiscountDecimal
    DiscountTotalDecimal += DiscountDecimal
End Sub
```

Note that to use base-class properties in the derived class as in this example, the properties must have both a `Get` and a `Set` accessor method. Read-only or write-only properties cannot be accessed by name from a derived class.

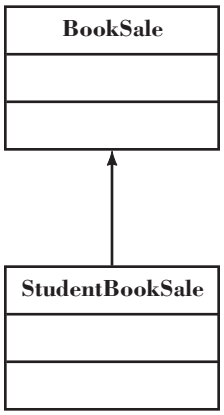
Creating a Derived Class Based on BookSale

The BookSale class could be considered a generic class, which is appropriate for most sales. But now we want another similar class, but with some differences. The new class should have all of the same properties and methods of the BookSale class, but it will calculate sales with a student discount of 15 percent. We also want a new shared property in the new class to hold the total of the student discounts.

Our new derived class will be called StudentBookSale; the base class is BookSale. Figure 12.8 shows the UML diagram to indicate the inherited class. The inherited class automatically has all public and protected properties and methods of the base class; in this case, StudentBookSale automatically has six properties and one method.

Figure 12.8

The diagram for a base class and a derived class.



Adding Inheritance to the Step-by-Step Exercise

This continuation of the chapter step-by-step exercise includes adding a new subclass class, overriding a method, and adding a new property.

Add the New Class

STEP 1: Open your project, if necessary, and select *Add Class* from the *Project* menu.

STEP 2: In the *Add New Item* dialog, with *Class* selected, type "StudentBookSale" for the class name and click on *Add*. You will see a new tab in the Document window for the new class.

STEP 3: Add a new line after the class declaration and type the `Inherits` statement.

```
Public Class StudentBookSale
  Inherits BookSale
```

You can ignore the warning error message; it tells you that this subclass must have a constructor, which you will do in the next step.

All of the public and protected properties and methods of the base class will be inherited by the subclass.

Add the Constructor

STEP 1: The subclass must have its own constructors, since constructors are not inherited. Write the following code inside the new class:

```
Sub New(ByVal TitleIn As String, ByVal QuantityIn As Integer, _
  ByVal PriceIn As Decimal)
    ' Call the base class constructor.

    MyBase.New(TitleIn, QuantityIn, PriceIn)
End Sub
```

Add the New Property

STEP 1: Add a module-level variable to hold the value of a new shared property for the total of discounts.

```
Private Shared DiscountTotalDecimal As Decimal
```

STEP 2: Add the property procedure for `DiscountTotal`.

```
Shared ReadOnly Property DiscountTotal() As Decimal
    Get
        Return DiscountTotalDecimal
    End Get
End Property
```

Add a Constant

STEP 1: Add a constant at the module level to hold the discount rate of 15 percent.

```
Const DISCOUNT_RATE_Decimal As Decimal = 0.15D
```

Override a Method

When you override a method from the base class in an inherited class, the method name and the argument list must match exactly.

STEP 1: Open the BookSale base class in the editor and modify the procedure header for `CalculateExtendedPrice`.

```
Protected Overridable Sub CalculateExtendedPrice()
```

STEP 2: In the StudentBookSale inherited class, write the new `CalculateExtendedPrice` procedure, using the `Overrides` keyword.

```
Protected Overrides Sub CalculateExtendedPrice()
    ' Calculate the discount, extended price, and add to the total.
    Dim DiscountDecimal As Decimal

    DiscountDecimal = Quantity * Price * DISCOUNT_RATE_Decimal
    ExtendedPrice = Quantity * Price – DiscountDecimal
    DiscountTotalDecimal += DiscountDecimal
End Sub
```

Modify the Form to Use the Inherited Class

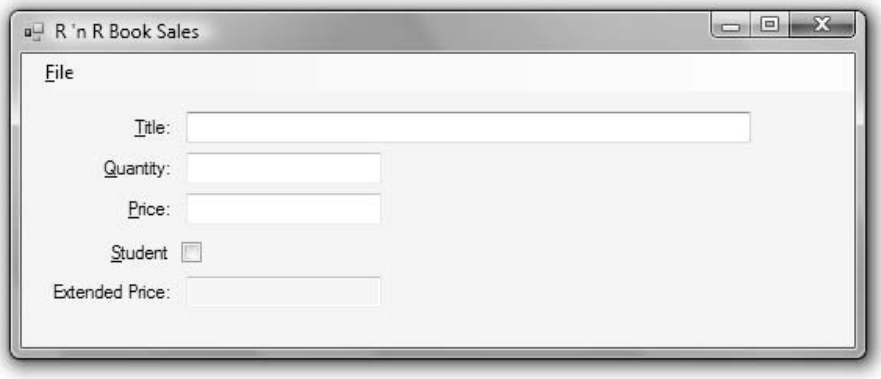
STEP 1: Add a check box to the form, named StudentCheckBox, with the Text set to "Student". You can set the RightToLeft property to Yes, if you want the text to appear to the left of the box (Figure 12.9). Rearrange the controls to keep the input fields together and reset the tab sequence.

STEP 2: In the form's code editor window, add a module-level variable for an object of the new StudentBookSale class.

```
Private TheStudentBookSale As StudentBookSale
```

Figure 12.9

Add a Student check box to the form.



STEP 3: Modify the CalculateSaleToolStripMenuItem_Click event procedure to create the correct object, depending on the state of StudentCheckBox.

```
Try
    If StudentCheckBox.Checked Then
        ' Instantiate the StudentBookSale object and set the properties.
        TheStudentBookSale = New StudentBookSale(TitleTextBox.Text, _
          Integer.Parse(QuantityTextBox.Text), Decimal.Parse(PriceTextBox.Text))
        ' Calculate and format the result.
        ExtendedPriceTextBox.Text = TheStudentBookSale.ExtendedPrice.ToString("N")
    Else
        ' Instantiate the BookSale object and set the properties.
        TheBookSale = New BookSale(TitleTextBox.Text, _
          Integer.Parse(QuantityTextBox.Text), Decimal.Parse(PriceTextBox.Text))
        ' Calculate and format the result.
        ExtendedPriceTextBox.Text = TheBookSale.ExtendedPrice.ToString("N")
    End If
Catch   ' Rest of code for the procedure is unchanged.
```

Notice that the code uses the ExtendedPrice property in either case. But when StudentCheckBox is checked, the ExtendedPrice of the subclass is retrieved; when the check box is not checked, the ExtendedPrice property of the base class is used. Both classes add to the shared SalesTotal and SalesCount properties of the base class, which will hold the totals for both classes.

STEP 4: Modify the SummaryToolStripMenuItem_Click event procedure to include the discount total.

```
        MessageString = "Sales Total: " & BookSale.SalesTotal.ToString("C") & _
          Environment.NewLine & "Sales Count: " & BookSale.SalesCount.ToString() & _
          Environment.NewLine & "Total of Student Discounts: " & _
          StudentBookSale.DiscountTotal.ToString("C")
```

STEP 5: Run the program. Try both student and nonstudent sales; check the totals.

STEP 6: Close the project.

Creating a Base Class Strictly for Inheritance

Sometimes you may want to create a class solely for the purpose of inheritance by two or more similar classes. For example, you might create a Person class that you don't intend to instantiate. Instead you will create subclasses of the Person class, such as Employee, Customer, and Student.

For a base class that you intend to inherit, include the **`MustInherit`** modifier on the class declaration, which creates an abstract class. In each of the methods in the base class that must be overridden, include the `MustOverride` modifier. The method that must be overridden does not contain any code in the base class.

Base Class

```
MustInherit Class BaseClass
     Public MustOverride Sub SomeProcedure()
          ' No code allowed here, specifically, no End Sub statement.
End Class
```

Inherited Class

```
Class DerivedClass
     Inherits BaseClass
     Public Overrides Sub SomeProcedure()
          ' Code goes here.
     End Sub
End Class
```

Note: You must build (compile) the base class before using it for an inherited class.

Inheriting Form Classes

Some projects require that you have several forms. You may want to use a similar design from one form to the next. You can use **visual inheritance** by designing one form and then inheriting any other forms from the first (Figure 12.10).

Once you have designed the form that you want to use for a pattern, you can add more forms that inherit from your design master, called your *base class*. Your base class inherits from System.Windows.Forms.Form, and your new forms inherit from your base class.

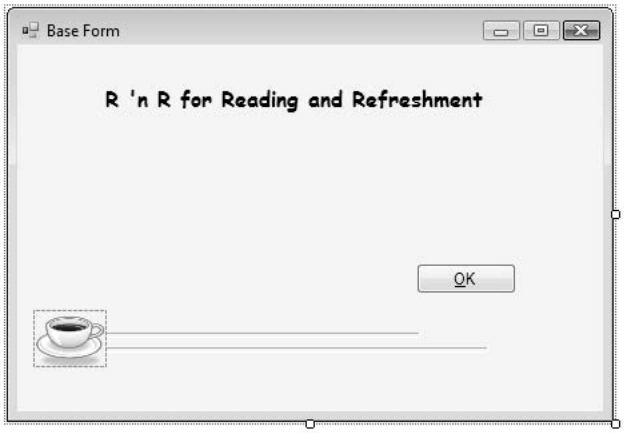
When you design the base class, you can include design elements and other controls, such as labels, text boxes, and buttons. You also can write procedures and declare variables in the base class. Just as you saw earlier, all public and protected procedures and variables are inherited from the base class to the sub class. You can write procedures in the base class and specify `Overridable` or `MustOverride`, and then in the subclass write the identically named procedure with the `Overrides` keyword.

To create an inherited form to your project, first create the base class, save, and build the project. You cannot inherit from a form that has not been compiled. Then you can define the inherited form class in two ways:

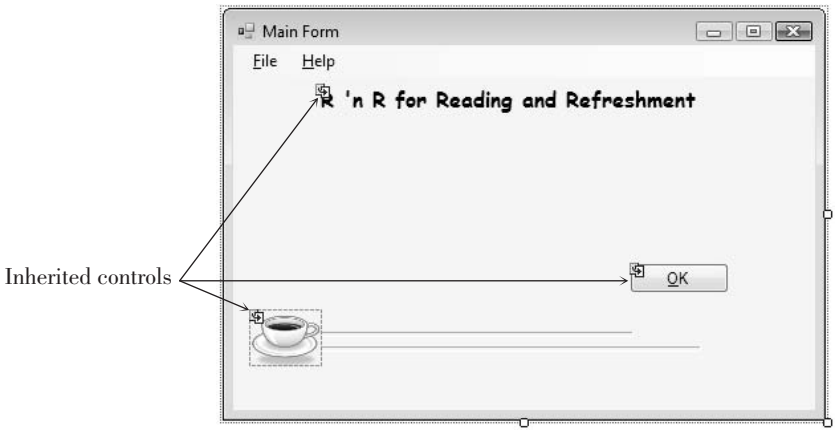
1. Select *Project / Add Windows Form* and type the name of the new Windows Form. In the Solution Explorer, show all files and open the

Figure 12.10

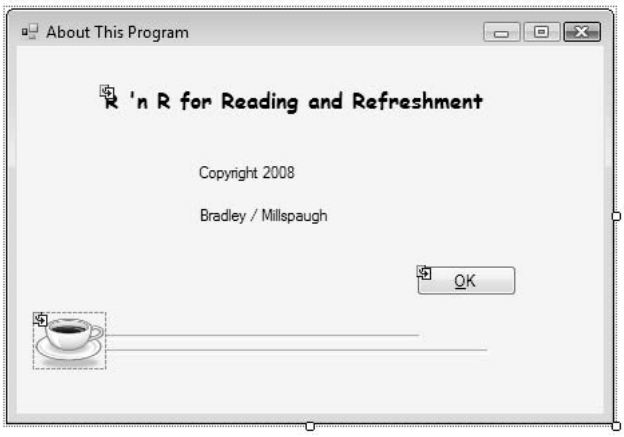
Create a base form and inherit the visual interface to new forms. a. The base form; b., c., and d., inherited forms.



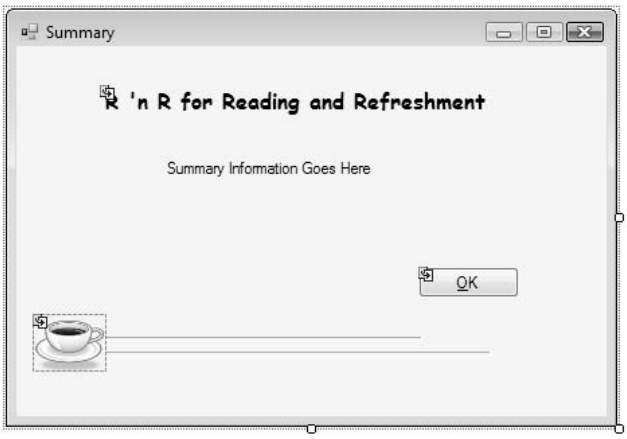
a.



b.



c.



d.

designer-generated code file for the form. For example, if your form is called EntryForm, the Solution Explorer will have two files: EntryForm.vb and EntryForm.Designer.vb. Change the `Inherits` clause to inherit from your base form using your project name as the namespace.

```
Partial Public Class EntryForm
    Inherits Ch12VisualInheritance.BaseForm
```

Open the new form in the designer and you should see the inherited visual elements.

Note: The `Inherits` clause can be in either the FormName.vb or FormName.Designer.vb file, but not both. Since the designer places the `Inherits` clause in the Designer file, it's best to make the change there.

2. Select *Project / Add Windows Form* and select the template for Inherited Form. Note that the Inherited Form template is not available in the Express Edition of VB, so the first technique must be used.

   Type the name of the new form. After naming your form, you are shown a dialog displaying the compiled forms in the project from which to select.

Form Inheritance Example

This example has three forms that inherit from a base class. The base class has an *OK* button, a picture box, and labels. All forms that inherit from the base class will have all of these controls. You cannot delete any of the controls on the inherited forms, but you can make a control invisible. For example, in MainForm, the *OK* button's Visible property is set to False.

The base class has an OkButton_Click event procedure, which can be overridden in the sub classes. Note that the OkButton_Click event procedure must be declared as `Public` or `Protected` to be inherited and overridden in derived classes.

All forms are in the same project, called Ch12VisualInheritance.

Make sure to open the Project Designer (*Project / ProjectName Properties*) and set the startup object to the form that you want to appear first.

BaseForm.Designer.vb

```
Partial Public Class BaseForm
    Inherits System.Windows.Forms.Form
```

BaseForm.vb

```
Public Class BaseForm

    Public Overridable Sub OkButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles OkButton.Click
        ' Allow inherited classes to override this method.

        Me.Close()
    End Sub
End Class
```

AboutForm.Designer.vb

```
Partial Public Class AboutForm
    Inherits Ch12VisualInheritance.BaseForm
```

AboutForm.vb

```
Public Class AboutForm

    ' No code needed; event procedure for OkButton is inherited from the base class.

End Class
```

MainForm.Designer.vb

```
Partial Public Class MainForm
    Inherits Ch12VisualInheritance.BaseForm
```

MainForm.vb

Make sure to set this form as the startup object in the Project Designer (*Project / ProjectName Properties*).

```
Public Class MainForm

    Private Sub MainForm_Load(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles MyBase.Load
        ' Hide the OK button for this form.

        OkButton.Hide()
    End Sub

    Private Sub AboutToolStripMenuItem_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles AboutToolStripMenuItem.Click
        ' Show the About Box.

        AboutForm.ShowDialog()
    End Sub

    Private Sub SummaryToolStripMenuItem_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles SummaryToolStripMenuItem.Click
        ' Show the Summary form.

        SummaryForm.ShowDialog()
    End Sub

    Private Sub ExitToolStripMenuItem_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ExitToolStripMenuItem.Click
        ' Exit the project.

        Me.Close()
    End Sub
End Class
```

SummaryForm.Designer.vb

```
Partial Public Class SummaryForm
    Inherits Ch12VisualInheritance.BaseForm
```

SummaryForm.vb

```
Public Class SummaryForm
    Public Overrides Sub OkButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs)
```

```
        ' Override the base class method.

        Me.Hide()
    End Sub

    Private Sub SummaryForm_Activated(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles Me.Activated
        ' Code to retrieve the summary data and fill the form's controls.

    End Sub
End Class
```

Note: If you have problems with creating inherited forms or want further information, see the MSDN topics "Walkthrough: Demonstrating Visual Inheritance" and "Windows Forms Inheritance".

Coding for Events of an Inherited Class

When you derive a new form class from an existing form, you often want to write code for events of inherited controls. Unfortunately, you can't double-click on an inherited control and have the event procedure open, as you can for most controls. In the previous example of form inheritance, for the OkButton_Click event procedure header, we copied the procedure from the base class into the derived class and made the modifications.

Passing Properties between Forms

In Chapter 6 you learned to pass values among forms by declaring the variables as `Friend`. Now that you can create your own new properties, you can comply with OOP principles and pass data the correct way. For a form's class to be properly encapsulated, the only data values visible to other classes should be the properties it exposes.

As you know, a form is a class, which has properties. You can add properties to any form by writing property procedures that allow other forms to get and/or set values. In that way, each form's variables are `Private`, and any values that you want to pass are properties.

Passing Values to a Summary Form

In this example, based on the hands-on project from Chapter 6, the main form (BillingForm) accumulates totals and displays a summary form. The original form of the project used `Friend` variables in BillingForm so SummaryForm could retrieve the values. In this improved version, BillingForm has ReadOnly properties for the totals, and SummaryForm retrieves the properties in its Form_Activated event procedure.

The Main Form

Here is the code from the top of the main form, which is the only section of this form's code that is changed.

```
'Program Name:     Ch12PassProperties
'Programmer:       Bradley/Millspaugh
'Date:             June 2008
'Description:      This project is based on Ch06HandsOn. It calculates
```

```
'                  the amount due based on the customer selection
'                  and accumulates summary data for the day.
'                  This version of the project uses form properties to
'                  pass values to the summary form, in order to conform
'                  to OOP principles.
'Folder:           Ch12PassProperties
'Form:             BillingForm

Public Class BillingForm
    ' These Friend variables have been removed and replaced with Private
    ' variables and property procedures.
    ' Friend GrandTotalDecimal, AverageDecimal As Decimal
    ' Friend CustomerCountInteger As Integer
    ' Declare new module-level variables for the form's properties.
    Private GrandTotalDecimal, AverageDecimal As Decimal
    Private CustomerCountInteger As Integer

    ' Property procedures.
    ReadOnly Property SalesGrandTotal() As Decimal
        Get
            Return GrandTotalDecimal
        End Get
    End Property

    ReadOnly Property SalesAverage() As Decimal
        Get
            Return AverageDecimal
        End Get
    End Property

    ReadOnly Property SalesCustomerCount() As Integer
        Get
            Return CustomerCountInteger
        End Get
    End Property
```

The Summary Form

In SummaryForm you can retrieve the properties of BillingForm to display the summary data. The form's properties pop up in IntelliSense to make the coding extremely easy.

```
'Program Name:     Ch12PassProperties
'Programmer:       Bradley/Millspaugh
'Date:             June 2008
'Description:      This project is based on Ch06HandsOn. It retrieves
'                  the summary values from properties of the main form
'                  instead of from Friend variables.
'Folder:           Ch12PassProperties.
'Form:             SummaryForm

Public Class SummaryForm

    Private Sub SummaryForm_Activated(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles MyBase.Activated
        ' Get the data from properties of the main form.

        TotalSalesTextBox.Text = BillingForm.SalesGrandTotal.ToString("C")
        AverageSalesTextBox.Text = BillingForm.SalesAverage.ToString("C")
        NumberCustomersTextBox.Text = BillingForm.SalesCustomerCount.ToString()
```

```
        ' Removed references to the Friend variables.
        ' TotalSalesTextBox.Text = BillingForm.GrandTotalDecimal.ToString("C")
        ' AverageSalesTextBox.Text = BillingForm.AverageDecimal.ToString("C")
        ' NumberCustomersTextBox.Text = BillingForm.CustomerCountInteger.ToString()
    End Sub
```

Passing Objects as Properties

Earlier in this chapter you learned to display summary values from shared properties of a class. At times you may need to display the instance properties of an object, rather than the shared properties. For example, in the in-chapter step-by-step example, perhaps you want to display the details of a single sale on a second form. In the main form, SalesForm, you declare an object of the BookSale class and calculate a sale. But that object is declared as `Private` (as it should be) and is not available to other forms unless you create a property to expose it.

The following example is based on the BookSale step-by-step exercise. After a sale is calculated, a second form displays the details of the form. The main SalesForm needs a ReadOnly property for a BookSale so that the second form, ViewForm, can retrieve the BookSale object and display its values.

The Form—SalesForm

The only changes to the SalesForm are a new ReadOnly property, called CompletedSale, and a `ShowDialog` method to display ViewForm at the conclusion of the calculations.

```
Public Class SalesForm
    ' Declare the new object.
    Private TheBookSale As BookSale

    ReadOnly Property CompletedSale() As BookSale
        Get
          Return TheBookSale
        End Get
    End Property

    Private Sub CalculateSaleToolStripMenuItem_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles CalculateSaleToolStripMenuItem.Click
        ' Calculate the extended price for the sale.

        Try
            'Instantiate the object and set the properties
            TheBookSale = New BookSale(TitleTextBox.Text, _
              Integer.Parse(QuantityTextBox.Text), Decimal.Parse(PriceTextBox.Text))
            ' Calculate and format the result.
            ExtendedPriceTextBox.Text = TheBookSale.ExtendedPrice.ToString("N")
            ViewForm.ShowDialog()
        Catch ex As Exception
            MessageBox.Show("Enter numeric data.", "R 'n R Book Sales", _
              MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
        End Try
    End Sub
```

The Second Form—ViewForm

This form must declare an object variable for the BookSale object. It retrieves the object from the main form through the CompletedSale property and displays the individual elements from the object.

```
'Project:        Ch12PassObjectAsProperty
'Programmer:     Bradley/Millspaugh
'Date:           June 2008
'Description:    Retrieve a BookSale from the main form and display
'                the elements.

Public Class ViewForm

    Private ABookSale As BookSale

    Private Sub ViewForm_Activated(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles Me.Activated
        ' Retrieve and display the sale figures.

        ABookSale = SalesForm.CompletedSale
        TitleLabel.Text = ABookSale.Title
        QuantityLabel.Text = ABookSale.Quantity.ToString
        PriceLabel.Text = ABookSale.Price.ToString("C")
        ExtendedPriceLabel.Text = ABookSale.ExtendedPrice.ToString("C")
    End Sub
End Class
```

Managing Multiclass Projects

This chapter has examples of projects with multiple forms and multiple classes. In each case, every class is stored in a separate file. Although you must keep form classes in separate files, other classes do not have that requirement. You can code multiple classes in one file.

Adding an Existing Class File to a Project

If you have an existing form or other class file that you want to include in a project, you can choose to reference the file in its original location or move or copy it into your project folder. Unless you need to share a class among several projects, it's best to place the class file into the project folder. After you move or copy the desired file into the project folder, add the file to the project by selecting *Project / Add Existing Item* (or right-click the project name in the Solution Explorer and select *Add / Existing Item* from the context menu).

Using the Object Browser

The Object Browser is an important tool for working with objects. The Object Browser can show you the names of objects, properties, methods, events, and constants for VB objects, your own objects, and objects available from other applications.

Select *View / Object Browser* or the *Object Browser* toolbar button (Figure 12.11) to open the Object Browser window (Figure 12.12). You can enter an item for which to search in the Search box.

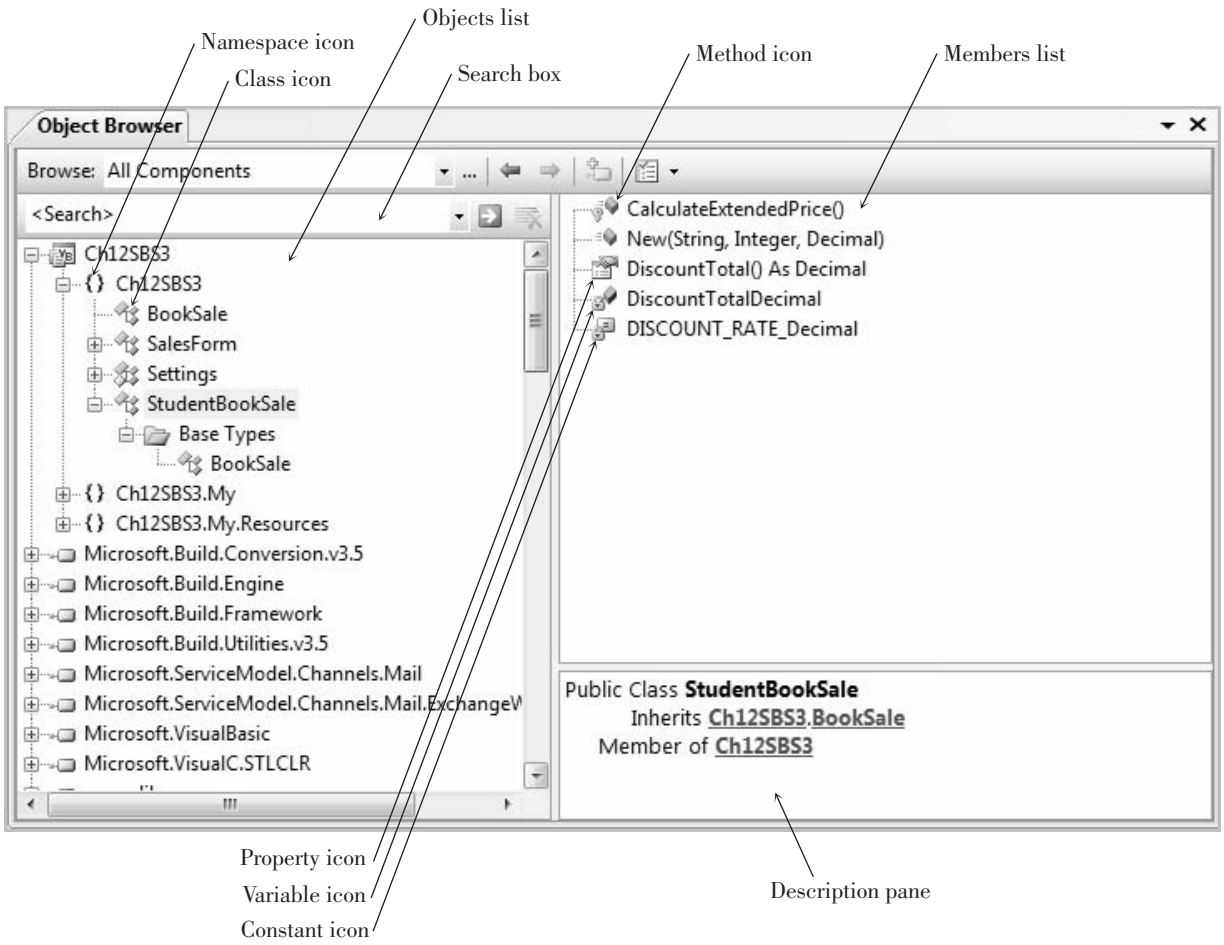
The Object Browser uses several icons to represent items. Notice in Figure 12.12 the icons that represent properties, methods, events, constants, classes, and namespaces. In the lower-right corner of the window you can see a description of any item you select.

Figure 12.11

Open the Object Browser from the toolbar button.

Figure 12.12

The Object Browser window; notice the icons to indicate the member type.



Examining VB Classes

You can look up the available properties, methods, events, or constants of a Visual Basic class. You can see which elements are defined in the class, what is the base class, and which properties, methods, and events are inherited. In Figure 12.13 notice the entries for System.Windows.Forms.MessageBox; the overloaded constructors appear in the *Members* list. And in Figure 12.14, you can see the constants for MessageBoxButtons.

Figure 12.13

Display the members of the System.Windows.Forms.MessageBox class.

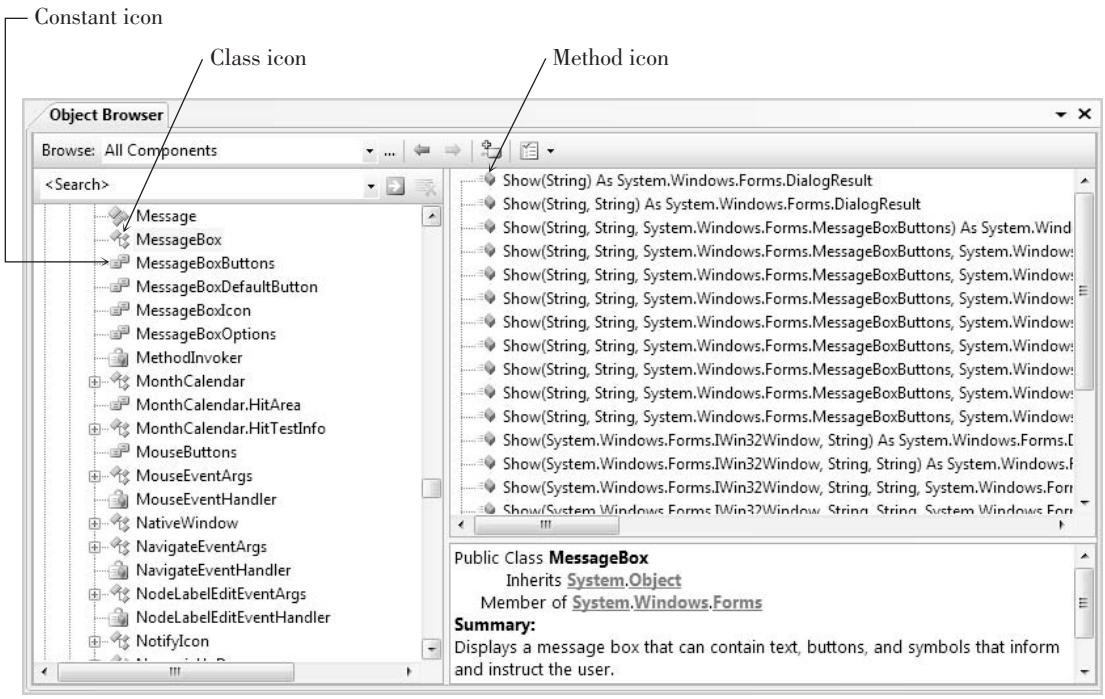
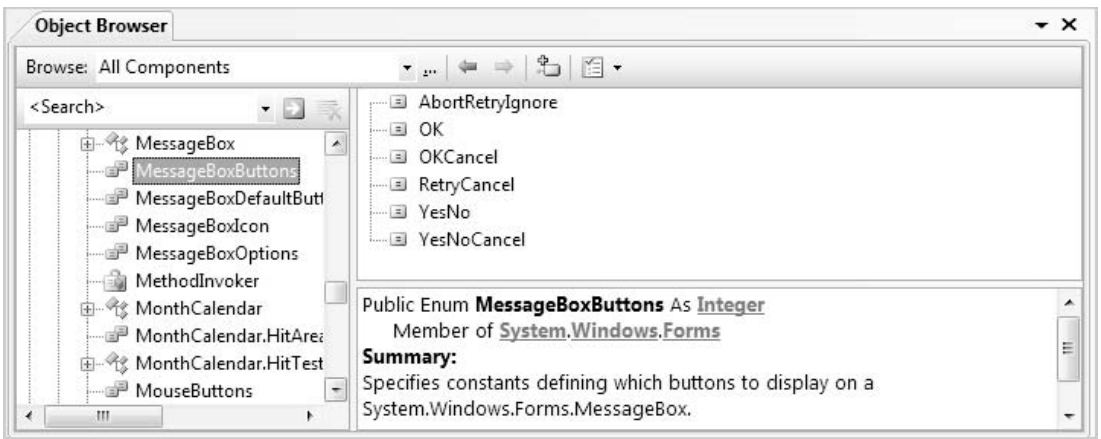


Figure 12.14

Display the MessageBoxButtons constants.

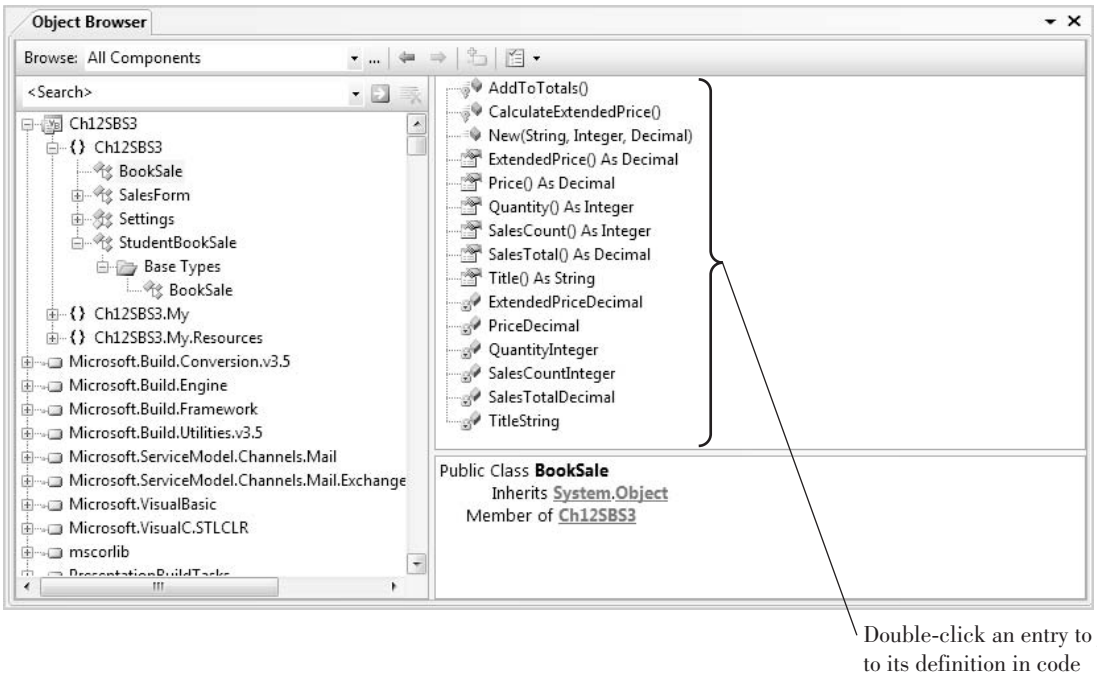


Examining Your Own Classes

You can see your own classes listed in the Object Browser. With the chapter step-by-step project open, select your project name in the Object Browser. Try clicking on each class name and viewing the list of properties and methods (Figure 12.15).

Figure 12.15

View the properties and methods for your own classes. Double-click on an item in the Members *list to jump to its definition in code.*



You can use the Object Browser to jump to the definition of any property or method by double-clicking on its name in the *Members* list. This technique is also a great way to jump to any of the procedures in your forms. Select your form name in the *Objects* list and double-click on the name of the procedure you want to view.

Your Hands-On Programming Example

This program must calculate book sales for R 'n R, with a discount of 15 percent for students. The project will use the BookSale and StudentBookSale classes developed in the chapter step-by-step.

Create a project with multiple forms that have a shared design element. Include a main form, an About form, and a summary form that displays the sales summary information.

Design a base form to use for inheritance and make the other three forms inherit from the base form. The About form and summary form must have an *OK* button, which closes or hides the form. The main form will have menus and no *OK* button.

Main Form Menu

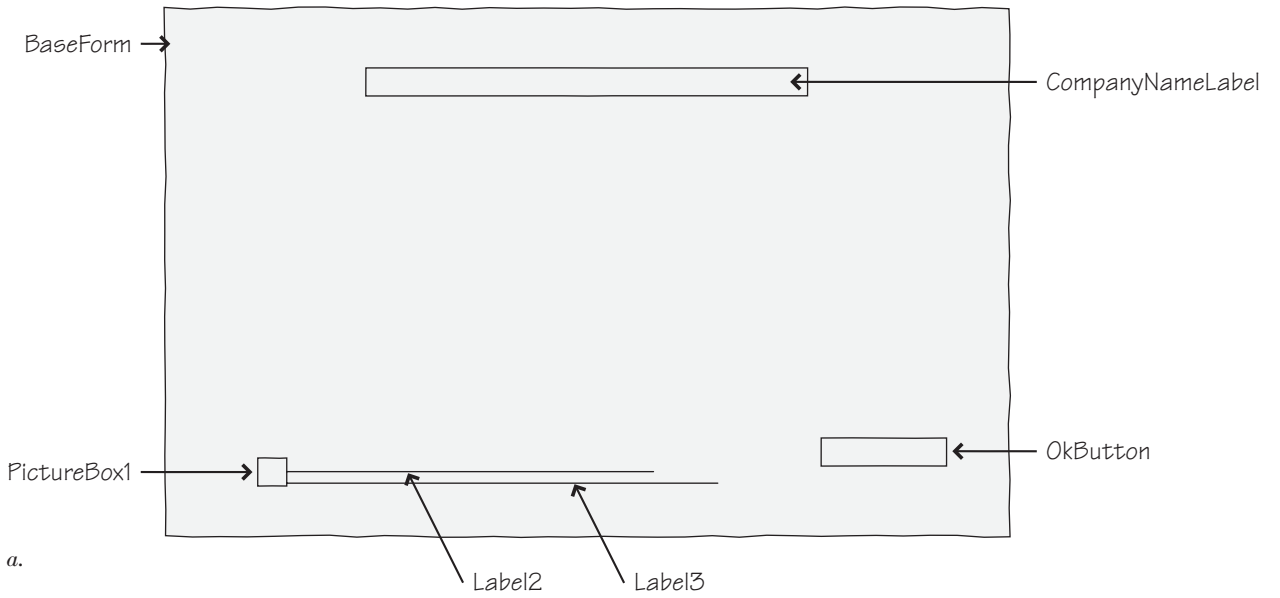
```
File                    Help
  Calculate Sale          About
  Clear
  Summary
  ------
  Exit
```

Planning the Project

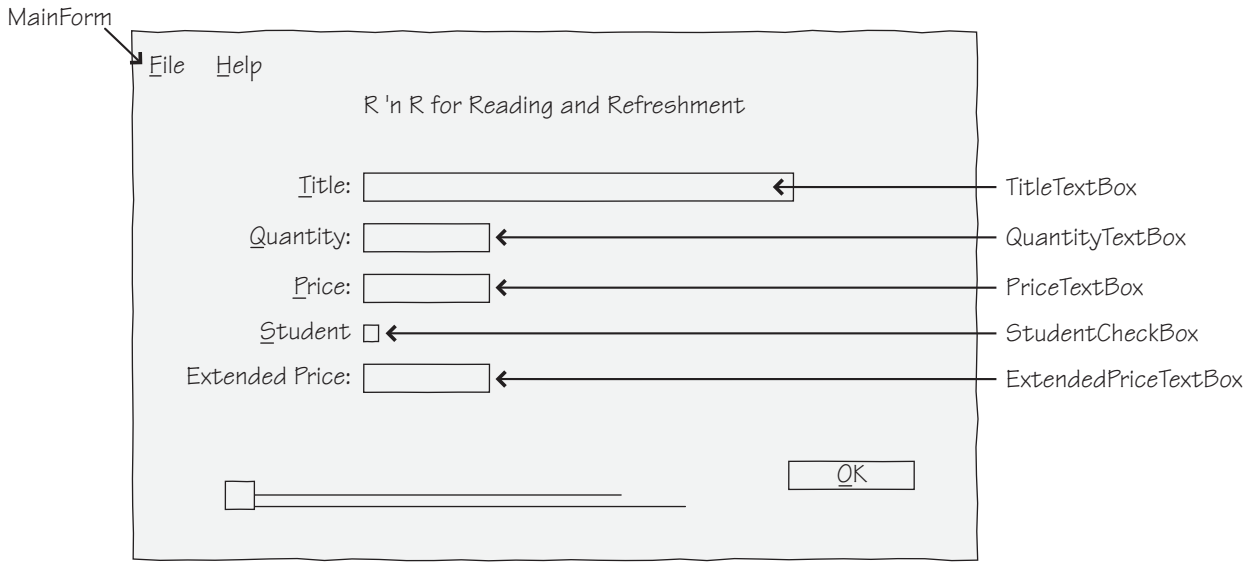
Sketch a base form for inheritance, a main form, an About form, and a summary form (Figure 12.16) for your users. The users approve and sign off the forms as meeting their needs.

Figure 12.16

The planning sketches of the forms for the hands-on programming example. a. The base form; b. the main form; c. the About form; and d. the Summary form.



a.

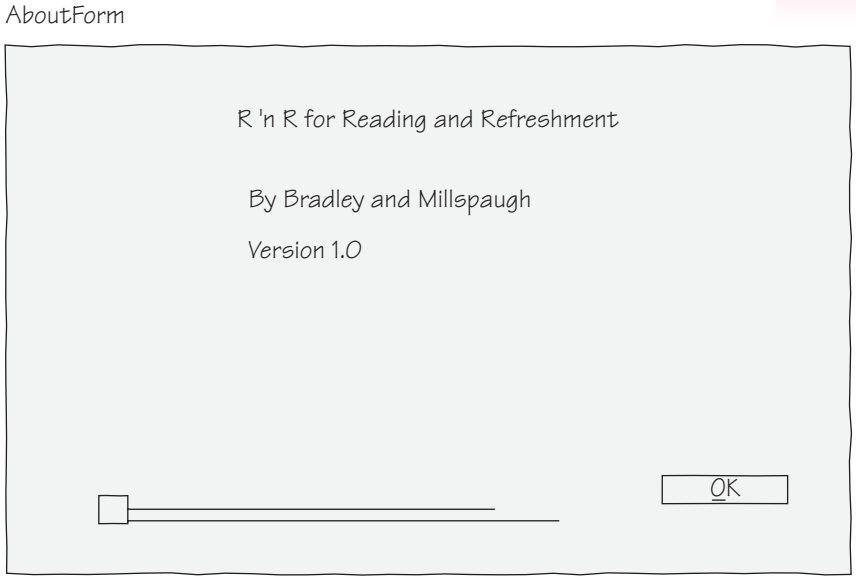


b.

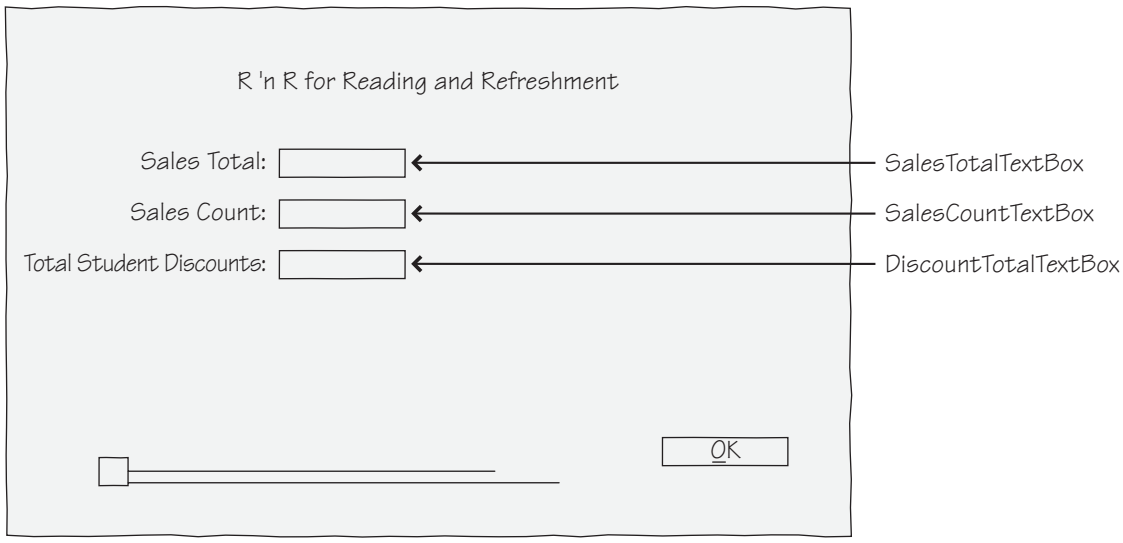
Figure 12.16

(continued)

c.



d.



Plan the Objects and Properties for the Base Form

Object	Property	Setting
BaseForm	Name	BaseForm
CompanyNameLabel	Name	CompanyNameLabel
	Text	R 'n R for Reading and Refreshment
OkButton	Name	OkButton
	Text	&OK
Label2	Name	Label2
	Size	250, 4
Label3	Name	Label3
	Size	300, 4
PictureBox1	Name	PictureBox1
	Image	Coffee.png

Plan the Procedures for the Base Form

Procedure	Actions
OkButton_Click	(Overridable) Close the form.

Plan the Objects and Properties for the Main Form

Object	Property	Setting
MainForm	Name	MainForm
	Text	R 'n R Book Sales
Label1	Name	Label1
	Text	&Title:
TitleTextBox	Name	TitleTextBox
Label2	Name	Label2
	Text	&Quantity:
QuantityTextBox	Name	QuantityTextBox
Label3	Name	Label3
	Text	&Price:
PriceTextBox	Name	PriceTextBox
StudentCheckBox	Name	StudentCheckBox
	Text	&Student
	RightToLeft	Yes
Label4	Name	Label4
	Text	Extended Price:
ExtendedPriceTextBox	Name	ExtendedPriceTextBox
	ReadOnly	True
	TabStop	False

Object	Property	Setting
FileToolStripMenuItem	Name	FileToolStripMenuItem
	Text	&File
CalculateSaleToolStripMenuItem	Name	CalculateSaleToolStripMenuItem
	Text	&Calculate Sale
ClearToolStripMenuItem	Name	ClearToolStripMenuItem
	Text	C&lear
SummaryToolStripMenuItem	Name	SummaryToolStripMenuItem
	Text	&Summary
ExitToolStripMenuItem	Name	ExitToolStripMenuItem
	Text	E&xit
HelpToolStripMenuItem	Name	HelpToolStripMenuItem
	Text	&Help
AboutToolStripMenuItem	Name	AboutToolStripMenuItem
	Text	&About

Plan the Procedures for the Main Form

Procedure	Actions
Form_Load	Hide the inherited OK button.

CalculateSaleToolStripMenuItem_Click	If student sale then
	  Create a StudentBookSale object.
	  Calculate and format the extended price.
	Else
	  Create a BookSale object.
	  Calculate and format the extended price.
	End If

ClearToolStripMenuItem_Click	Clear the text boxes. Uncheck the check box. Set the focus on first text box.
SummaryToolStripMenuItem_Click	Show the Summary form.
ExitToolStripMenuItem_Click	End the project.
AboutToolStripMenuItem_Click	Show the About form.

Plan the Objects and Properties for the About Form

Object	Property	Setting
AboutForm	Name	AboutForm
	Text	About This Program
OkButton	Name	(Inherited) OkButton
	Text	&OK

Plan the Procedures for the About Form

Procedure	Actions
OkButton_Click	(No code; inherited from base class)

Plan the Objects and Properties for the Summary Form

Object	Property	Setting
SummaryForm	Name	SummaryForm
	Text	Summary
Label1	Name	Label1
	Text	Sales Total:
SalesTotalTextBox	Name	SalesTotalTextBox
	ReadOnly	True
	TabStop	False
Label2	Name	Label2
	Text	Sales Count:
SalesCountTextBox	Name	SalesCountTextBox
	ReadOnly	True
	TabStop	False
Label3	Name	Label3
	Text	Total Student Discounts:
DiscountTotalTextBox	Name	DiscountTotalTextBox
	ReadOnly	True
	TabStop	False
OkButton	Name	(Inherited) OkButton
	Text	&OK

Plan the Procedures for the Summary Form

Procedure	Actions
Form_Activated	Fill the form controls.
OkButton_Click	(Override the base class method) Hide this form.

Plan the BookSale Object Class

Properties

Declare private module-level variables and write property procedures for all public properties:

Instance:
- Title
- Quantity
- Price

Shared:
- SalesTotal
- SalesCount

Methods

Procedure	Actions
ExtendedPrice	Calculate Extended price = Quantity * Price. Add Extended price to SalesTotal. Add 1 to SalesCount. Return Extended price.

Plan the StudentBookSale Object Class

Inherit from BookSale.

Additional Properties

Shared:
DiscountTotal

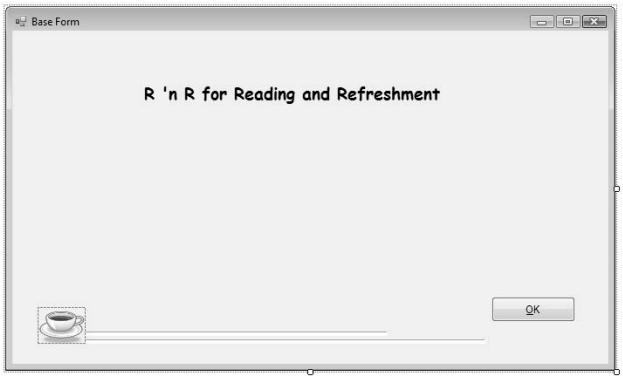
Methods

Procedure	Actions
ExtendedPrice	Calculate Discount = Price * Quantity * Discount rate. Calculate Extended price = Quantity * Price – Discount. Add Extended price to SalesTotal. Add 1 to SalesCount. Add Discount to DiscountTotal. Return Extended price.

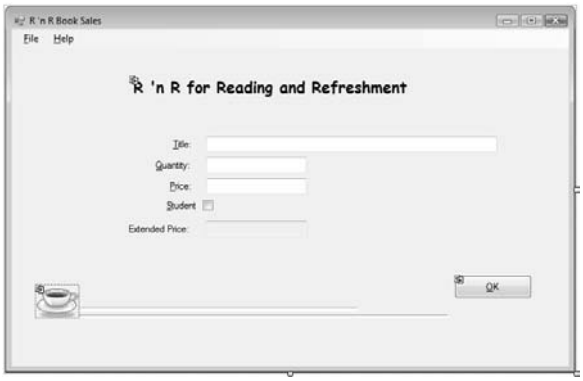
Write the Project Follow the sketches in Figure 12.16 to create the forms. Create the base form first and inherit the other three forms from the base form. Figure 12.17 shows the completed forms.

Figure 12.17

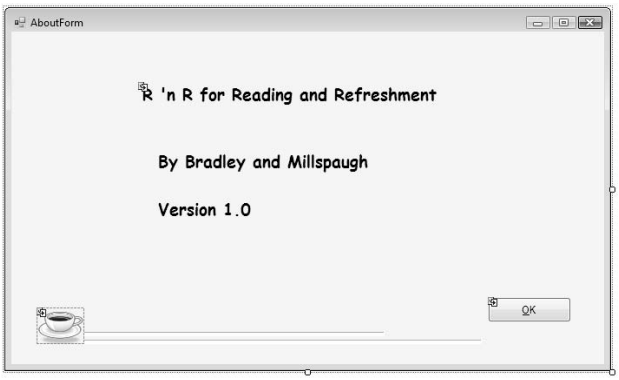
The completed forms for the hands-on programming example. a. The base form; b. the main form; c. the About form; and d. the Summary form.



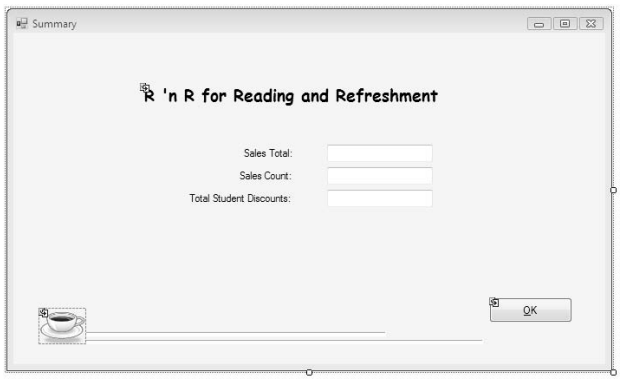
a.



b.



c.



d.

- Set the project's startup object to the main form.
- Set the properties of each of the objects according to your plan.
- Create the BookSale and StudentBookSale classes, or copy them into your project folder and add them to the project.
- Write the code. Working from the pseudocode, write each procedure.
- When you complete the code, use a variety of data to thoroughly test the project.

The Project Coding Solution

BaseForm

```
'Program:       Chapter 12 BookSale Hands-On Program
'Programmer:    Bradley/Millspaugh
'Date:          June 2008
'Description:   Base form for hands-on project.
'Folder:        Ch12HandsOn

Public Class BaseForm

  Public Overridable Sub OkButton_Click(ByVal sender As Object, _
    ByVal e As System.EventArgs) Handles OkButton.Click
      ' Allow inherited classes to override this method.

  End Sub
End Class
```

MainForm

```
'Program:       Chapter 12 BookSale Hands-On Program
'Programmer:    Bradley/Millspaugh
'Date:          June 2008
'Description:   Calculate sales price using the BookSale and StudentBookSale classes.
'               Main form for hands-on project.
'Folder:        Ch12HandsOn

Public Class MainForm
    ' Inherits BaseForm

    ' Declare the new objects.
    Private TheBookSale As BookSale
    Private TheStudentBookSale As StudentBookSale

    Private Sub MainForm_Load(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles MyBase.Load
        ' Make the OK button invisible on this form.

        OkButton.Visible = False
    End Sub

    Private Sub CalculateSaleToolStripMenuItem_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles CalculateSaleToolStripMenuItem.Click
        ' Calculate the extended price for the sale.
```

```
        Try
            If StudentCheckBox.Checked Then

                ' Instantiate the StudentBookSale object and set the properties.
                TheStudentBookSale = New StudentBookSale(TitleTextBox.Text, _
                  Integer.Parse(QuantityTextBox.Text), Decimal.Parse(PriceTextBox.Text))
                ' Calculate and format the result.
                ExtendedPriceTextBox.Text = _
                   TheStudentBookSale.ExtendedPrice.ToString("N")
            Else
                ' Instantiate the BookSale object and set the properties.
                TheBookSale = New BookSale(TitleTextBox.Text, _
                  Integer.Parse(QuantityTextBox.Text), _
                  Decimal.Parse(PriceTextBox.Text))
                ' Calculate and format the result.
                ExtendedPriceTextBox.Text = TheBookSale.ExtendedPrice.ToString("N")
            End If
        Catch
            MessageBox.Show("Error in quantity or price field.", "R 'n R Book Sales", _
              MessageBoxButtons.OK, MessageBoxIcon.Exclamation)
        End Try
    End Sub

    Private Sub ClearToolStripMenuItem_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles ClearToolStripMenuItem.Click
        ' Clear the screen controls.

        QuantityTextBox.Clear()
        PriceTextBox.Clear()
        ExtendedPriceTextBox.Clear()
        StudentCheckBox.Checked = False
        With TitleTextBox
            .Clear()
            .Focus()
        End With
    End Sub

    Private Sub SummaryToolStripMenuItem_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles SummaryToolStripMenuItem.Click
        ' Display the sales summary information.

        SummaryForm.ShowDialog()
    End Sub

    Private Sub AboutToolStripMenuItem_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles AboutToolStripMenuItem.Click
        ' Display the About form.

        AboutForm.ShowDialog()
    End Sub

    Private Sub ExitToolStripMenuItem_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles ExitToolStripMenuItem.Click
        ' End the project.

        Me.Close()
    End Sub
End Class
```

AboutForm

```
'Program:        Chapter 12 BookSale Hands-On Program
'Programmer:     Bradley/Millspaugh
'Date:           June 2008
'Description:    Calculate sales price using the BookSale class.
'                About form for hands-on project.
'Folder:         Ch12HandsOn

Public Class AboutForm

    Public Overrides Sub OkButton_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles OkButton.Click
         ' Override the base class method.

        Me.Close()
    End Sub
End Class
```

SummaryForm

```
'Program:        Chapter 12 BookSale Hands-On Program
'Programmer:     Bradley/Millspaugh
'Date:           June 2008
'Description:    Calculate sales price using the BookSale class.
'                Summary form for hands-on project.
'Folder:         Ch12HandsOn

Public Class SummaryForm
    ' Inherits BaseForm

    Public Overrides Sub OkButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles OkButton.Click
         ' Override the base class method.

        Me.Hide()
    End Sub

    Private Sub SummaryForm_Activated(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles Me.Activated
         ' Display the summary information on the form.

        SalesTotalTextBox.Text = BookSale.SalesTotal.ToString("C")
        SalesCountTextBox.Text = BookSale.SalesCount.ToString()
        DiscountTotalTextBox.Text = StudentBookSale.DiscountTotal.ToString("C")
    End Sub
End Class
```

BookSale Class

```
'Class Name:     BookSale
'Programmer:     Bradley/Millspaugh
'Date:           June 2008
'Description:    Handle book sale information.
'Folder:         Ch12HandsOn
```

```
Public Class BookSale
    Private TitleString As String
    Private QuantityInteger As Integer
    Private PriceDecimal, ExtendedPriceDecimal As Decimal
    Private Shared SalesTotalDecimal As Decimal
    Private Shared SalesCountInteger As Integer

    ' Parameterized Constructor.
    Sub New(ByVal TitleIn As String, ByVal QuantityIn As Integer, _
      ByVal PriceIn As Decimal)
        ' Assign property values.

        Title = TitleIn
        Quantity = QuantityIn
        Price = PriceIn
        CalculateExtendedPrice()
        AddToTotals()
    End Sub

    Property Title() As String
        Get
            Return TitleString
        End Get

        Set(ByVal Value As String)
            TitleString = Value
        End Set
    End Property

    Property Quantity() As Integer
        Get
            Return QuantityInteger
        End Get

        Set(ByVal Value As Integer)
            If Value >= 0 Then
                QuantityInteger = Value
            End If
        End Set
    End Property

    Property Price() As Decimal
        Get
            Return PriceDecimal
        End Get

        Set(ByVal Value As Decimal)
            If Value >= 0 Then
                PriceDecimal = Value
            End If
        End Set
    End Property

    Property ExtendedPrice() As Decimal
        Get
            Return ExtendedPriceDecimal
        End Get
        Set(ByVal Value As Decimal)
            ExtendedPriceDecimal = Value
        End Set
    End Property
```

```
    Shared ReadOnly Property SalesTotal() As Decimal
        Get
            Return SalesTotalDecimal
        End Get
    End Property

    Shared ReadOnly Property SalesCount() As Integer
        Get
            Return SalesCountInteger
        End Get
    End Property

    Protected Overridable Sub CalculateExtendedPrice()
        ' Calculate the extended price.

        ExtendedPriceDecimal = QuantityInteger * PriceDecimal
    End Sub

    Protected Sub AddToTotals()
        ' Add to the summary information.

        SalesTotalDecimal += ExtendedPriceDecimal
        SalesCountInteger += 1
    End Sub
End Class
```

StudentBookSale Class

```
'Class Name:     StudentBookSale
'Programmer:     Bradley/Millspaugh
'Date:           June 2008
'Description:    Handle book sale information for student sales,
'                which receive a discount.
'Folder:         Ch12HandsOn

Public Class StudentBookSale
    Inherits BookSale

    Const DISCOUNT_RATE_Decimal As Decimal = 0.15D
    Private DiscountDecimal As Decimal
    Private Shared DiscountTotalDecimal As Decimal

    Sub New(ByVal Title As String, ByVal Quantity As Integer, _
      ByVal Price As Decimal)
        ' Assign property values.

        ' Call base-class constructor and pass the property values.
        MyBase.New(Title, Quantity, Price)
    End Sub

    Shared ReadOnly Property DiscountTotal() As Decimal
        Get
            Return DiscountTotalDecimal
        End Get
    End Property
```

```
    Protected Overrides Sub CalculateExtendedPrice()
        ' Calculate the extended price and add to the totals.

        DiscountDecimal = Quantity * Price * DISCOUNT_RATE_Decimal
        ExtendedPrice = Quantity * Price – DiscountDecimal
        DiscountTotalDecimal += DiscountDecimal
    End Sub
End Class
```

Summary

1. Objects have properties and methods, and can trigger events.
2. You can create a new class that can then be used to create new objects.
3. Creating a new object is called *instantiating* the class; the object is called an *instance* of the class.
4. In object-oriented terminology, *encapsulation* refers to the combination of the characteristics and behaviors of an item into a single class definition.
5. Polymorphism allows different classes of objects in an inheritance hierarchy to have similarly named methods that behave differently for that particular object.
6. Inheritance provides a means to derive a new class based on an existing class. The existing class is called a *base class*, *superclass*, or *parent class*. The inherited class is called a *subclass*, *derived class*, or *child class*.
7. One of the biggest advantages of object-oriented programming is that classes that you create for one application may be reused in another application.
8. Multitier applications separate program functions into a Presentation tier (the user interface), Business tier (the logic of calculations and validation), and Data tier (accessing stored data).
9. The variables inside a class used to store the properties should be private, so that data values are accessible only by procedures within the class.
10. The way to make the properties of a class available to code outside the class is to use Property procedures. The `Get` portion returns the value of the property, and the `Set` portion assigns a value to the property. Validation is often performed in the `Set` portion.
11. Read-only properties are declared with the `ReadOnly` keyword and have only a `Get` accessor method. Write-only properties are written with the `WriteOnly` keyword and have only a `Set` accessor method.
12. The public functions and sub procedures of a class module are its methods.
13. To instantiate an object of a class, you must use the `New` keyword on either the declaration statement or an assignment statement. The location of the `New` keyword determines when the object is created.
14. A constructor is a method that automatically executes when an object is created; a destructor method is triggered when an object is destroyed.

15. A constructor method must be named `New` and may be overloaded.
16. A parameterized constructor requires arguments to create a new object.
17. Shared members (properties and methods) have one copy that can be used by all objects of the class, generally used for totals and counts. Instance members have one copy for each instance of the object. Declare shared members with the `Shared` keyword.
18. The garbage collection feature periodically checks for unreferenced objects, destroys the object references, and releases resources.
19. A subclass inherits all public and protected properties and methods of its base class, except for the constructor.
20. To override a method from a base class, the original method must be declared as `Overridable` or `MustOverride`, and the new method must use the `Overrides` keyword.
21. A base class used strictly for inheritance is called an abstract class and cannot be instantiated. The class should be declared as `MustInherit`, and the methods that must be overridden should be declared as `MustOverride`.
22. You can use visual inheritance to derive new forms from existing forms.
23. You can use the Object Browser to view classes, properties, methods, events, and constants in system classes as well as your own classes.

Key Terms

abstract class *492*
abstract method *492*
accessor methods *475*
base class *471*
child class *471*
class *470*
constructor *477*
derived class *471*
destructor *477*
encapsulation *471*
garbage collection *491*
inheritance *471*
instance *470*
instance property *487*
instance variable *487*
instantiate *470*
multitier application *473*
`MustInherit` *497*
`MustOverride` *492*
object *470*
overloading *472*
overriding *472*
parameterized constructor *477*
parent class *471*
polymorphism *472*
property procedure *475*
`Protected` *491*
`ReadOnly` *476*
reusability *472*
shared property *487*
shared variable *487*
subclass *471*
superclass *471*
`value` keyword *475*
visual inheritance *497*

Review Questions

1. What is an object? a property? a method?
2. What is the purpose of a class?
3. Why should property variables of a class be declared as private?
4. What are property procedures and what is their purpose?
5. Explain how to create a new object.
6. What steps are needed to assign property values to an object?
7. What actions trigger the constructor and destructor methods of an object?
8. How can you write methods for a new class?
9. What is a shared member? How is it created?
10. Explain the steps necessary to inherit a class from another class.
11. Differentiate between overriding and overloading.
12. What is a parameterized constructor?
13. When might you use the `Protected` keyword on a constructor?
14. What is visual inheritance?

Programming Exercises

Note: For help in basing a new project on an existing project, see "Copy and Move Projects" in Appendix C.

12.1 Modify the program for Programming Exercise 5.1 (the piecework pay) to separate the business logic into a separate class. The class should have properties for Name and Pieces, as well as shared read-only properties to maintain the summary information.

12.2 Modify Programming Exercise 12.1 to include multiple forms. Create a base form that you can use for visual inheritance. Display the summary information and the About box on separate forms, rather than in message boxes.

12.3 *Extra Challenge*: Modify Programming Exercise 12.2 to have an inherited class. Create a derived class for senior workers, who receive 10 percent higher pay for 600 or more pieces. Add a check box to the main form to indicate a senior worker.

12.4 Modify Programming Exercise 5.3 (the salesperson commissions) to separate the business logic into a separate class. The class should have properties for Name and Sales, as well as shared read-only properties to maintain the summary information.

12.5 Modify Programming Exercise 12.4 to include multiple forms. Create a base form that you can use for visual inheritance. Display the summary information and the About box on separate forms, rather than message boxes.

12.6 *Extra Challenge*: Modify Programming Exercise 12.5 to have an inherited class. Create a derived class for supervisors, who have a different pay scale. The supervisor quota is $2,000, the commission rate is 20 percent, and the base pay is $500. Include a check box on the main form to indicate a supervisor, and calculate separate totals for supervisors.

12.7 Modify Programming Exercise 5.2 (the check transactions) to separate the business logic from the user interface. Create a Transaction class and derived classes for Deposit, Check, and Service Charges. Display the summary information on a separate form rather than a message box. *Optional Extra:* Use visual inheritance for the forms.

12.8 Modify Programming Exercise 5.4 (the library reading program) to separate the business logic from the user interface. Create a class with properties for Name and Number of Books. Display the summary information and About box in separate forms rather than message boxes. *Optional Extra:* Use visual inheritance for the forms.

12.9 *Extra Challenge*: Modify Programming Exercise 12.8 to have inherited classes. Have separate classes and separate totals for elementary, intermediate, and high school. Include radio buttons on the form to select the level; display totals for all three groups on the summary.

12.10 Create a project that contains a class for sandwich objects. Each sandwich object should have properties for Name, Bread, Meat, Cheese, and Condiments. Use a form for user input. Assign the input values to the properties of the object, and display the properties on a separate form. *Hint:* Use a ReadOnly property on the input form to pass the object to the second form.

12.11 Create a project that contains a Pet class. Each object will contain pet name, animal type, breed, and color. The form should contain text boxes to enter the information for the pets. A button or menu item should display the pet information on a separate form. *Hint:* Use a ReadOnly property on the input form to pass the object to the second form.

12.12 Modify the project that you created in Chapter 3 to separate the user interface from the business logic (calculations) and return the results through a property.

Case Studies

VB Mail Order

Modify your VB Mail Order project from Chapter 5 to separate the user interface from the business logic. Create two new classes: one for customer information and one for order items. The order item class should perform the calculations and maintain the summary information.

Add a menu option to display the customer information. Display the properties of the Customer object on a separate form. *Hint:* Use a ReadOnly property on the input form to pass the object to the second form.

Display the About box and the summary information on forms, rather than message boxes.

Optional extra: Use visual inheritance for the forms.

Need a bigger challenge? Create an inherited class for preferred customers. Preferred customers receive an automatic 5 percent discount on all purchases. Use a check box to determine if the customer is a preferred customer and instantiate the appropriate class. Maintain and display separate totals for preferred customers.

Note: For help in basing a new project on an existing project, see "Copy and Move Projects" in Appendix C.

VB Auto Center

Modify your VB Auto Center project from Chapter 5 to separate the business logic from the user interface. Create a class for purchases, with properties for each of the options. The class method will calculate the subtotal, tax, total, and amount due.

Make the About box display on a separate form, rather than a message box.

Need a bigger challenge? Add summary totals for the number of sales, the total sales, and the total trade-ins. Maintain the totals as shared read-only properties of the class and display the summary information on a separate form.

Note: For help in basing a new project on an existing project, see "Copy and Move Projects" in Appendix C.

Video Bonanza

Modify the Video Bonanza project from Chapter 5 to separate the user interface from the business logic. Create a class for each rental. Include a property for title, Boolean properties for video format, new members, price of current item, and membership, and shared read-only properties for the summary information.

Display the summary information and the About box on forms, rather than message boxes.

Note: For help in basing a new project on an existing project, see "Copy and Move Projects" in Appendix C.

Very Very Boards

Modify the Very Very Boards project from Chapter 5 to separate the user interface from the business logic. Create a class for each shirt sale with properties for Order Number, Quantity, and Size. Use Boolean properties for Monogram and Pocket and a method to calculate the price. Maintain shared read-only properties for the summary information.

Display the summary information and the About box on forms, rather than message boxes.

Optional extra: Use visual inheritance for the forms.

Note: For help in basing a new project on an existing project, see "Copy and Move Projects" in Appendix C.

CHAPTER

13

Graphics, Animation, Sound, and Drag-and-Drop

at the completion of this chapter, you will be able to . . .

1. Use Graphics methods to draw shapes, lines, and filled shapes.
2. Create a drawing surface with a Graphics object.
3. Instantiate Pen and Brush objects as needed for drawing.
4. Create animation by changing pictures at run time.
5. Create simple animation by moving images.
6. Use the Timer component to automate animation.
7. Use scroll bars to move an image.
8. Add sounds to a project.
9. Play videos on a form.
10. Incorporate drag-and-drop events into your program.
11. Draw a pie chart using the methods of the Graphics object.

You had your first introduction to graphics when you learned to print documents in Chapter 7. In this chapter you will learn to draw shapes, such as lines, rectangles, and ellipses, using the methods of the Graphics object. You can use the Graphics methods to draw pictures and charts in a business application.

You will do simple animation by replacing and moving graphics. You also will use a Timer component to cause events to fire, so that you can create your own animation.

Graphics in Windows and the Web

The term ***graphics*** refers to any text, drawing, image, or icon that you display on the screen. You have placed a graphic image in a PictureBox control to display pictures on your forms. A picture box also can display animated .gif files, so you can easily produce animation on the screen.

You can display a graphics file on either a Web Form or a Windows Form. Recall that the Web control is an Image control and the Windows control is a PictureBox. Both display graphics files, but the Windows control accepts a few more file formats.

Using Windows Forms, you can draw graphics shapes such as circles, lines, and rectangles on a form or control. The Graphics methods work only on Windows Forms, not Web Forms. Therefore, the programs in the next section use Windows Forms only.

The Graphics Environment

The .NET Framework uses a technology called *GDI+* for drawing graphics. GDI+ is more advanced and an improvement over the previous Graphics Device Interface (GDI) used in previous versions of VB. GDI+ is designed to be device-independent, so that the programmer doesn't have to be concerned about the physical characteristics of the output device. For example, the code to draw a circle is the same whether the output goes to a large-screen monitor, a low-resolution monitor, or the printer.

Steps for Drawing Graphics

When you draw a picture, you follow these general steps. The sections that follow describe the steps in more detail.

- Create a Graphics object to use as a drawing surface.
- Instantiate a Pen or Brush object to draw with.
- Call the drawing methods from the Graphics object.

Looking over the steps, you realize that this is what you did for creating printer output in Chapter 7. In that chapter you used the `DrawString` method

to place text on the Graphics object; in this chapter you will use methods that draw shapes.

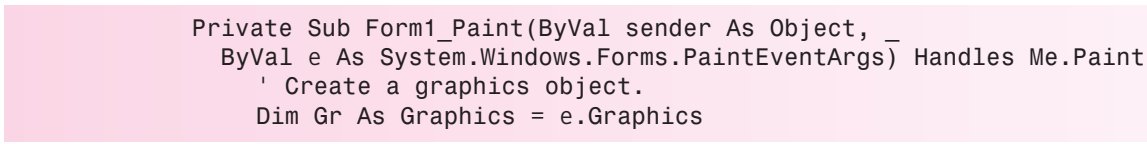
The Paint Event Procedure

You draw lines and shapes on a form or control by drawing on a Graphics object. And where do you place the code for the drawing methods? In the Paint event procedure for the form or the control on which you are drawing.

Each time a window is displayed, resized, moved, maximized, restored, or uncovered, the form's Paint event executes. In the Paint event procedure, the form and its controls are redrawn. If you draw some graphics on the form, in say the Form_Load event procedure or the click event of a button, the graphics are not automatically redrawn when the form is repainted. The only way to make sure that the graphics appear is to create them in the Paint event procedure. Then they are redrawn every time the form is rendered.

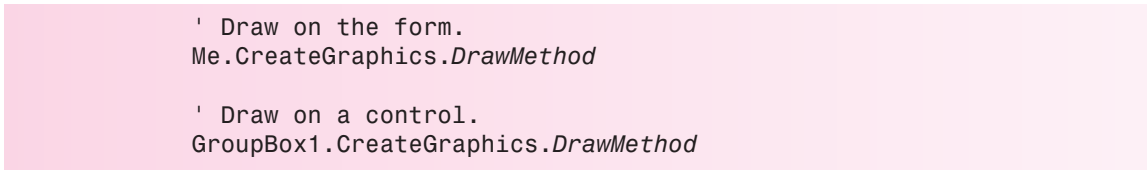
So far we have ignored the Paint event and allowed the repainting to proceed automatically. Now we will place code in that event procedure. You can write code in the form's Paint event procedure to draw on the form, or code in a control's Paint event procedure to draw graphics on the control.

In the Paint event procedure, you can use the e.Graphics object or declare a Graphics object. You assign the Graphics property of the procedure's PaintEventArgs argument to the new Graphics object.



```
Private Sub Form1_Paint(ByVal sender As Object, _
  ByVal e As System.Windows.Forms.PaintEventArgs) Handles Me.Paint
    ' Create a graphics object.
    Dim Gr As Graphics = e.Graphics
```

You also can create a graphic object by calling the `CreateGraphics` method of a form or control. You would use this method when you want to display a graphic from a procedure other than the Paint event.



```
' Draw on the form.
Me.CreateGraphics.DrawMethod

' Draw on a control.
GroupBox1.CreateGraphics.DrawMethod
```

TIP

To write code for the form's Paint event, in the Editor window select *(FormName Events)* from the *Class Name* list and then drop down the *Method Name* list and click on *Paint*; or in the Form Designer, click on the *Events* button in the Properties window and double-click on *Paint*. ■

Pen and Brush Objects

Using a **Pen object** you can draw lines or outlined shapes such as rectangles or circles. A **Brush object** creates filled shapes. You can set the width of a Pen and the color for both a Pen and a Brush. Figure 13.1 shows some lines and shapes created with Pen and Brush objects.

When you create a new Pen object, you set the color using the Color constants, such as Color.Red, Color.Blue, and Color.Aquamarine. You also can set the pen's width, which is measured in pixels. The term **pixel** is an abbreviation of *picture element*—a dot that makes up a picture. You are probably most familiar with pixels in the determination of the resolution of a monitor. A display of 1,280 by 1,024 is a reference to the number of pixels horizontally and vertically.

TIP

You can use the form's `Refresh` method to force a Paint event to occur. ■

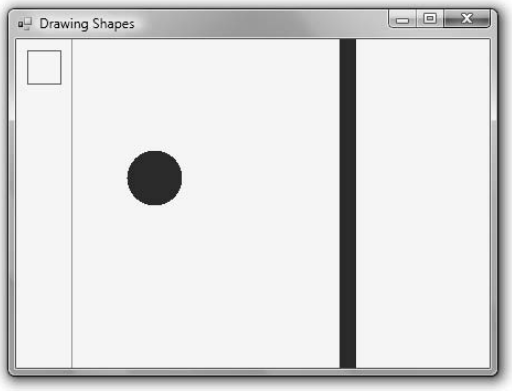


Figure 13.1

Graphic shapes created by drawing with Pen and Brush objects and the methods of the Graphics class.

The Pen Class—Constructors

General Forms

```
Pen(Color)
Pen(Color, Width)
```

If you don't set the width of the pen, it defaults to one pixel.

The Pen Class—Examples

Examples

```
Dim RedPen As New Pen(Color.Red)
Dim WidePen As New Pen(Color.Black, 10)
```

You may find that you want several different pens. For each different color or line width, you can create another Pen object or redefine an already dimensioned Pen variable if you are finished with it.

If you want to create filled figures, declare Brush objects—one for each different color that you want to use.

The SolidBrush Class—Constructor

General Form

```
SolidBrush(Color)
```

Use the Color constants to assign a color to your Brush objects.

The SolidBrush Class—Example

Example

```
Dim BlueBrush As New SolidBrush(Color.Blue)
```

You may have deduced from the name of the SolidBrush class that other types of brushes exist. See Help if you are interested in using a TextureBrush, HatchBrush, LinearGradientBrush, or PathGradientBrush.

The Coordinate System

Graphics are measured from a starting point of 0,0 for the X and Y coordinates beginning in the upper-left corner. The *X* is the horizontal position, and the *Y* is the vertical measurement. The starting point depends on where the graphic is being placed. If the graphic is going directly on a form, the 0,0 coordinates are the upper-left corner of the form, below the title bar and menu bar. You also can draw graphics in a container, such as a PictureBox, GroupBox, or Button. In this case, the container has its own 0,0 coordinates to be used as the starting point for measuring the location of items inside the container (Figure 13.2).

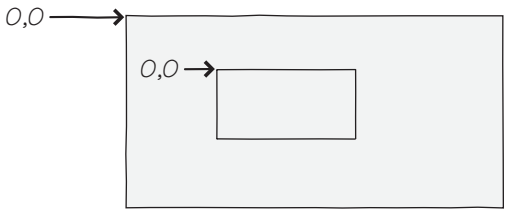


Figure 13.2

The coordinates for graphics begin with 0,0 in the upper-left corner of a form or container.

Each of the drawing methods allows you to specify the starting position using X and Y coordinates. Most of the methods also allow you to specify the position using a Point structure. In some methods it is useful to use a Rectangle structure, and in others a Size structure comes in handy.

The Point Structure

A **Point structure** is designed to hold the X and Y coordinates as a single unit. You can create a Point object, giving it values for the *X* and *Y*. Then you can use the object anywhere that accepts a Point as an argument.

```
Dim MyStartingPoint As New Point(20, 10)
```

You can see an example of a Point in the design of any of your forms. Examine the Location property of any control; the Location is assigned a Point object, with X and Y properties.

The Size Structure

A **Size structure** has two components, the width and height. Both integers specify the size in pixels. Some Graphics methods accept a Size structure as an argument.

```
Dim MyPictureSize As New Size(100, 20) ' Width is 100, height is 20.
```

You also can see an example of a Size structure by examining the design of any of your forms. Each of the controls has a Size property, which has width and height properties.

For an interesting exercise, examine the automatically generated code for a Button control in the *FormName*.Designer.vb file. The button's Location is set to a new Point object, and the size is set to a new Size object.

The Rectangle Structure

A **Rectangle structure** defines a rectangular region, specified by its upper-left corner and its size.

```
Dim MyRectangle As New Rectangle(MyStartingPoint, MyPictureSize)
```

The overloaded constructor also allows you to declare a new Rectangle by specifying its location in X and Y coordinates and its width and height.

```
Dim MyOtherRectangle As New Rectangle(XInteger, YInteger, WidthInteger, HeightInteger)
```

Note that you also can create Point, Size, and Rectangle structures for single-precision floating-point values. Specify the PointF, SizeF, and RectangleF structures.

Graphics Methods

The drawing methods fall into two basic categories: draw and fill. The draw methods create an outline shape and the fill methods are solid shapes. The first argument in a draw method is a Pen object; the fill methods use Brush objects. Each of the methods also requires the location for the upper-left corner, which you can specify as X and Y coordinates or as a Point object. Some of the methods require the size, which you may supply as width and height, or as a Rectangle object.

TIP

Rather than declaring a Pen or Brush, you can type `Pens.color` or `Brushes.color` directly in your Graphics method. You must declare the Pen or Brush object if you want to change the width. ■

Graphics Methods—General Forms

General Forms

```
DrawLine(Pen, X1Integer, Y1Integer, X2Integer, Y2Integer)
DrawLine(Pen, Point1, Point2)

DrawRectangle(Pen, XInteger, YInteger, WidthInteger, HeightInteger)
DrawRectangle(Pen, Rectangle)

FillRectangle(Brush, XInteger, YInteger, WidthInteger, HeightInteger)
FillRectangle(Brush, Rectangle)

FillEllipse(Brush, XInteger, YInteger, WidthInteger, HeightInteger)
FillEllipse(Brush, Rectangle)
```

The following code draws the outline of a rectangle in red using the **`DrawRectangle` method** and draws a line with the **`DrawLine` method**. The **`FillEllipse` method** is used to draw a filled circle.

```
Private Sub GraphicsForm_Paint(ByVal sender As Object, _
  ByVal e As System.Windows.Forms.PaintEventArgs) Handles Me.Paint
    With e.Graphics
        ' Draw a red rectangle.
        '.DrawRectangle(Pens.Red, 10, 10, 30, 30)
        'or
        Dim SmallRectangle as New Rectangle(10, 10, 30, 30)
        .DrawRectangle(Pens.Red, SmallRectangle)

        ' Draw a green line.
        .DrawLine(Pens.Green, 50, 0, 50, 300)
```

```
        ' Draw a blue filled circle.
        ' If the width and height are equal, then the FillEllipse method
        ' draws a circle; otherwise it draws an ellipse.
        .FillEllipse(Brushes.Blue, 100, 100, 50, 50)

        ' Draw a fat blue line.
        .DrawLine(New Pen(Color.Blue, 15), 300, 0, 300, 300)
    End With
End Sub
```

Table 13.1 shows some of the methods in the Graphics class.

Selected Methods from the Graphics Class **Table 13.1**

Method	Purpose
`Clear()`	Clear the drawing surface by setting it to the container's background color.
`Dispose()`	Release the memory used by a Graphics object.
`DrawArc(`*`Pen`*`, `*`X1Integer`*`, `*`Y1Integer`*`, `*`X2Integer`*`, `*`Y2Integer`*`, `*`WidthInteger`*`, `*`HeightInteger`*`)` `DrawArc(`*`Pen`*`, `*`Rectangle`*`, `*`StartAngleSingle`*`, `*`AngleLengthSingle`*`)`	Draw an arc (segment of an ellipse).
`DrawLine(`*`Pen`*`, `*`X1Integer`*`, `*`Y1Integer`*`, `*`X2Integer`*`, `*`Y2Integer`*`)` `DrawLine(`*`Pen`*`, `*`Point1`*`, `*`Point2`*`)`	Draw a line from one point to another.
`DrawEllipse(`*`Pen`*`, `*`XInteger`*`, `*`YInteger`*`, `*`WidthInteger`*`, `*`HeightInteger`*`)` `DrawEllipse(`*`Pen`*`, `*`Rectangle`*`)`	Draw an oval shape. A circle has equal width and height.
`DrawRectangle(`*`Pen`*`, `*`XInteger`*`, `*`YInteger`*`, `*`WidthInteger`*`, `*`HeightInteger`*`)` `DrawRectangle(`*`Pen`*`, `*`Rectangle`*`)`	Draw a rectangle.
`DrawPie(`*`Pen`*`, `*`XInteger`*`, `*`YInteger`*`, `*`WidthInteger`*`, `*`HeightInteger`*`, `*`AngleStartInteger`*`, `*`AngleLengthInteger`*`)` `DrawPie(`*`Pen`*`, `*`Rectangle`*`, `*`AngleStartSingle`*`, `*`AngleLengthSingle`*`)`	Draw a partial circle (segment of a pie).
`DrawString(`*`TextString`*`, `*`Font`*`, `*`Brush`*`, `*`XSingle`*`, `*`YSingle`*`)` `DrawString(`*`TextString`*`, `*`Font`*`, `*`Brush`*`, `*`PointF`*`)`	Draw a string of text. Note that coordinates are single-precision.
`FillEllipse(`*`SolidBrush`*`, `*`XInteger`*`, `*`YInteger`*`, `*`WidthInteger`*`, `*`HeightInteger`*`)` `FillEllipse(`*`SolidBrush`*`, `*`Rectangle`*`)`	Draw a filled oval; a circle for equal width and height.
`FillPie(`*`Brush`*`, `*`XInteger`*`, `*`YInteger`*`, `*`WidthInteger`*`, `*`HeightInteger`*`, `*`AngleStartInteger`*`, `*`AngleLengthInteger`*`)` `FillPie(`*`Brush`*`, `*`Rectangle`*`, `*`AngleStartSingle`*`, `*`AngleLengthSingle`*`)`	Draw a partial filled oval (segment of a pie).
`FillRectangle(`*`SolidBrush`*`, `*`XInteger`*`, `*`YInteger`*`, `*`WidthInteger`*`, `*`HeightInteger`*`)` `FillRectangle(`*`SolidBrush`*`, `*`Rectangle`*`)`	Draw a filled rectangle.

There are a number of other draw and fill methods, like `DrawCurve`, `DrawLines`, `DrawPath`, `FillClosedCurve`, `FillPolygon`, and so forth. See Help for all the draw and fill methods.

Random Numbers

Often it is useful to be able to generate random numbers. The **Random class** contains various methods for returning random numbers of different data types. A Random object is popular for use in games, as well as problems in probability and queuing theory.

```
Dim GenerateRandom As New Random()
```

Unfortunately, the computer can't really generate random numbers. Each time you run an application, the Random object produces the identical sequence of "random" numbers. To generate a different series for each run, use an integer value when you instantiate an object from the Random class. This is called *seeding* the random number generator. You can use the system date and time to get a different seed for each execution of the code.

```
' Instantiate and seed the random number generator.
Dim GenerateRandom As Random = New Random(DateTime.Now.Millisecond)
```

You seed the Random object once when you instantiate it and generate the random numbers using the Random object's **`Next` method**, which returns a positive integer number. You can use one of three overloaded argument lists to choose the range for the random numbers.

The Random.Next Method—General Forms

General Forms

```
' Any positive integer number.
Object.Next()

' A positive integer up to the value specified.
Object.Next(MaximumValueInteger)

' A positive integer in the range specified.
Object.Next(MinimumValueInteger, MaximumValueInteger)
```

The Random.Next Method—Examples

Examples

```
' Return an integer in the range 0 – 10.
GenerateRandomInteger = GenerateRandom.Next(10)

' Return an integer in the range 1 to the width of the form.
RandomNumberInteger = GenerateRandom.Next(1, Me.Width)
```

A Random Number Example

This example program draws graphics using the Graphics methods and generates snowflakes using the `Random.Next` method. Figure 13.3 shows the screen generated by this code.

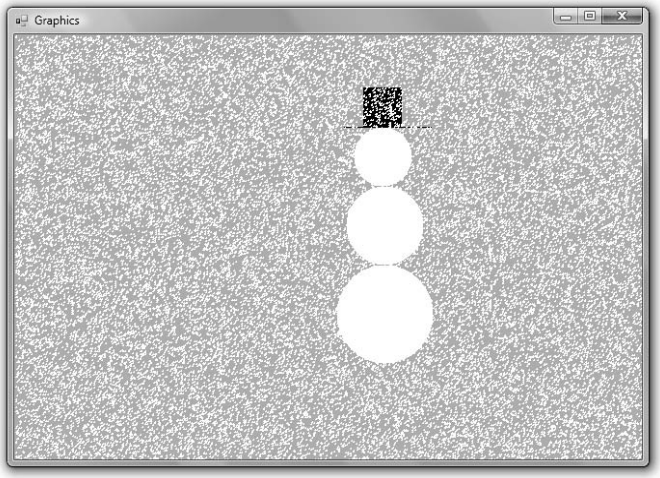


Figure 13.3

This output is produced by the Ch13RandomNumbers example program. The program draws the figure and generates random snowflakes in the form's Paint event handler.

```
'Program:       Chapter 13 Random Numbers
'Programmer:    Bradley/Millspaugh
'Date:          June 2008
'Description:   Draw a snowman using filled ellipses and then snow using
'               random locations.
'Folder:        Ch13RandomNumbers

Public Class GraphicsForm
    ' Declare module-level variable.
    Private GenerateRandom As Random = New Random(DateTime.Now.Millisecond)

    Private Sub GraphicsForm_Paint(ByVal sender As Object, _
      ByVal e As System.Windows.Forms.PaintEventArgs) _
      Handles MyBase.Paint
        ' Generate dots (snowflakes) in random locations.
        ' Draw a snowman at the bottom center of the screen.
        Dim xInteger As Integer = Convert.ToInt32(Me.Width / 2)
        Dim yInteger As Integer = Convert.ToInt32(Me.Height / 2)
        Dim IndexInteger As Integer
        Dim WhitePen As New Pen(Color.White, 2)

        With e.Graphics
            ' Draw the snowman.
            .FillEllipse(Brushes.White, xInteger, yInteger, 100, 100)
            ' Top of last circle.
            yInteger -= 80
            ' Offset for smaller circle.
            xInteger += 10
            .FillEllipse(Brushes.White, xInteger, yInteger, 80, 80)
            yInteger -= 60
            xInteger += 8
            .FillEllipse(Brushes.White, xInteger, yInteger, 60, 60)

            ' Add a top hat.
            .DrawLine(Pens.Black, xInteger - 10, yInteger, _
              xInteger + 80, yInteger)
            .FillRectangle(Brushes.Black, xInteger + 10, yInteger - 40, 40, 40)
```

```
            ' Make it snow in random locations.
            For IndexInteger = 1 To 40000
                xInteger = GenerateRandom.Next(1, Me.Width)
                yInteger = GenerateRandom.Next(1, Me.Height)
                .DrawLine(WhitePen, xInteger, yInteger, _
                  xInteger + 1, yInteger + 1)
            Next
        End With
    End Sub
End Class
```

Feedback 13.1

1. Write the statements necessary to draw a green vertical line down the center of a form.
2. Write the statements to draw one circle inside another one.
3. Write the statements to define three points and draw lines between the points.

TIP

Use the time's millisecond property as a seed for the Random class to generate different random numbers for each execution of the program. ■

Simple Animation

There are several ways to create animation on a form. The simplest way is to display an animated .gif file in a PictureBox control. The animation is already built into the graphic. Other simple ways to create animation are to replace one graphic with another, move a picture, or rotate through a series of pictures. You also can create graphics with the various Graphics methods.

If you want to create animation on a Web page, displaying an animated .gif file is the best way. Another way is to write script using a scripting language such as VBScript or JavaScript or to embed a Java applet, which creates the animation on the client side. It doesn't make any sense to create animation using server-side controls, since each movement would require a round-trip to the server.

Displaying an Animated Graphic

You can achieve animation on either a Windows Form or a Web Form by displaying an animated .gif file (Figure 13.4). Use a PictureBox control on a Windows Form and an Image control on a Web Form.

Note: You can find the graphics for the programs in this chapter in the Graphics folder.

Controlling Pictures at Run Time

You can add or change a picture at run time. To speed execution, it is usually best to have the pictures loaded into controls that you can make invisible until you are ready to display them. But you also can use the **`FromFile` method** of the Image object to load a picture at run time.

Figure 13.4

Create animation by displaying an animated .gif file on either a Windows Form or a Web Form.

If you store a picture in an invisible control, you can change the Visible property to True at run time; or you may decide to copy the picture to another control.

```
LogoPictureBox.Visible = True
LogoPictureBox.Image = InvisiblePictureBox.Image
```

You can use the `FromFile` method to retrieve a file during run time. One problem with this method is that the path must be known. When you are running an application on multiple systems, the path names may vary.

```
LogoPictureBox.Image = Image.FromFile("C:\VB\LOGO.BMP")
```

If you store your image file in your project's bin\Debug folder, you can omit the path. The bin\Debug folder is the default folder for the application's executable file.

```
LogoPictureBox.Image = Image.FromFile("LOGO.BMP")
```

To remove a picture from the display, either hide it or use the `Nothing` constant.

```
LogoPictureBox.Visible = False
LogoPictureBox.Image = Nothing
```

Switching Images

An easy way to show some animation is to replace one picture with another. Many of the icons in the Visual Studio icon library have similar sizes but opposite states, such as a closed file cabinet and an open file cabinet; a mailbox with the flag up and with the flag down; a closed envelope and an open envelope; or a traffic light in red, yellow, or green.

This sample program demonstrates switching between two phone icons: a phone and a phone being held. The program has three PictureBox controls: one to display the selected image and two, with their Visible property set to False, to

hold the two phone images. The two icons are Phone12.ico and Phone13.ico in the Graphics\MicrosoftIcons folder in StudentData. When the user clicks the *Change* button, the icon is switched to the opposite one. (See Figure 13.5.)

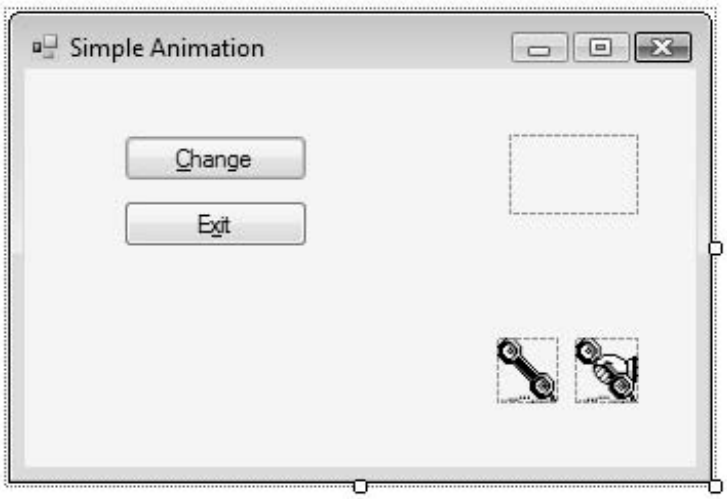


Figure 13.5

Create animation by switching from one icon to another. Each of these graphics is placed into the upper picture box when the user clicks the Change *button.*

```
'Program:       Chapter 13 Simple Animation
'Programmer:    Bradley/Millspaugh
'Date:          June 2008
'Description:   Change a picture of a phone to show someone holding it.
'Folder:        Ch13SimpleAnimation

Public Class AnimationForm
    Private Sub ExitButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ExitButton.Click
        ' End the program.

        Me.Close()
    End Sub

    Private Sub ChangeButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ChangeButton.Click
        ' Toggle the image from one to the other.
        Static SwitchBoolean As Boolean = True

        If SwitchBoolean Then
            DisplayPictureBox.Image = WithHandPictureBox.Image
            SwitchBoolean = False
        Else
            DisplayPictureBox.Image = PhonePictureBox.Image
            SwitchBoolean = True
        End If
    End Sub
```

```
    Private Sub AnimationForm_Load(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles MyBase.Load
        ' Set the initial image.

        DisplayPictureBox.Image = PhonePictureBox.Image
    End Sub
End Class
```

Moving a Picture

The best way to move a control is to use the control's **`SetBounds` method**. The `SetBounds` method produces a smoother-appearing move than the move that is produced by changing the Left and Top properties of controls.

The SetBounds Method—General Form

General Form

```
SetBounds(XInteger, YInteger, WidthInteger, HeightInteger)
```

You can use a control's `SetBounds` method to move it to a new location and/or to change its size.

The SetBounds Method—Examples

Examples

```
PlanePictureBox.SetBounds(XInteger, YInteger, PlaneWidthInteger, PlaneHeightInteger)

EnginePictureBox.SetBounds(XInteger, YInteger, WidthInteger, HeightInteger)
```

The program example in the next section uses a timer and the `SetBounds` method to move a graphic across the screen.

The Timer Component

Generally events occur when the user takes an action. But what if you want to make events occur at some interval, without user action? You can cause events to occur at a set interval using the **Timer component** and its **Tick event**. Timers are very useful for animation; you can move or change an image each time the Tick event occurs.

When you have a Timer component on a form, it "fires" each time an interval elapses. You can place any desired code in the Tick event procedure; the code executes each time the event occurs. You choose the interval for the timer by setting its **Interval property**, which can have a value of 0 to 65,535. This value specifies the number of milliseconds between the calls to the Tick event. One second is equivalent to 1,000 milliseconds. Therefore, for a three-second delay, set the timer's Interval property to 3,000. You can set the value at run time or at design time.

You can keep the Tick event from occurring by setting the Timer's Enabled property to False. The default value is False, so you must set it to True when

you want to enable the Timer. You can set the Enabled property at design time or run time.

When you add a timer to your form, it goes into the component tray. The tool for the timer is represented by the little stopwatch in the toolbox (Figure 13.6).

This Timer example program achieves animation in two ways: It moves an animated .gif file for a steam engine across the screen. When the steam engine moves off the left edge of the form, it reappears at the right edge, so it comes around again. Figure 13.7 shows the form. You'll have to use your imagination for the animation.

Figure 13.6

The tool for the Timer component in the toolbox.

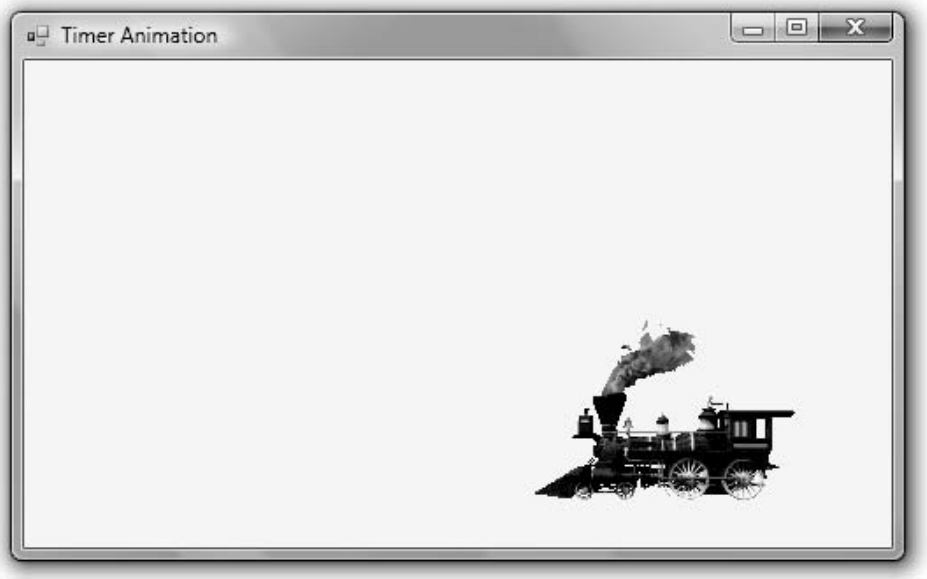


Figure 13.7

Each time the Timer fires, the train moves 10 pixels to the left.

```
'Program         Ch13 Timer Animation
'Programmer:     Bradley/Millspaugh
'Date:           June 2008
'Description:    Move a steam engine across the screen.
'                It reappears on the other side after leaving the screen.
'Folder:         Ch13TimerAnimation

Public Class TimerForm

    Private Sub TrainTimer_Tick(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles TrainTimer.Tick
        ' Move the graphic across the form.

        Static XInteger As Integer = EnginePictureBox.Left
        Static YInteger As Integer = EnginePictureBox.Top
        Static WidthInteger As Integer = EnginePictureBox.Width
        Static HeightInteger As Integer = EnginePictureBox.Height
```

```
        ' Set new X coordinate.
        XInteger -= 10
        If XInteger <= -EnginePictureBox.Width Then
            ' Graphic entirely off edge of form; reset it.
            XInteger = Me.Width
        End If
        ' Move image.
        EnginePictureBox.SetBounds(XInteger, YInteger, _
          WidthInteger, HeightInteger)
    End Sub
End Class
```

Feedback 13.2

1. Write the statement(s) to move CommandButton 10 pixels to the left using the `SetBounds` method
2. How long is an interval of 450?
3. What fires a Timer's Tick event?

The Scroll Bar Controls

You can add **horizontal scroll bars** and **vertical scroll bars** to your form (Figure 13.8). These scroll bar controls are similar to the scroll bars in Windows that can be used to scroll through a document or window. Often scroll bars are used to control sound level, color, size, and other values that can be changed in small amounts or large increments. The HScrollBar control and VScrollBar control operate independently of other controls and have their own methods, events, and properties.

Figure 13.8

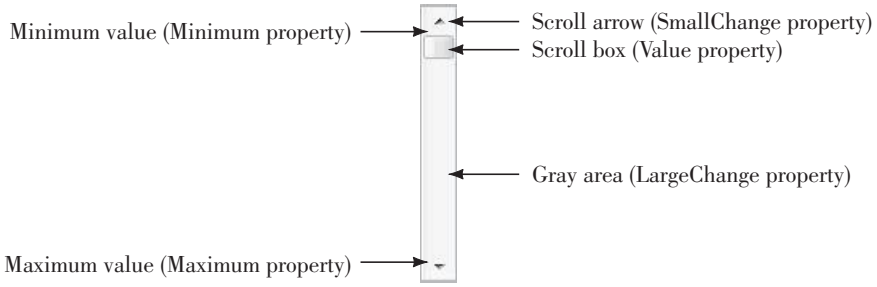
Horizontal scroll bars and vertical scroll bars can be used to select a value over a given range.

Scroll Bar Properties

Properties for scroll bars are somewhat different from the controls we have worked with previously. Because the scroll bars represent a range of values,

they have the following properties: **Minimum** for the minimum value, **Maximum** for the maximum value, **SmallChange** for the distance to move when the user clicks on the scroll arrows, and **LargeChange** for the distance to move when the user clicks on the gray area of the scroll bar or presses the Page-Up or Page-Down keys (Figure 13.9). Each of these properties has a default value (Table 13.2).

Figure 13.9



Clicking on the scroll arrow changes the Value property by SmallChange amount; clicking the gray area of the scroll bar changes the Value property by LargeChange amount.

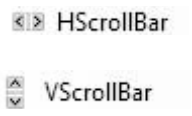
Table 13.2 **Default Values for Scroll Bar Properties**

Property	Default Value
Minimum	0
Maximum	100
SmallChange	1
LargeChange	10
Value	0

The **Value property** indicates the current position of the scroll box (also called the *thumb*) and its corresponding value within the scroll bar. When the user clicks the up arrow of a vertical scroll bar, the Value property decreases by the amount of SmallChange (if the Minimum value has not been reached) and moves the scroll box up. Clicking the down arrow causes the Value property to increase by the amount of SmallChange and moves the thumb down until it reaches the bottom or Maximum value.

Figure 13.10 shows the horizontal scroll bar tool and vertical scroll bar tool from the toolbox.

Figure 13.10



The toolbox tools for horizontal scroll bars and vertical scroll bars.

Scroll Bar Events

The events that occur for scroll bars differ from the ones used for other controls. Although a user might click on the scroll bar, there is no Click event; rather there are two events: a **ValueChanged event** and a **Scroll event**. The ValueChanged event occurs any time that the Value property changes, whether it's changed by the user or by the code.

If the user drags the scroll box, a Scroll event occurs. In fact, multiple scroll events occur, as long as the user continues to drag the scroll box. As soon as the user releases the mouse button, the Scroll events cease and a ValueChanged event occurs. When you write code for a scroll bar, usually you will want to code both a ValueChanged event procedure and a Scroll event procedure.

A Programming Example

This little program uses scroll bars to move an image of cars around inside a container (Figure 13.11). The image is in a PictureBox, and a GroupBox is the container. By placing the image inside a container, you use the container's coordinates rather than those of the form.

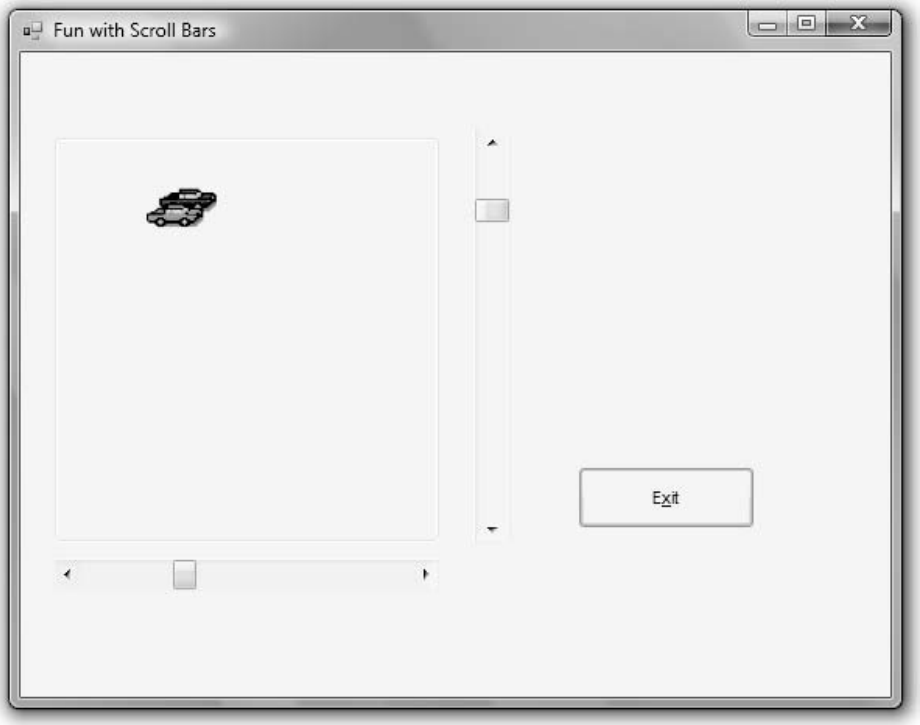


Figure 13.11

The form for the scroll bar programming example. Move the cars around inside the container using the scroll bars.

A horizontal scroll bar will make the image move sideways in the container, and the vertical scroll bar will make it move up and down. Although you want the Maximum properties of the scroll bars to reflect the height and width of the container, due to the shape of the image, you may need to set the properties using trial and error. For example, the width of the GroupBox is 247 pixels but the Maximum property of the horizontal scroll bar is set to 210; that's the point at which a car's bumper touches the edge of the container.

```
'Program:       Ch13ScrollBars
'Programmer:    Bradley/Millspaugh
'Date:          June 2008
'Description:   Use scroll bars to move an image
'               horizontally and vertically within the
'               limits of a group box.
'Folder:        Ch13ScrollBars

Public Class ScrollForm

    Private Sub ExitButton_Click(ByVal Sender As System.Object, _
      ByVal e As System.EventArgs) Handles ExitButton.Click
        ' Terminate the project.

        Me.Close()
    End Sub

    Private Sub MoveCarHorizontalScrollBar_Scroll(ByVal sender _
      As System.Object, ByVal e As System.Windows.Forms.ScrollEventArgs) _
      Handles MoveCarHorizontalScrollBar.Scroll
        ' Control the side-to-side movement.
        ' Used when scroll box is moved.

        CarPictureBox.Left = MoveCarHorizontalScrollBar.Value
    End Sub

    Private Sub MoveCarVerticalScrollBar_Scroll(ByVal sender _
      As System.Object, ByVal e As System.Windows.Forms.ScrollEventArgs) _
      Handles MoveCarVerticalScrollBar.Scroll
        ' Position the up and down movement.
        ' Used when the scroll box is moved.

        CarPictureBox.Top = MoveCarVerticalScrollBar.Value
    End Sub

    Private Sub MoveCarVerticalScrollBar_ValueChanged(ByVal sender _
      As Object, ByVal e As System.EventArgs) _
      Handles MoveCarVerticalScrollBar.ValueChanged
        ' Position the up and down movement.
        ' Used for arrow clicks.

        CarPictureBox.Top = MoveCarVerticalScrollBar.Value
    End Sub

    Private Sub MoveCarHorizontalScrollBar_ValueChanged(ByVal sender _
      As Object, ByVal e As System.EventArgs) _
      Handles MoveCarHorizontalScrollBar.ValueChanged
        ' Control the side-to-side movement.
        ' Used for arrow clicks.

        CarPictureBox.Left = MoveCarHorizontalScrollBar.Value
    End Sub
End Class
```

Playing Sounds

It's fun to add sound to an application. Your computer plays sounds as you turn it on or off. There's also likely a sound when you receive e-mail. You can make your program play sound files, called wave files (.wav), by using `My.Computer.Audio.Play`.

Adding Sound Files to the Resources for a Project

When you plan to use sounds in a project, the best plan is to add the files to the project's resources. Open the Project Designer (*Project / ProjectName Properties*) and click on the *Resources* tab (Figure 13.12). Drop down the *Add* list and choose *Existing File* to add an existing file to your project. You can browse to find the file wherever it is; the file will be copied into a Resources folder in the project.

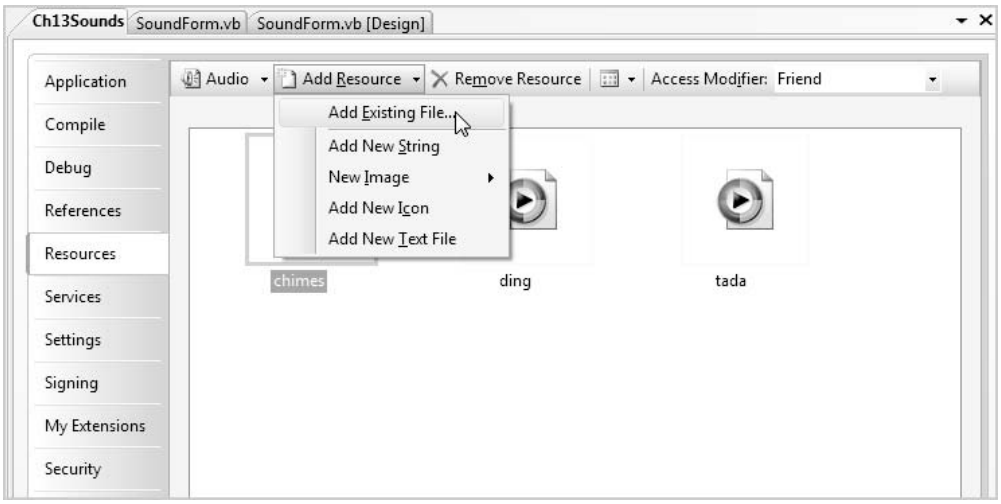
When you want to refer to the filename in code, use this form: `"My.Resources.Filename"`.

Example

```
My.Computer.Audio.Play(My.Resources.chimes, AudioPlayMode.WaitToComplete)
```

Figure 13.12

Add sound files to the project resources in the Resources *tab of the Project Designer.*



A Sound-Playing Program

The following program (Figure 13.13) plays three different sounds found in the Windows\Media folder or allows the user to select a file using the OpenFileDialog component. The filter property for the OpenFileDialog is set to wave files (WAV Files (*.wav)|*.wav).

Figure 13.13

The user can choose to play one of three preselected sounds or select a .wav file to play.

```
'Program:       Chapter 13 Sounds
'Programmer:    Bradley/Millspaugh
'Date:          June 2008
'Description:   Play sounds using a SoundPlayer component and My.Computer.Audio.Play.
'Folder:        Ch13Sounds

Public Class SoundForm

    Private Sub ChimesButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ChimesButton.Click
        ' Play the chimes sound.

        ' Play the sound using My.Computer and My.Resources.
        My.Computer.Audio.Play(My.Resources.chimes, AudioPlayMode.WaitToComplete)
    End Sub

    Private Sub DingButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles DingButton.Click
        ' Play the ding sound.

        ' Play the sound using My.Computer and My.Resources.
        My.Computer.Audio.Play(My.Resources.ding, AudioPlayMode.WaitToComplete)
    End Sub

    Private Sub TadaButton_Click(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles TadaButton.Click
        ' Play the tada sound.

        ' Play the sound using My.Computer and My.Resources.
        My.Computer.Audio.Play(My.Resources.tada, AudioPlayMode.WaitToComplete)
    End Sub

    Private Sub SelectButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles SelectButton.Click
        ' Allow user to select the sound file.
```

```
        If OpenFileDialog1.ShowDialog() = DialogResult.OK Then
            My.Computer.Audio.Play(OpenFileDialog1.FileName.ToString)
        End If
    End Sub
End Class
```

If you want to have a sound play as the application opens, you can play the sound in the Form_Load or Form Activate event procedure.

Playing Videos

You have seen how to play sounds using `My.Computer.Audio`. If you would like to include a video in your Windows application, use the Windows Media Player control (Figure 13.14), which can play audio and video files in many formats, including .avi, .wmv, and .wav.

Figure 13.14

Place a Windows Media Player control on a form to play an audio or video file.

Using the Windows Media Player Control

The Windows Media Player control does not appear in the Visual Studio toolbox by default, so you must add it. Right-click on the toolbox and select *Choose Items*. You will find the control on the COM components tab. Place a check mark in the box and press *OK* to add the control. Then you can place a Windows Media Player control on your form.

The URL property of the control determines the file that plays. If you set the property at design time, you must include a hard-coded path, and the file

begins playing when the program loads. You also can control the URL property at run time. If you want to copy the files into the project folder for greater portability, place the files in the bin\Debug folder. Although you can use Resources for audio files, at this point Resources cannot handle video files.

You can set several properties of the Windows Media Player control. If you wish to just play sound, you may choose to set the visibility to False. Set `Ctlenabled` to True to allow the user access to the *Play*, *Pause*, and *Stop* buttons. Set the URL property to the path and filename to play, and choose whether the loaded file will begin playing automatically with the settings. autoStart property. For example, set `WindowsMediaPlayer1.settings.autoStart = False` so that the video won't begin playing until the user clicks the *Play* button. By default autoStart is set to True, so the video starts playing as soon as it is loaded.

The following program allows the user to select and play a sample file by choosing the file type from a list box. It then assigns the URL property in a `Select Case` statement in the list box Selection Committed event procedure.

```
'Program:        Ch13Video
'Programmer:     Bradley/Millspaugh
'Date:           June 2008
'Description:    Uses a Windows media player for wmv, avi, and wav files.
'                Video files are stored in bin\Debug to make the project portable.

Public Class MediaForm

    Private Sub MediaComboBox_SelectionChangeCommitted(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles MediaComboBox.SelectionChangeCommitted
        ' Select the type of file.
        Dim SelectString = System.IO.Directory.GetCurrentDirectory

        With WindowsMediaPlayer1
            Select Case MediaComboBox.SelectedIndex
                Case 0
                    .URL = SelectString & "\bear.wmv"
                Case 1
                    .URL = SelectString & "\music.avi"
                Case 2
                    .URL = SelectString & "\applause.wav"
                Case Else
                    MessageBox.Show("Please select media type.")
            End Select
        End With
    End Sub

    Private Sub MediaForm_Load(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles MyBase.Load
        ' Enable the controls on the player.

        With WindowsMediaPlayer1
            .Ctlenabled = True
            .settings.autoStart = False
        End With
    End Sub
End Class
```

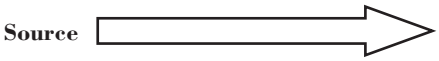
Drag-and-Drop Programming

Often Windows users use drag-and-drop events rather than selecting a menu item or pressing a button. For example, you can copy or move files in My Computer by dragging the file and dropping it on the new location icon.

Drag-and-drop programming requires you to begin the drag-drop with a **MouseDown event** and determine the effect of the drop with a **DragEnter event**. The event that holds the code for the drop is the **DragDrop event**. Figure 13.15 shows the objects and events for a drag-and-drop operation.

Figure 13.15

The source object is dragged to the target object in a drag-and-drop operation.



In MouseDown or MouseMove event: DoDragDrop method.	AllowDrop property must be set to True.
In MouseEnter event (Optional): Set cursor to give feedback that a drag will occur.	In DragEnter event: Set DragDrop effect (Move or Copy).
	In DragDrop event: Code to add dragged object to target.

The Source Object

The item that you wish to drag is commonly referred to as the source object. With .NET programming you begin a drag-drop operation by setting the source object using a control's **`DoDragDrop` method**.

The DoDragDrop Method—General Form

General Form

```
ObjectName.DoDragDrop(DataToDrag, DesiredDragDropEffect)
```

The DragDrop effect specifies the requested action for the operation. Choices include `DragDropEffects.Copy`, `DragDropEffects.Move`, and `DragDropEffects.None`.

The DoDragDrop Method—Example

Example

```
With NameTextBox
     .DoDragDrop(.SelectedText, DragDropEffects.Move)
End With
```

Look at the following MouseDown event procedure. First, an `If` statement checks to see if the user pressed the left mouse button. If so, the contents of the text box are selected and the effect of the drag is set to a move operation.

```
Private Sub NameTextBox_MouseDown(ByVal sender As Object, _
  ByVal e As System.Windows.Forms.MouseEventArgs) _
  Handles NameTextBox.MouseDown
    ' Select contents of the text box and invoke the drag/drop.

    If e.Button = Windows.Forms.MouseButtons.Left Then
        With NameTextBox
            .SelectAll()
            .DoDragDrop(.SelectedText, DragDropEffects.Move)
        End With
    End If
End Sub
```

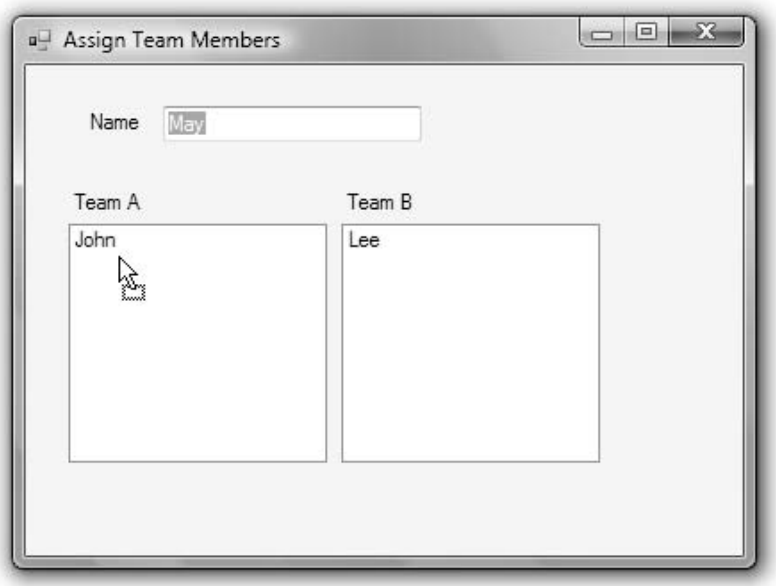
The Target Object

The location at which a user releases the mouse, a drop, is the target. A form may have multiple targets. To set a control to be a target, set its **AllowDrop property** to True. The target control needs a DragEnter event procedure that sets the effect and a DragDrop event procedure that executes the action to take when the drop takes place.

In the following example program (Figure 13.16), the value in a text box can be transferred to one of two list boxes. Each list box would be a potential target and must have its AllowDrop property set to True. And each target object needs a DragEnter event procedure and a DragDrop event procedure.

Figure 13.16

The user types a name in the top text box and then drags the name to one of two list boxes.



The DragEnter Event

When the user drags a source object over the target, the target control's DragEnter event fires. Notice in the DragEnter's procedure header that the `e` argument is defined as `DragEventArgs`, which has some special properties for the drag operation. You assign the desired effect to the `e` argument.

```
Private Sub TeamAListBox_DragEnter(ByVal sender As Object, _
  ByVal e As System.Windows.Forms.DragEventArgs) _
  Handles TeamAListBox.DragEnter
     ' Set the desired DragDrop effect.

     e.Effect = DragDropEffects.Move
End Sub
```

The DragDrop Event

Assume that when the user drops the text value on a list box we want to add the value to the Items collection for the list and clear the original text box. The statements to perform these actions are entered into the DragDrop event for the list box.

The data that are being dragged are contained in the Data property of the `e` argument of the DragDrop event procedure. You can retrieve the dragged data using the `GetData` method of the Data object. You also can format the data yourself or use a predefined clipboard data format. The predefined format for text is `DataFormats.Text`.

```
Private Sub TeamAListBox_DragDrop(ByVal sender As Object, _
  ByVal e As System.Windows.Forms.DragEventArgs) _
  Handles TeamAListBox.DragDrop
     ' Add the item to the list box.

     TeamAListBox.Items.Add(e.Data.GetData(DataFormats.Text).ToString())
     NameTextBox.Clear()
End Sub
```

Note: .NET actually allows the target to be outside the current application, but that topic is beyond the scope of this text.

The Drag-and-Drop Program

Following is the completed program that is illustrated in Figure 13.16.

```
'Program        Chapter 13 Drag and Drop
'Programmer:    Bradley/Millspaugh
'Date:          June 2008
'Description:   Drag a name from the text box and drop on a list.
'Folder:        Ch13DragDropListBoxes

Public Class TeamAssignmentForm

    Private Sub NameTextBox_MouseDown(ByVal sender As Object, _
      ByVal e As System.Windows.Forms.MouseEventArgs) _
      Handles NameTextBox.MouseDown
        ' Select contents of the text box and invoke the drag/drop.
        If e.Button = Windows.Forms.MouseButtons.Left Then
            With NameTextBox
                .SelectAll()
                .DoDragDrop(.SelectedText, DragDropEffects.Move)
            End With
        End If
    End Sub
```

```
    Private Sub TeamAListBox_DragDrop(ByVal sender As Object, _
      ByVal e As System.Windows.Forms.DragEventArgs) _
      Handles TeamAListBox.DragDrop
        ' Add the item to the list box.

        TeamAListBox.Items.Add(e.Data.GetData(DataFormats.Text).ToString())
        NameTextBox.Clear()
    End Sub

    Private Sub TeamAListBox_DragEnter(ByVal sender As Object, _
      ByVal e As System.Windows.Forms.DragEventArgs) _
      Handles TeamAListBox.DragEnter
        ' Set the desired DragDrop effect.

        e.Effect = DragDropEffects.Move
    End Sub

    Private Sub TeamBListBox_DragDrop(ByVal sender As Object, _
      ByVal e As System.Windows.Forms.DragEventArgs) _
      Handles TeamBListBox.DragDrop
        ' Add the item to the list box.

        TeamBListBox.Items.Add(e.Data.GetData(DataFormats.Text).ToString())
        NameTextBox.Clear()
    End Sub

    Private Sub TeamBListBox_DragEnter(ByVal sender As Object, _
      ByVal e As System.Windows.Forms.DragEventArgs) _
      Handles TeamBListBox.DragEnter
        ' Set the desired DragDrop effect.

        e.Effect = DragDropEffects.Move
    End Sub

    Private Sub NameTextBox_MouseEnter(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles NameTextBox.MouseEnter
        ' Set the mouse pointer to give feedback that a drag is legal.

        With NameTextBox
            If .Text <> "" Then
                .SelectAll()
                .Cursor = Cursors.Arrow
            Else
                .Cursor = Cursors.IBeam
            End If
        End With
    End Sub
End Class
```

Dragging and Dropping an Image

You also can drag and drop images (Figure 13.17), but with one small difference. The AllowDrop property of a PictureBox is not available at design time, but you can set it in the Form_Load event procedure.

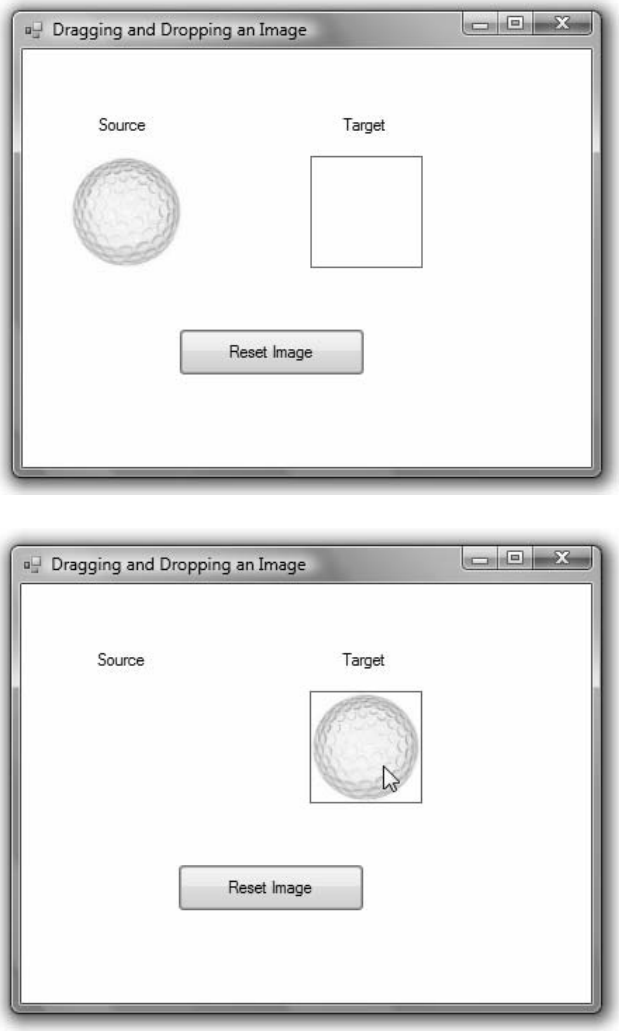
```
TargetPictureBox.AllowDrop = True
```

To make the drop appear like a move, set the original picture box image to *Nothing*. To make it a copy, you could leave the original alone.

```
Private Sub TargetPictureBox_DragDrop(ByVal sender As Object, _
  ByVal e As System.Windows.Forms.DragEventArgs) _
  Handles TargetPictureBox.DragDrop
    ' Assign the image to the target; original is erased.

    TargetPictureBox.Image = SourcePictureBox.Image
    SourcePictureBox.Image = Nothing
End Sub
```

Figure 13.17

The user can drag the source image and drop it on the target control.



The DragDropImage Program

```
'Program         Ch13DragDropImage
'Programmer:     Bradley/Millspaugh
'Date:           June 2008
'Description:    Use a picture box for the source and target in a drag and
'                drop operation.

Public Class DragDropForm

    Private Sub DragDropForm_Load(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles MyBase.Load
        ' Set the AllowDrop for the target.
```

```
        TargetPictureBox.AllowDrop = True
    End Sub

    Private Sub SourcePictureBox_MouseMove(ByVal sender As Object, _
      ByVal e As System.Windows.Forms.MouseEventArgs) _
      Handles SourcePictureBox.MouseMove
        ' Drag the picture.

        SourcePictureBox.DoDragDrop(SourcePictureBox.Image, DragDropEffects.Move)
    End Sub

    Private Sub TargetPictureBox_DragDrop(ByVal sender As Object, _
      ByVal e As System.Windows.Forms.DragEventArgs) _
      Handles TargetPictureBox.DragDrop
        ' Assign the image to the target; original is erased.

        TargetPictureBox.Image = SourcePictureBox.Image
        SourcePictureBox.Image = Nothing
    End Sub

    Private Sub TargetPictureBox_DragEnter(ByVal sender As Object, _
      ByVal e As System.Windows.Forms.DragEventArgs) _
      Handles TargetPictureBox.DragEnter
        ' Set the effect to a move.

        e.Effect = DragDropEffects.Move
    End Sub

    Private Sub ResetButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ResetButton.Click
        ' Clear the target image and reset the orginal.

        SourcePictureBox.Image = TargetPictureBox.Image
        TargetPictureBox.Image = Nothing
    End Sub
End Class
```

Feedback 13.3

1. Code the DragEnter event for TaskListBox that will copy the value received in a drag operation.
2. Write the statement for the DragDrop method to add the value to the list box.

Your Hands-On Programming Example

Create a project that will draw a pie chart showing the relative amount of sales for Books, Periodicals, and Food for R 'n R—For Reading and Refreshment.

Include text boxes for the user to enter the sales amount for Books, Periodicals, and Food. Include buttons for *Display Chart*, *Clear*, and *Exit*.

Calculate the values for the pie chart in the *Display Chart* button's Click event procedure and use a `Refresh` method to force the form's Paint event to occur. In the form's Paint event procedure, use the `CreateGraphics.FillPie` method to draw each of the pie segments.

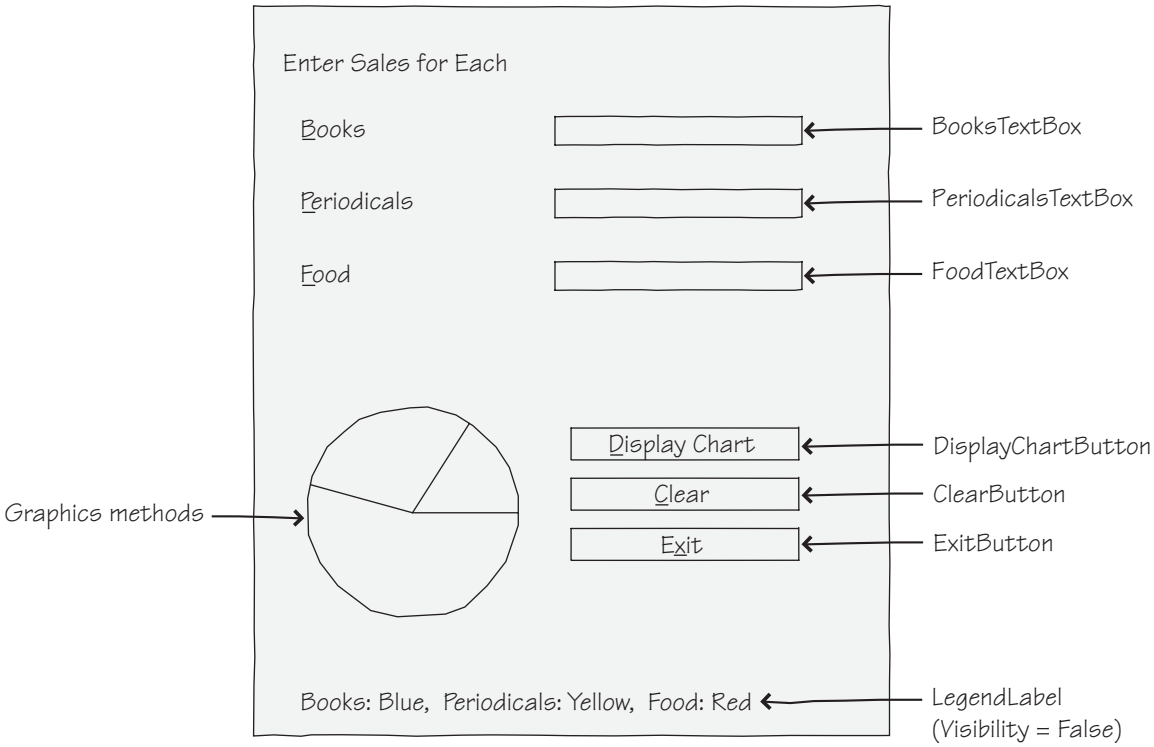
```
Me.CreateGraphics.FillPie(Brush, XInteger, YInteger, WidthInteger, HeightInteger, _
  BeginAngleInteger, LengthInteger)
```

Planning the Project

Sketch a form (Figure 13.18) that your users sign off as meeting their needs.

Figure 13.18

A planning sketch of the hands-on programming example.



Plan the Objects and Properties Plan the property settings for the form and each control.

Object	Property	Setting
Form	Name	PieChartForm
	Text	R 'n R Sales Pie Chart
	AcceptButton	DisplayChartButton
	CancelButton	ClearButton
Label1	Name	Label1
	Text	Enter Sales for Each
Label2	Name	Label2
	Text	&Books
BooksTextBox	Name	BooksTextBox
	Text	(blank)
Label3	Name	Label3
	Text	&Periodicals
PeriodicalsTextBox	Name	PeriodicalsTextBox
	Text	(blank)
Label4	Name	Label4
	Text	&Food

Object	Property	Setting
FoodTextBox	Name	FoodTextBox
	Text	(blank)
LegendLabel	Name	LegendLabel
	Text	Books: Blue, Periodicals: Yellow, Food: Red
	Visible	False
DisplayChartButton	Name	DisplayChartButton
	Text	&Display Chart
ClearButton	Name	ClearButton
	Text	&Clear Sale
ExitButton	Name	ExitButton
	Text	E&xit

Plan the Event Procedures

Event Procedure	Actions—Pseudocode

DisplayChartButton_Click	If text fields are numeric
	  Find each category sales.
	  Find total sales.
	  Force form to repaint (Refresh).

Form_Paint	If DrawChartBoolean
	  If total sales <> 0
	  Make legend visible.
	  Calculate ratio of each department to total sales.
	  Draw portions of the pie for each department.
	Else
	  Clear chart.

ClearButton_Click	Set each text box and label to blanks. Set the focus in the first text box. Set DrawChartBoolean = False. Force form to repaint (Refresh).
ExitButton_Click	Exit the project.

Write the Project Following the sketch in Figure 13.18, create the form. Figure 13.19 shows the completed form.

- Set the properties of each of the objects, as you have planned.
- Write the code. Working from the pseudocode, write each event procedure.
- When you complete the code, use a variety of test data to thoroughly test the project.

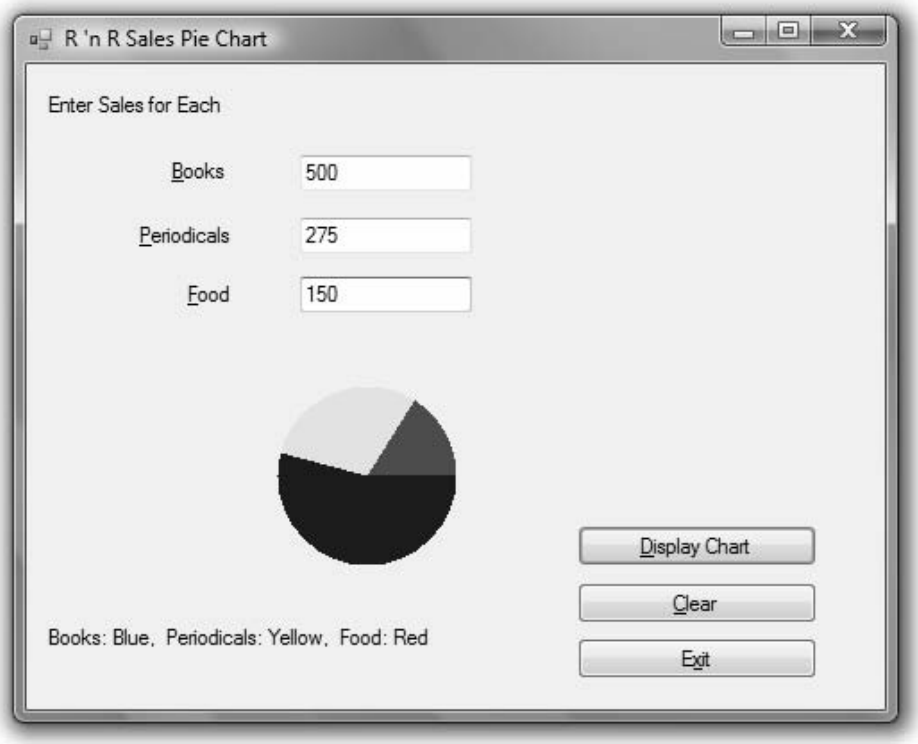


Figure 13.19

The form for the hands-on programming example.

The Project Coding Solution

```
'Program:       Chapter 13 Pie Chart Hands On
'Programmer:    Bradley/Millspaugh
'Date:          June 2008
'Description:   Draw a chart for relative sales amounts.
'Folder:        Ch13PieChart

Public Class PieChartForm

    Private TotalSalesDecimal, BookSalesDecimal, PeriodicalSalesDecimal, _
      FoodSalesDecimal As Decimal
    Private DrawChartBoolean As Boolean = False

    Private Sub DisplayChartButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles DisplayChartButton.Click
        ' Display a pie chart showing relative sales by department.
```

```
        ' Need total sales amount.
        Try
            BookSalesDecimal = Decimal.Parse(BooksTextBox.Text)
            Try
                PeriodicalSalesDecimal = Decimal.Parse(PeriodicalsTextBox.Text)
                Try
                    FoodSalesDecimal = Decimal.Parse(FoodTextBox.Text)
                    TotalSalesDecimal = BookSalesDecimal + PeriodicalSalesDecimal _
                      + FoodSalesDecimal
                    DrawChartBoolean = True
                Catch
                    MessageBox.Show("Invalid Food Sales")
                    FoodTextBox.Focus()
                End Try
            Catch
                MessageBox.Show("Invalid Periodical Sales")
                PeriodicalsTextBox.Focus()
            End Try
        Catch
            MessageBox.Show("Invalid Book Sales")
            BooksTextBox.Focus()
        End Try

        ' Force a Paint of the form.
        Refresh()
    End Sub

    Private Sub ExitButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ExitButton.Click
        ' End the project.

        Me.Close()
    End Sub

    Private Sub ClearButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ClearButton.Click
        ' Clear the screen controls.

        FoodTextBox.Clear()
        PeriodicalsTextBox.Clear()
        With BooksTextBox
            .Clear()
            .Focus()
        End With
        LegendLabel.Visible = False
        DrawChartBoolean = False
        Refresh()
    End Sub

    Private Sub PieChartForm_Paint(ByVal sender As Object, _
      ByVal e As System.Windows.Forms.PaintEventArgs) Handles Me.Paint
        Dim xCenterInteger As Integer = 140
        Dim yCenterInteger As Integer = 180
        Dim ClearBrush As New SolidBrush(PieChartForm.DefaultBackColor)
```

```
        If DrawChartBoolean Then
            ' Create the pie chart.
            ' Amounts are a portion of the total circle of 360 degrees.
            ' The pie graphic includes a start angle and end angle.
            If TotalSalesDecimal <> 0 Then
                LegendLabel.Visible = True
                ' Find the end of the book portion of 360 degrees.
                Dim EndBooksInteger As Integer = _
                   Convert.ToInt32(BookSalesDecimal / TotalSalesDecimal * 360)
                e.Graphics.FillPie(Brushes.Blue, xCenterInteger, yCenterInteger, _
                  100, 100, 0, EndBooksInteger)
                ' Find the end of the Periodicals portion.
                  Dim EndPeriodicalsInteger As Integer = _
                    Convert.ToInt32(PPeriodicalSalesDecimal / TotalSalesDecimal * 360)
                e.Graphics.FillPie(Brushes.Yellow, xCenterInteger, yCenterInteger, 100, 100, _
                  EndBooksInteger, EndPeriodicalsInteger)
                Dim EndFoodInteger As Integer = _
                  Convert.ToInt32(FoodSalesDecimal / TotalSalesDecimal * 360)
                e.Graphics.FillPie(Brushes.Red, xCenterInteger, yCenterInteger, 100, 100, _
                  EndPeriodicalsInteger + EndBooksInteger, EndFoodInteger)
            End If
        Else
            e.Graphics.FillEllipse(ClearBrush, xCenterInteger, yCenterInteger, 100, 100)
        End If
    End Sub
End Class
```

Summary

1. A drawing surface is created with a Graphics object.
2. The Graphics methods should appear in the form's Paint event procedure so that the graphics are redrawn every time the form is repainted.
3. Pen objects are used for lines and the outline of shapes; brushes are used for filled shapes.
4. Measurements in drawings are in pixels.
5. The coordinate system begins with (0, 0) at the upper-left corner of the container object.
6. You can declare a Point structure, a Size structure, or a Rectangle structure to use as arguments in the Graphics methods.
7. You can generate random numbers using the Random class. Seed the random number generator when instantiating a variable of the class; use the `Next` method to generate a series of numbers.
8. An animated .gif file can be displayed in a PictureBox control to display animation on a Windows Form or a Web Form.
9. Animation effects can be created by using similar pictures and by controlling the location and visibility of controls.
10. Pictures can be loaded, moved, and resized at run time.
11. The Timer component can fire a Tick event that occurs at specified intervals, represented in milliseconds.

12. Scroll bar controls are available for both horizontal and vertical directions. Properties include Minimum, Maximum, SmallChange, LargeChange, and Value. Scroll and ValueChanged events are used to respond to the action.
13. Use `My.Computer.Audio.Play` for wave (.wav) sound files in the Resources folder.
14. Drag-and-drop programming allows a source object to be dropped on a target object. The target control has its AllowDrop property set to True. The source control calls the `DoDragDrop` method in its MouseDown event. The target control sets the effect of the drag in the DragEnter event and the results in the DragDrop event.

Key Terms

AllowDrop property *548*
Brush object *527*
`DoDragDrop` method *547*
DragDrop event *547*
DragEnter event *547*
`DrawLine` method *530*
`DrawRectangle` method *530*
`FillEllipse` method *530*
`FromFile` method *534*
graphics *526*
horizontal scroll bar *539*
Interval property *537*
LargeChange property *540*
Maximum property *540*
Minimum property *540*
MouseDown event *547*
`Next` method *532*
Pen object *527*
pixel *527*
Point structure *529*
Random class *532*
Rectangle structure *530*
Scroll event *541*
`SetBounds` method *537*
Size structure *529*
SmallChange property *540*
Tick event *537*
Timer component *537*
Value property *540*
ValueChanged event *541*
vertical scroll bar *539*

Review Questions

1. What is a pixel?
2. What class contains the Graphics methods?
3. Describe two ways to add a Graphics object to a form.
4. Name three methods available for drawing graphics.
5. How is a pie-shaped wedge created?
6. Differentiate between using a Brush and a Pen object.
7. Which function loads a picture at run time?
8. How can you remove a picture at run time?
9. What steps are necessary to change an image that contains a turned-off light bulb to a turned-on light bulb?
10. What is the purpose of the Timer component?
11. Explain the purpose of these scroll bar properties: Minimum, Maximum, SmallChange, LargeChange, and Value.

12. What determines the file to be played by a SoundPlayer?
13. Explain the purpose of the following events for a drag-and-drop operation:
    a. `MouseDown`
    b. `DragEnter`
    c. `DragDrop`
14. Explain the parameters of the `DoDragDrop` method.

Programming Exercises

13.1 Create a project that contains two buttons labeled "Smile" and "Frown". The *Smile* button will display a happy face; *Frown* will display a sad face. Use Graphics methods to draw the two faces.
Optional: Add sound effects when the faces appear.

13.2 Use Graphics methods to create the background of a form. Draw a picture of a house, including a front door, a window, and a chimney.

13.3 Use a PictureBox control with a .bmp file from Windows. Set the SizeMode property to StretchImage. Use scroll bars to change the size of the image.

13.4 Use graphics from any clip art collection to create a project that has a button for each month of the year. Have an appropriate image display in a PictureBox for each month.

13.5 Use the bicycle icon and a Timer component to move the bicycle around the screen. Add a *Start* button and a *Stop* button. The *Stop* button will return the bicycle to its original position. (The bicycle icon is stored as Graphics\Icons\Industry\Bicycle.ico or in the Graphics\MicrosoftIcons folder on the text Web site.)

13.6 Modify the snowman project ("Random Numbers") from earlier in the chapter by adding eyes, a mouth, and buttons. Play an appropriate sound file; you can play it in the Form_Load, in the Form_Activated, or at the end of the Form_Paint procedure. Do not place the sound in the middle of the graphics code in the Form_Paint procedure.

13.7 Modify the chapter hands-on example to add two more categories: Drinks and Gifts. Allow the user to enter the additional values and make the pie chart reflect all five categories. Make sure to set the legend label at the bottom of the form to include the new categories.

13.8 Write a project that has list boxes for a potluck party: appetizers, salad, entrée, dessert. Have a text box for entering attendees' names and then drag them to the appropriate list box.
Optional extra: Code a save feature to save the contents of each of the list boxes to a separate file. Then add a feature to load the list boxes when the program begins.

Case Studies

VB Mail Order

Create a logo for VB Mail Order using Graphics methods. Place the logo in the startup form for the project from Chapter 12. Add appropriate images and graphics to enhance each form. The graphics may come from .bmp files, .gif files, clip art, or your own creation from Paintbrush.

VB Auto Center

Have the startup screen initially fill with random dots in your choice of colors. Use Graphics methods to draw an Auto Center advertisement that will appear on the screen. Have various appropriate images (icons) appear in different locations, remain momentarily, and then disappear.

Video Bonanza

Use the Timer component and the random number generator to create a promotional game for Video Bonanza customers. Create three image controls that will display an image selected from five possible choices. When the user clicks on the *Start* button, a randomly selected image will display in each of the image controls and continue to change for a few seconds (like a "slot machine") until the user presses the *Stop* button. If all three images are the same, the customer receives a free video rental.

Display a message that says "Congratulations" or "Better Luck Next Visit".

Very Very Boards

Modify your Very Very Boards project from Chapter 8 or 12 to add a moving graphic to the About form. Use the graphic Skateboard.wmf or other graphic of your choice. Include a Timer component to move the graphic across the form. When the graphic reaches the edge of the form, reset it so that the graphic appears at the opposite edge of the form and begins the trip again.

Note: For help in basing a new project on an existing project, see "Copy and Move Projects" in Appendix C.

CHAPTER

14

Additional Topics in Visual Basic

at the completion of this chapter, you will be able to . . .

1. Validate user input in the Validating event and display messages using an ErrorProvider component.
2. Use code snippets in the editor.
3. Create a multiple document project with parent and child forms.
4. Arrange the child forms vertically, horizontally, or cascaded.
5. Add toolbars and status bars to your forms using tool strip and status strip controls.
6. Use calendar controls and date functions.
7. Display a Web page on a Windows Form using a WebBrowser control.
8. Capture and check an individual keypress from the user.
9. Use WPF Interoperablility to add Windows Presentation Foundation controls to a Windows Form.
10. Create a WPF application.

This chapter introduces some topics that can make your programs a bit more professional. You can use an ErrorProvider control to display error messages to the user and perform field-level validation, rather than validate an entire form. You can improve the operation of multiple-form applications by using a multiple document interface (MDI), which allows you to set up parent and child forms. Most professional applications have toolbars and status bars, which you learn to create in this chapter.

This chapter also introduces the WebBrowser control, which you can add to a Windows application, and creating special effects using Windows Presentation Foundation (WPF).

Advanced Validation Techniques

You already know how to validate user input using `Try/Catch`, `If` statements, and message boxes. In addition to these techniques, you can use the ErrorProvider components, which share some characteristics with the Web validation controls. Other useful techniques are to set the MaxLength and/or CharacterCasing properties of text boxes and to perform field-level validation using the Validating event of input controls.

The ErrorProvider Component

In Chapters 3 and 4 you learned to validate user input and display message boxes for invalid data. Now you will learn to display error messages directly on the form using an **ErrorProvider component**, rather than pop up messages in message boxes. Using an ErrorProvider component, you can make an error indication appear next to the field in error, in a manner similar to the validator controls in Web applications.

Although you can add multiple ErrorProvider components to a form, generally you use a single ErrorProvider for all controls on a form. Once you add the ErrorProvider into the component tray, you can validate a control. If the data value is invalid, the ErrorProvider component can display a blinking icon next to the field in error and display a message in a popup, similar to a ToolTip (Figure 14.1).

The logic of your program can be unchanged from a MessageBox solution. When you identify an error, you use the ErrorProvider **`SetError` method**, which pops up the icon.

ErrorProvider SetError Method—General Form

General Form

```
ErrorProviderObject.SetError(ControlName, MessageString)
```

ErrorProvider SetError Method—Examples

Examples

```
ErrorProvider1.SetError(QuantityTextBox, "Quantity must be numeric.")
ErrorProvider1.SetError(CreditCardTextBox, "Required field.")
```

Figure 14.1

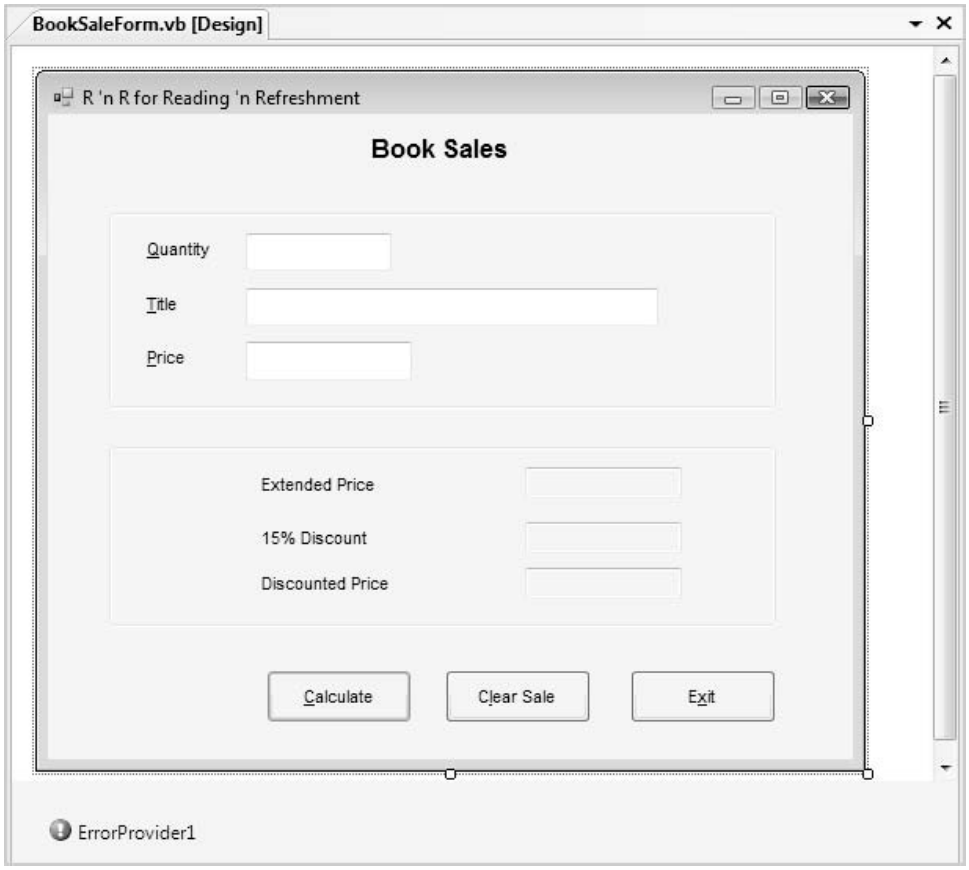
The ErrorProvider displays a blinking icon next to the field in error. When the user points to the icon, the error message appears in a popup.

The following example is taken from Chapter 3. The message boxes have been removed and replaced with ErrorProvider icons and messages. Notice that all messages are cleared at the top of the CalculateButton_Click procedure so that no icons appear for fields that have passed validation. Figure 14.2 shows the form in Design view.

```
'Project:        Chapter 14 Error Provider
'Date:           June 2008
'Programmer:     Bradley/Millspaugh
'Description:    This project demonstrates using an ErrorProvider control
'                for validation. It replaces the message boxes used in the
'                original version of this program in Chapter 3.
'Folder:         Ch14ErrorProvider

Public Class BookSaleForm
    Const DISCOUNT_RATE_Decimal As Decimal = 0.15D

    Private Sub CalculateButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles CalculateButton.Click
        ' Calculate the price and discount.
        Dim QuantityInteger As Integer
        Dim PriceDecimal, ExtendedPriceDecimal, DiscountDecimal, _
          DiscountedPriceDecimal As Decimal

        ' Clear all error messages.
        ErrorProvider1.Clear()
```

Figure 14.2

The calculation form from Chapter 3 with an ErrorProvider added.




```
Try
    ' Convert quantity to numeric variables.
    QuantityInteger = Integer.Parse(QuantityTextBox.Text)
    Try
        ' Convert price if quantity was successful.
        PriceDecimal = Decimal.Parse(PriceTextBox.Text)

        ' Calculate values for sale.
        ExtendedPriceDecimal = QuantityInteger * PriceDecimal
        DiscountDecimal = ExtendedPriceDecimal * DISCOUNT_RATE_Decimal
        DiscountedPriceDecimal = ExtendedPriceDecimal – DiscountDecimal

        ' Format and display answers for the sale.
        ExtendedPriceTextBox.Text = ExtendedPriceDecimal.ToString("C")
        DiscountTextBox.Text = DiscountDecimal.ToString("N")
        DiscountedPriceTextBox.Text = DiscountedPriceDecimal.ToString("C")

    Catch ex As Exception
        ' Handle a price exception.
        ErrorProvider1.SetError(PriceTextBox, "Price must be numeric.")
        With PriceTextBox
            .Focus()
            .SelectAll()
        End With
    End Try
```

```
        Catch ex As Exception
            ' Handle a quantity exception.
            ErrorProvider1.SetError(QuantityTextBox, "Quantity must be numeric.")
            With QuantityTextBox
                .Focus()
                .SelectAll()
            End With
        End Try
    End Sub

    Private Sub ClearButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ClearButton.Click
        ' Clear previous amounts from the form.

        TitleTextBox.Clear()
        PriceTextBox.Clear()
        ExtendedPriceTextBox.Clear()
        DiscountTextBox.Clear()
        DiscountedPriceTextBox.Clear()
        With QuantityTextBox
            .Clear()
            .Focus()
        End With
    End Sub

    Private Sub ExitButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ExitButton.Click
        ' Exit the project.

         Me.Close()
    End Sub
End Class
```

The MaxLength and CharacterCasing Properties

You can use the **MaxLength** and **CharacterCasing properties** of text boxes to help the user enter correct input data. If you set the MaxLength property, the user is unable to enter more characters than the maximum. The user interface beeps and holds the insertion point in place to indicate the error to the user. The CharacterCasing property has possible values of Normal, Upper, or Lower, with a default of Normal. If you change the setting to Upper, for example, each character that the user types is automatically converted to uppercase, with no error message or warning. Figure 14.3 shows a State text box on a form. The user can enter only two characters, and any characters entered are converted to uppercase.

Note: Although the MaxLength property limits user input, the program can assign a longer value to the text box in code, if necessary.

Figure 14.3

To help the user enter only good data, the StateTextBox.MaxLength property is set to 2 and the CharacterCasing property is set to Upper.

Field-Level Validation

So far all of the validation you have coded is for the entire form, after the user clicks a button such as *OK*, *Calculate*, or *Save*. If the form has many input fields, the validation code can be quite long and complex. Also, the user can become confused or annoyed if multiple message boxes appear, one after another. You can take advantage of the Validating event, the CausesValidation property, and the ErrorProvider components to perform **field-level validation**, in which any error message appears as soon as the user attempts to leave a field with invalid data.

Using the Validating Event and CausesValidation Property

As the user enters data into input fields and tabs from one control to another, multiple events occur in the following order:

Enter
GotFocus
Leave
Validating
Validated
LostFocus

Although you could write event procedures for any or all of these events, the Validating event procedure's header includes a CancelEventArgs argument, which you can use to cancel the event and return the focus to the control that is being validated.

Each control on the form has a **CausesValidation property** that is set to True by default. When the user finishes an entry and presses Tab or clicks on another control, the Validating event occurs for the control just left. That is, the event occurs if the CausesValidation property of the ***new*** control (receiving the input focus) is set to True. You can leave the CausesValidation property of most controls set to True, so that validation occurs. Set CausesValidation to False on a control such as Cancel or Exit to give the user a way to bypass the validation if he or she doesn't want to complete the transaction.

In the Validating event procedure, you can perform any error checking and display a message for the user. If the data value does not pass the error checking, set the Cancel property for the `e` argument of the event to True. This cancels the Validating event and returns the focus to the text box, making the text box "sticky." The user is not allowed to leave the control until the input passes validation.

```
Private Sub FirstNameTextBox_Validating(ByVal sender As Object, _
  ByVal e As System.ComponentModel.CancelEventArgs) _
  Handles FirstNameTextBox.Validating
    ' Validate for a required entry.

    ' Cancel any previous error.
    ErrorProvider1.SetError(FirstNameTextBox, "")
```

```
    ' Check for an empty string.
    If FirstNameTextBox.Text = String.Empty Then
        ' Cancel the event.
        e.Cancel = True
        ErrorProvider1.SetError(FirstNameTextBox, "Required Field.")
    End If
End Sub
```

One note of caution: If you use the validating event on the field that receives focus when the form is first displayed and require an entry, the user will be unable to close the form without filling in the text box. You can work around this problem by setting `e.Cancel = False` in the form's FormClosing event procedure.

```
Private Sub ValidationForm_FormClosing(ByVal sender As Object, _
  ByVal e As System.Windows.Forms.FormClosingEventArgs) _
  Handles Me.FormClosing
      ' Do not allow validation to cancel the form's closing.

      e.Cancel = False
End Sub
```

A Validation Example Program

The following program combines many of the techniques presented in this section. The form (Figure 14.4) has an ErrorProvider component, and all controls have their CausesValidation property set to True. The StateTextBox has its MaxLength property set to 2 and its CharacterCasing property set to Upper. Although it seems out of place, the AmountTextBox is included strictly to show an example of numeric range validation.

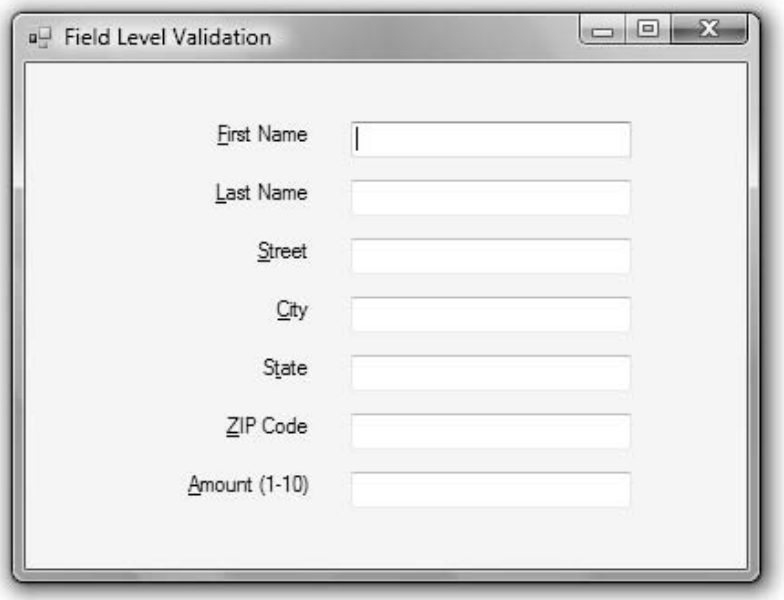


Figure 14.4

The Validation example form, which provides field-level validation.

```
'Program:        Ch14Validation
'Programmer:     Bradley/Millspaugh
'Date:           June 2008
'Description:    Demonstrate validation using the Validating event
'                and an Error Provider component.
'Folder:         Ch14Validation

Public Class ValidationForm

    Private Sub FirstNameTextBox_Validating(ByVal sender As Object, _
      ByVal e As System.ComponentModel.CancelEventArgs) _
      Handles FirstNameTextBox.Validating
        ' Validate for a required entry.

        ' Cancel any previous error.
       ErrorProvider1.SetError(FirstNameTextBox, "")

        ' Check for an empty string.
       If FirstNameTextBox.Text = String.Empty Then
            ' Cancel the event.
            e.Cancel = True
            ErrorProvider1.SetError(FirstNameTextBox, "Required Field.")
       End If
    End Sub

    Private Sub LastNameTextBox_Validating(ByVal sender As Object, _
      ByVal e As System.ComponentModel.CancelEventArgs) _
      Handles LastNameTextBox.Validating
        ' Validate for a required entry.

        ' Cancel any previous error.
       ErrorProvider1.SetError(LastNameTextBox, "")

        If LastNameTextBox.Text.Length = 0 Then
            ' Cancel the event.
            e.Cancel = True
            ErrorProvider1.SetError(LastNameTextBox, "Required Field. ")
        End If
    End Sub

    Private Sub StateTextBox_Validating(ByVal sender As Object, _
      ByVal e As System.ComponentModel.CancelEventArgs) _
      Handles StateTextBox.Validating
        ' Make sure the state is two characters.
        ' The control's CharacterCasing property forces uppercase.
        ' The MaxLength property limits input to 2 characters.

        ' Cancel any previous error.
       ErrorProvider1.SetError(StateTextBox, "")

        If StateTextBox.Text.Length <> 2 Then
            ' Cancel the event and select the text.
            e.Cancel = True
            StateTextBox.SelectAll()
            ErrorProvider1.SetError(StateTextBox, "Must be 2 characters.")
        End If
    End Sub
```

```
    Private Sub AmountTextBox_Validating(ByVal sender As Object, _
      ByVal e As System.ComponentModel.CancelEventArgs) _
        Handles AmountTextBox.Validating
        ' Validate a numeric amount for a range of values.
        Dim AmountInteger As Integer

        ' Reset any previous error.
        ErrorProvider1.SetError(AmountTextBox, "")

        Try
            AmountInteger = Integer.Parse(AmountTextBox.Text)
            If AmountInteger < 1 Or AmountInteger > 10 Then
                ' Cancel the event.
                e.Cancel = True
                AmountTextBox.SelectAll()
                ErrorProvider1.SetError(AmountTextBox, _
                  "Amount must be between 1 and 10, inclusive.")
            End If
        Catch ex As Exception
            ' Cancel the event.
            e.Cancel = True
            AmountTextBox.SelectAll()
            ErrorProvider1.SetError(AmountTextBox, _
              "Enter a numeric amount between 1 and 10, inclusive.")
        End Try
    End Sub

    Private Sub ValidationForm_FormClosing(ByVal sender As Object, _
      ByVal e As System.Windows.Forms.FormClosingEventArgs) _
      Handles Me.FormClosing
        ' Do not allow validation to cancel the form's closing.

        e.Cancel = False
    End Sub
End Class
```

Capturing Keystrokes from the User

At times you may want to determine individual keystrokes entered by the user. You can check for the key that the user entered in a control's KeyDown, KeyPress, or KeyUp event procedure. These events occur in the order listed for most keyboard keys. But keystrokes that ordinarily cause an action to occur, such as the Tab key and the Enter key, generate only a KeyUp event.

The `e` argument of the KeyPress event procedure is KeyPressEventArgs, which has a KeyChar property that holds the character pressed. Another property of the KeyPressEventArgs is the Handled property, which you can set to True to say, "I have already taken care of this keystroke; it doesn't need any further processing." This action effectively "throws away" the keystroke just entered.

In the following code example, the KeyChar property is checked in the KeyPress event procedure. If the character is not a digit or a period, then `e.Handled` is set to True, which does not pass the keypress on to the text box. This means that ***only*** digits or a period are allowed through. You can use this technique in a text box for which you want to allow only numeric data to be entered, such as a Quantity or Price text box.

```
Private Sub PriceTextBox_KeyPress(ByVal sender As Object, _
  ByVal e As System.Windows.Forms.KeyPressEventArgs) _
  Handles PriceTextBox.KeyPress
      ' Accept only a digit or a period.

      If Not Char.IsDigit(e.KeyChar) And e.KeyChar <> "." Then
          e.Handled = True
      End If
End Sub
```

Using the Masked Text Box for Validation

Although you learned about the masked text box in Chapter 2, you may not have thought about using it to aid data validation. You can set the Mask property of a masked text box to any of the predefined masks or write your own. The easiest way to write your own is to modify one of the existing masks, or you can follow the syntax rules of a regular expression (see "Regular Expression Syntax" in MSDN Help).

The predefined masks include date, time, phone number, social security number, and ZIP code formats. If the user enters invalid data for the mask, such as a letter for a numeric month in the date mask, the character is not accepted.

Feedback 14.1

1. What is the purpose of the following code:

```
ErrorProvider1.SetError(QuantityTextBox, "Quantity must be numeric.")
```

2. Name two properties of a TextBox control that help the user enter correct input data. Describe the function of each.
3. What is meant by field-level validation?

Code Snippets and Samples

A great time-saving feature that was added in VB 2005 and expanded in VB 2008 is the ability to add segments of code for a variety of topics directly from the editor. You may wonder why this topic wasn't covered earlier, but it was really necessary for you to understand the code that you add to your program. Now that you understand the basic concepts, you will find that many of your new tools and techniques come from looking at sample projects. Visual Studio includes many sample projects as well as code snippets.

Code Snippets

Code snippets are small samples of code that can show you how to accomplish many programming tasks. The *Insert Snippet* menu option is available on the context menu (right-click) of the Editor window (Figure 14.5). When you select a snippet type, the editor places the code right in your program, where you can study it and/or modify and use it.

You can learn many useful techniques by opening snippets.

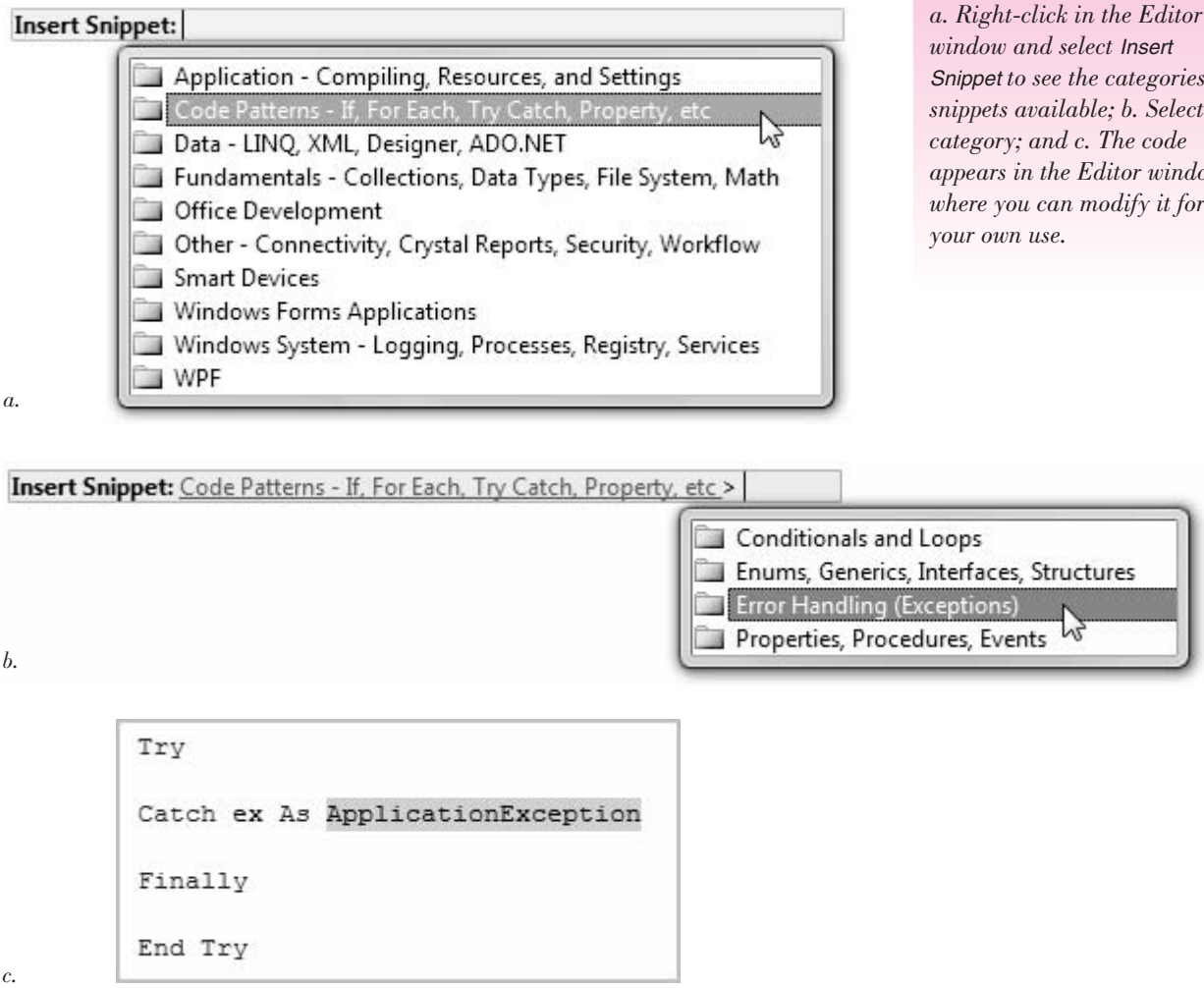


Figure 14.5

a. Right-click in the Editor window and select Insert Snippet to see the categories of snippets available; b. Select a category; and c. The code appears in the Editor window, where you can modify it for your own use.

Sample Projects

Visual Studio includes many sample projects (all editions except the Express Edition) that you can use to learn new techniques. From the *Help* menu, select *Contents*. Expand the nodes for *Development Tools and Languages / Visual Studio / Visual Basic* to find the *Samples* node.

The walkthroughs in Help are another avenue for pursuing your study of VB. These tutorials give step-by-step introduction to many techniques and controls.

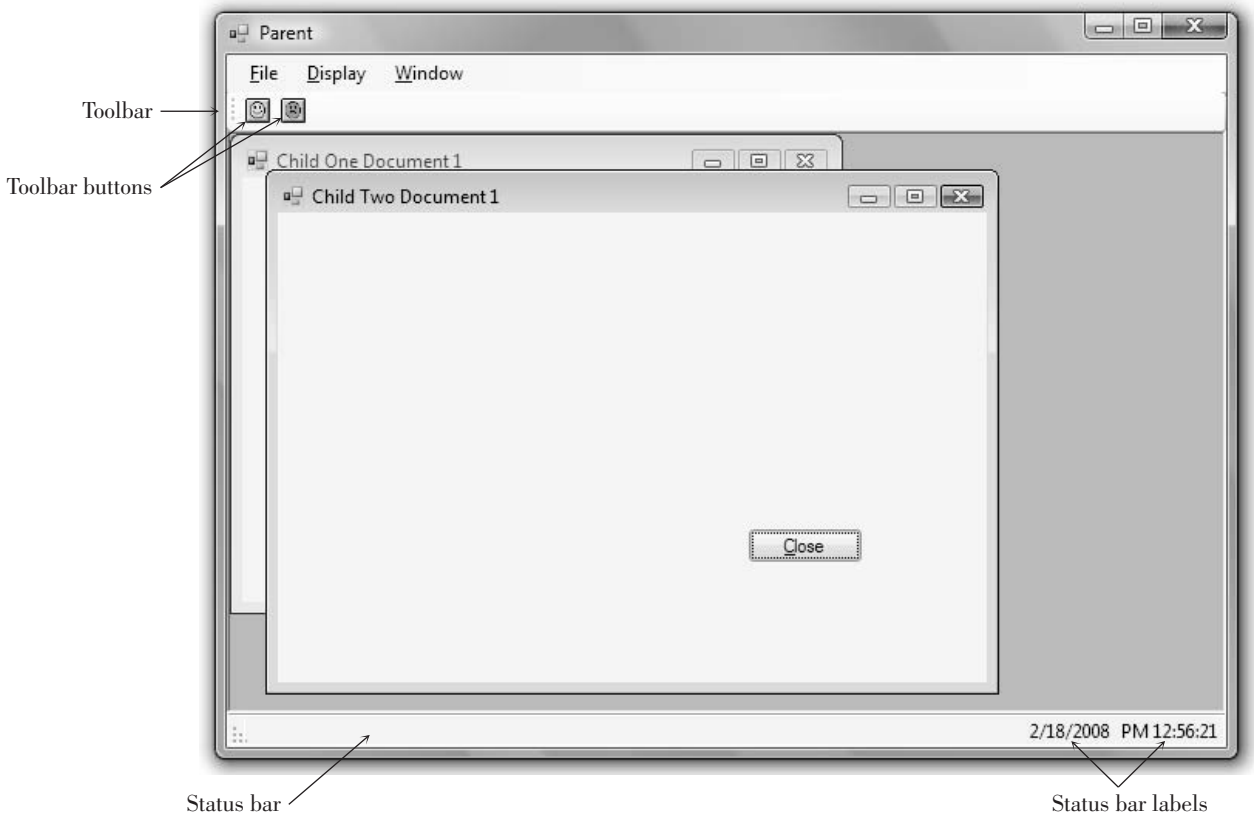
Multiple Document Interface

All of the projects so far have been **single document interface (SDI)**. Using SDI, each form in the project acts independently of the other forms. However, VB also allows you to create a **multiple document interface (MDI)**. For an example of MDI, consider an application such as Microsoft Word 2003. Word has a **parent form** (the main window) and **child forms** (each document window). You can open multiple child windows, and you can maximize, minimize, restore, or close each child window, which always stays within the boundaries of the parent

window. When you close the parent window, all child windows close automatically. Figure 14.6 shows an MDI parent window with two open child windows.

Figure 14.6

The main form is the parent and the smaller forms are the child forms in an MDI application.



With MDI, a parent and child relationship exists between the main form and the child forms. One of the rules for MDI is that if a parent form closes, all of its children leave with it. Pretty good rule. Another rule is that children cannot wander out of the parent's area; the child form always appears inside the parent's area.

VB allows you to have forms that act independently of each other. You may have a parent form and several child forms *and* some forms that operate independently. For example, a splash form likely should remain SDI.

One feature of MDI is that you can have several documents open at the same time. The menu strip generally contains a *Window* menu that allows you to display a list of open windows and move from one active document to another.

Creating an MDI Project

You can make any form a parent. In fact, a form can be both a parent and a child form (just as a person can be both a parent and a child). To make a form into a parent, simply change its **IsMdiContainer property** to True in the Properties window of the designer. One project can have multiple child forms and multiple parents.

Creating a child is almost as easy. Of course, your project must contain more than one form. You make a form into a child window in code at run time.

You must declare a new variable for the form, instantiate it, set the child's MdiParent property to the current (parent) form, and then show it.

```
Private Sub ChildOneMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles ChildOneMenuItem.Click
      ' Display Child One form.

      Dim AChildOneForm As New ChildOneForm
      AChildOneForm.MdiParent = Me
      AChildOneForm.Show()
End Sub
```

Our example application allows the user to display multiple child windows. Therefore, the title bar of each child window should be unique. We can accomplish this by appending a number to the title bar before displaying the form. This is very much like Microsoft Word, with its Document1, Document2, and so forth.

```
' Module-level declarations.
Dim ChildOneCountInteger As Integer

Private Sub ChildOneMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles ChildOneMenuItem.Click
      ' Display Child One form.

      Dim AChildOneForm As New ChildOneForm
      AChildOneForm.MdiParent = Me
      ChildOneCountInteger += 1
      AChildOneForm.Text = "Child One Document " _
        & ChildOneCountInteger.ToString()
      AChildOneForm.Show()
End Sub
```

Adding a Window Menu

A parent form should have a *Window* menu (Figure 14.7). The *Window* menu lists the open child windows and allows the user to switch between windows and arrange multiple child windows. Take a look at the *Window* menu in an application such as Word or Excel. You will see a list of the open documents as well as options for arranging the windows.

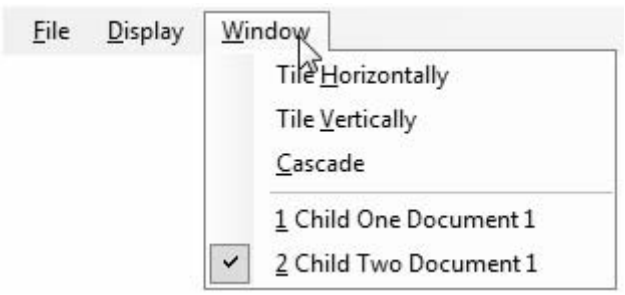


Figure 14.7

The Window menu in an MDI application lists the open child windows and allows the user to select the arrangement of the windows.

After you create the menus for a MenuStrip control, you can make one of the menus display the list of open child windows. Display the properties of the MenuStrip (not a menu item) in the Properties window. Drop down the list for the **MdiWindowListItem property**, which shows all of the menu items that

belong to the MenuStrip, and select WindowToolStripMenuItem (Figure 14.8). To actually arrange the windows requires a little code.

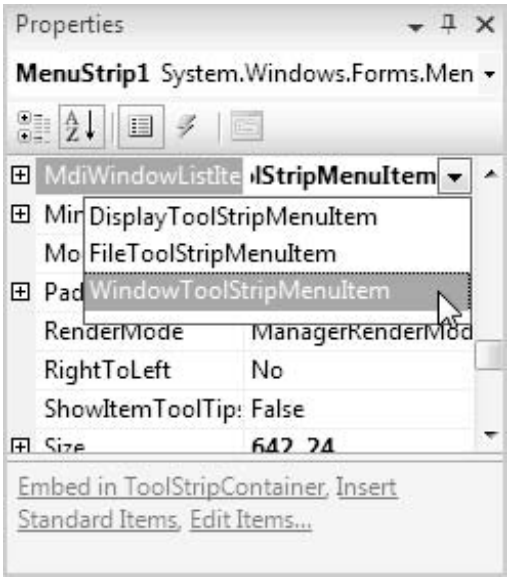


Figure 14.8

Set the MdiWindowListItem property to make the Window menu display the list of open MDI child windows.

Layout Options

When several child windows are open, the windows may be arranged in several different layouts: tiled vertically, tiled horizontally, or cascaded. You set the type of layout in code with an argument of the **`LayoutMdi` method**.

```
Me.LayoutMdi(MdiLayout.TileHorizontal)
```

You can use one of the three constants: TileHorizontal, TileVertical, and Cascade.

```
Private Sub TileHorizontallyToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles TileHorizontallyToolStripMenuItem.Click
    ' Arrange the child forms horizontally.

    Me.LayoutMdi(MdiLayout.TileHorizontal)
End Sub

Private Sub TileVerticallyToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles TileVerticallyToolStripMenuItem.Click
    ' Arrange the child forms vertically.

    Me.LayoutMdi(MdiLayout.TileVertical)
End Sub

Private Sub CascadeToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles CascadeToolStripMenuItem.Click
    ' Cascade the child forms.

    Me.LayoutMdi(MdiLayout.Cascade)
End Sub
```

Toolbars and Status Bars

You can enhance the usability of your programs by adding features such as a toolbar and/or status bar. You probably find that you use the toolbars in applications as an easy shortcut for menu items. Status bars normally appear at the bottom of the screen to display information for the user.

To create a **toolbar**, you need a **ToolStrip control** and the images in *Resources* to appear on the ToolStrip buttons.

Toolbars

You use the ToolStrip control (Figure 14.9) in the *Menus & Toolbars* tab of the toolbox to create a ToolStrip object for your project. The new ToolStrip is a container that does not yet contain any objects. After you add the ToolStrip, you can add several types of objects. The strip may contain ToolStripButtons, ToolStripLabels, and several other types of objects.

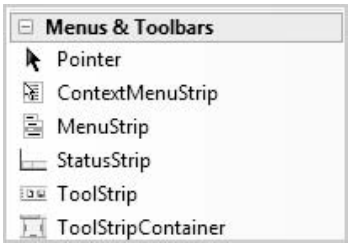


Figure 14.9

The ToolStrip and StatusStrip controls in the toolbox.

Setting Up the Buttons

The easiest way to set up buttons for a ToolStrip is to click on its Items property in the Properties window, which opens the Items Collection Editor (Figure 14.10).

In the ToolStrip's Items Collection Editor, you can drop down the list of available types of objects (Figure 14.11). For now you will use only the button. Click on the *Add* button, which adds a new ToolStripButton object to the collection. Then you can set the properties of the new button, such as its Name and ToolTipText properties. Make sure to give it a meaningful name. For example, a button that displays the Summary Window might be called SummaryToolStripButton, and one that displays the About box might be called AboutToolStripButton.

You also can assign an image to the button's Image property in the Items Collection Editor window. To display only the image and no text, set DisplayStyle to Image.

Note that with the ToolStrip selected, you can click *Insert Standard Items* below the Properties window. You will get New, Open, Save, Print, Cut, Copy, and Paste buttons with pictures added automatically. However, you must write the code for each button yourself.

TIP

Set the ToolTipText property of each ToolStrip button to aid the user in case the meaning of each graphic is not perfectly clear. ■

Coding for the ToolStrip

To code the actions for a ToolStrip button you can create a new event procedure for the button click. However, since most buttons are actually shortcuts for

Figure 14.10

Add buttons to a ToolStrip using the Items Collection Editor, which you can open from the ToolStrip's Items property in the Properties window.

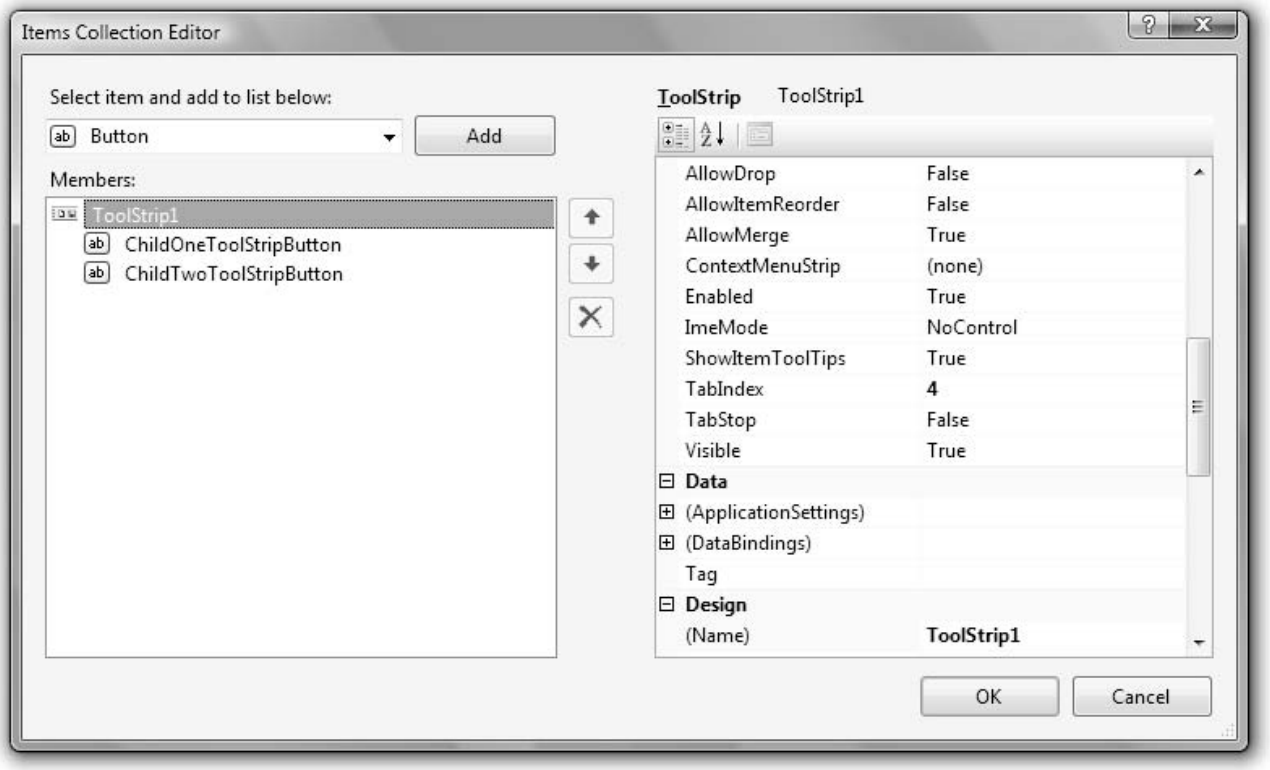
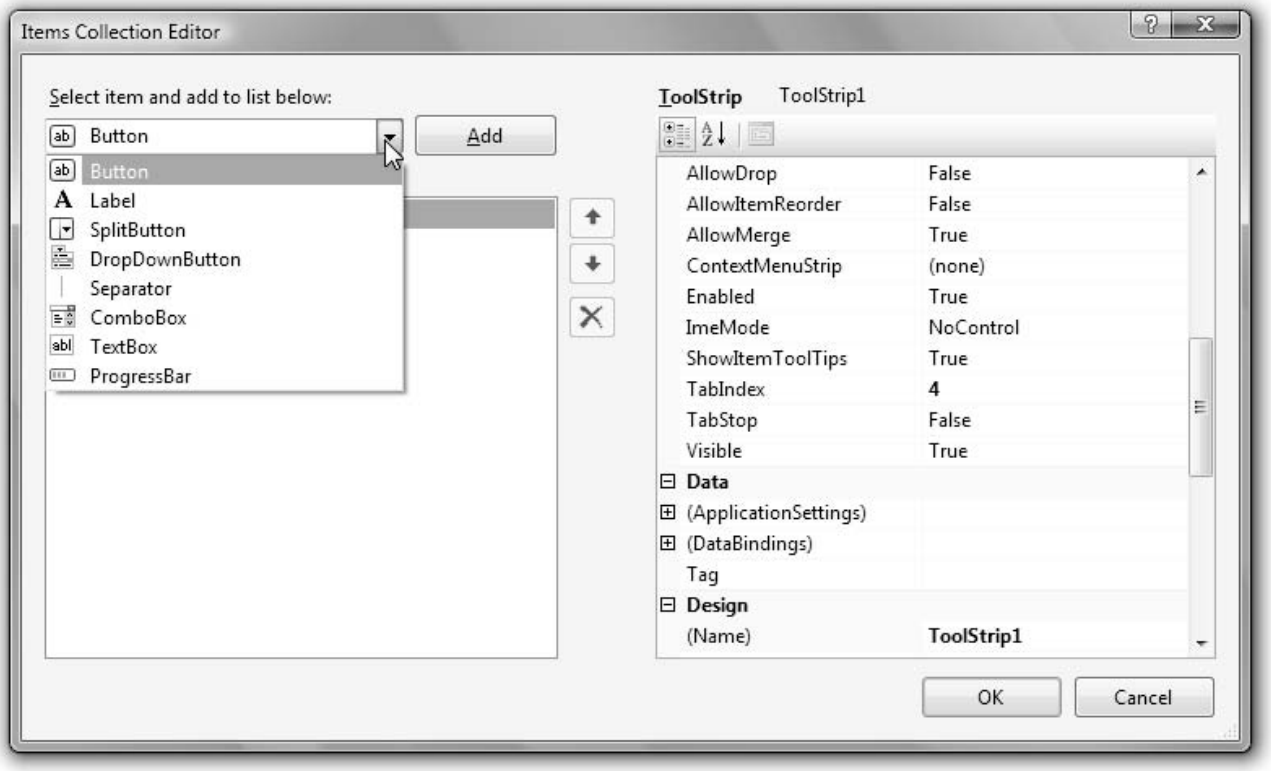


Figure 14.11

Drop down the list of available objects that can be added to the Items collection of a ToolStrip control.



menu items, you normally only need to add your ToolStripButton.Click event to the `Handles` clause for the menu event procedure.

```
Private Sub DisplayChildOneMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) _
  Handles DisplayChildOneMenuItem.Click, ChildOneToolStripButton.Click
    ' Display Child One form.

    Dim AChildOneForm As New ChildOneForm
    AChildOneForm.MdiParent = Me
    ChildOneCountInteger += 1
    AChildOneForm.Text = "Child One Document " _
      & ChildOneCountInteger.ToString()
    AChildOneForm.Show()
End Sub
```

Status Bars

A **status bar** is usually located at the bottom of a form (refer to Figure 14.6). A status bar displays information such as date, time, status of the Caps Lock or Num Lock key, or error or informational messages. If you want a status bar on your form, you need to take two steps: add a **StatusStrip control** (refer to Figure 14.9) to your form and add **ToolStripStatusLabel objects** to the StatusStrip.

Just as with ToolStrips, the easiest way to add items to the StatusStrip object is to select its Items property in the Properties window to open the Items Collection Editor. Click on the *Add* button to add a new ToolStripStatusLabel object. Then set the properties of the ToolStripStatusLabel, including the object's Name and ToolTipText properties.

You can make the labels appear at the right end of the status bar, as in Figure 14.6, by setting the StatusStrip's RightToLeft property to True. The default is False. When you set RightToLeft to True, the labels will appear in the opposite order that you define them.

Assigning Values to ToolStripStatusLabels

A ToolStripStatusLabel can hold text, such as the current date, the time, or error messages. You assign values to the Text property of labels at run time:

```
DateToolStripStatusLabel.Text = Now.ToShortDateString()
TimeToolStripStatusLabel.Text = Now.ToLongTimeString()
InformationToolStripLabel.Text = "It's very late."
```

Displaying the Date and Time

You use the properties and methods of the **DateTime structure** to retrieve and format the current date and time. The **Now property** holds the system date and time in a numeric format that can be used for calculations. You can format the date and/or time for display using one of the following methods: `ToShortDateString`, `ToLongDateString`, `ToShortTimeString`, or `ToLongTimeString`. The actual display format of each method depends on the local system settings.

You can set the display value of status strip labels in any procedure; however, the display does not update automatically. Generally you will set initial

values in the Form_Load event procedure and use a Timer component to update the time. Or you can skip the Form_Load event, figuring that in just one second the timer will fire and the clock will update.

```
Private Sub ClockTimer_Tick(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles ClockTimer.Tick
    ' Update the date and time on the status bar.
    ' Interval = 1000 milliseconds (one second).

    DateToolStripStatusLabel.Text = Now.ToShortDateString()
    TimeToolStripStatusLabel.Text = Now.ToLongTimeString()
End Sub

Private Sub ParentForm_Load(ByVal sender As Object, _
  ByVal e As System.EventArgs) Handles MyBase.Load
    ' Display the date and time in the status bar.

    ClockTimer_Tick(Sender, e)
End Sub
```

Don't forget to set the Enabled and Interval properties of your timer.

Feedback 14.2

1. Write the statements to display AboutForm as a child form.
2. Assume that you have a ToolStrip called ToolStrip1 that has buttons for *Exit* and *About*. How are the buttons coded?
3. What steps are necessary to display the current time in a status strip label called CurrentTimeToolStripStatusLabel?

Some Helpful Date Controls

There are many other controls in the toolbox. You may want to experiment with some of them to see how they work. This section demonstrates two more controls: the DateTimePicker and MonthCalendar controls.

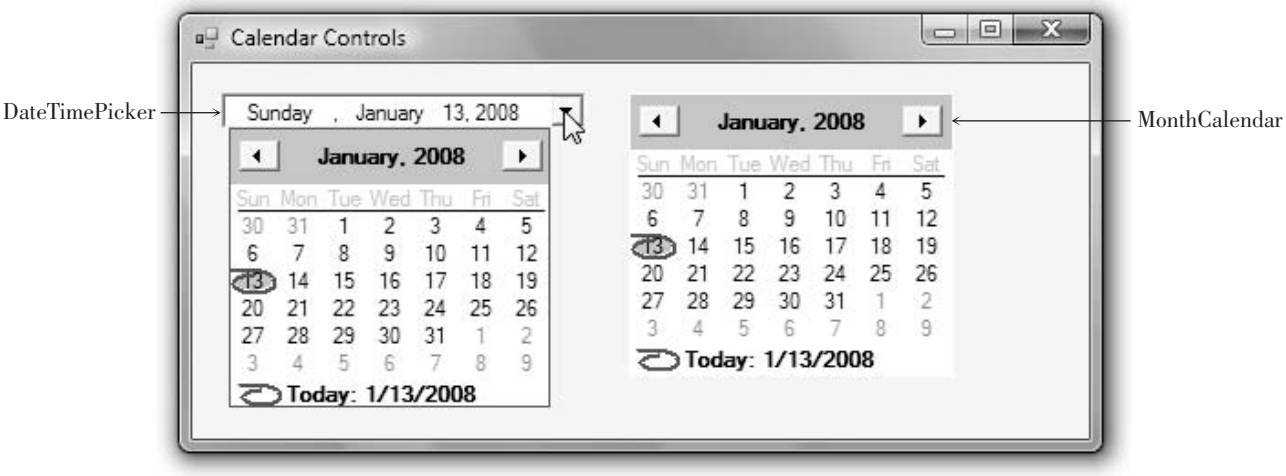
The Calendar Controls

The DateTimePicker and the MonthCalendar controls (Figure 14.12) provide the ability to display calendars on your form. One advantage of the DateTimePicker is that it takes less screen space; it displays only the day and date unless the user drops down the calendar. You can use either control to allow the user to select a date, display the current date, or set a date in code and display the calendar with that date showing.

The DateTimePicker control contains a Value property for the date. When the control initially displays, the Value is set to the current date. You can let the user select a date and then use the Value property or you can assign a Date value to the property.

Figure 14.12

The calendar controls: The DateTimePicker drops down a calendar when selected and shows the selected day and date when not dropped down; the MonthCalendar control displays the calendar.



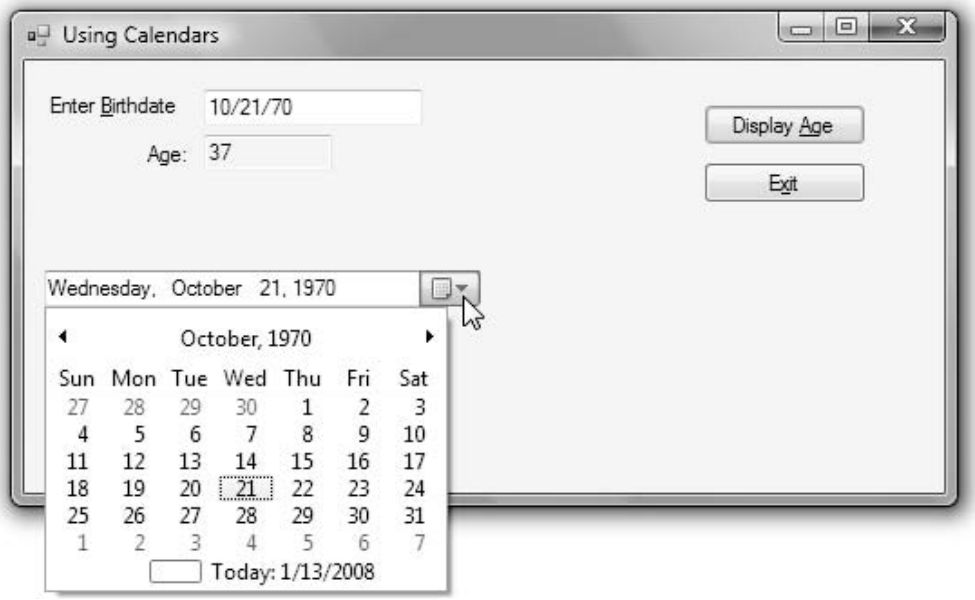
The following example allows the user to enter a birthdate in a text box. It converts the text box entry in a `Try/Catch` in order to trap for illegal date formats.

```
BirthdateDateTimePicker.Value = Convert.ToDateTime(BirthdateTextBox.Text)
```

This example program demonstrates the use of the calendar, date functions, and some interesting features of Visual Basic. Figure 14.13 shows the form for the project.

Figure 14.13

The birthday form with the calendar for the DateTimePicker dropped down.



```
'Program:       Chapter 14 Calendar
'Programmer:    Bradley/Millspaugh
'Date:          June 2008
'Description:   Enters and tests a date, displays a calendar, and uses
'               Date functions.
'Folder:        Ch14Calendar

Public Class CalendarForm

    Private Sub DisplayButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles DisplayButton.Click
        ' If the date is valid set the calendar and display.

        Try
            With BirthdateDateTimePicker
                .Value = Convert.ToDateTime(BirthdateTextBox.Text)
                .Visible = True
            End With
        Catch ex As Exception
            MessageBox.Show("Invalid Date")
            BirthdateTextBox.Focus()
        End Try
    End Sub

    Private Sub BirthdateDateTimePicker_ValueChanged(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles BirthdateDateTimePicker.ValueChanged
        ' Calculate the age when the calendar value changes.
        Dim YearsInteger As Integer

        With BirthdateDateTimePicker.Value
            ' If birthday already passed this year.
            If .DayOfYear <= Now.DayOfYear Then
                YearsInteger = Now.Year - .Year
            Else
                ' Birthday yet to come this year.
                YearsInteger = Now.Year - .Year - 1
            End If
        End With

        If YearsInteger > 0 Then
            AgeTextBox.Text = YearsInteger.ToString()
        End If
    End Sub

    Private Sub ExitButton_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ExitButton.Click
        ' Terminate the project.

        Me.Close()
    End Sub

    Private Sub CalendarForm_Load(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles MyBase.Load
        ' Set the calendar to today's date.

        BirthdateDateTimePicker.Value = Today
    End Sub
End Class
```

Notice the statements in the ValueChanged event procedure for the DateTimePicker. You can use all of the properties of the system time on the Value property of the control.

```
YearsInteger = Now.Year - BirthdateDateTimePicker.Value.Year
```

You can see all of the methods and properties using Visual Studio's IntelliSense feature.

Feedback 14.3

1. Write the code to assign the date from AppointmentDateTimePicker to the variable AppointmentDateTime.
2. Use the IntelliSense feature or Help to list five properties of the Value property for a DateTimePicker control.
3. Which of the five properties listed in Question 2 are also available for the Now property?

Displaying Web Pages on a Windows Form

You can add a **WebBrowser control** to a Windows Form and display Web pages on the form. The toolbox includes a WebBrowser control (Figure 14.14). The WebBrowser control can make your form resemble a browser window in Internet Explorer, or you can use the control to display any HTML page, online or offline. Note that you must have a live Internet connection to display Web pages in the WebBrowser control.

Figure 14.14

The Windows WebBrowser control in the toolbox.

The WebBrowser Control

When you add a WebBrowser control to an empty Windows Form, by default the control is set to fill the entire form (`Dock = Fill`). You can add a ToolStrip control to provide navigation. Some useful properties, methods, and events of the WebBrowser control follow:

Url property	Set this property to a URL at design time or run time to navigate to the entered page. `WebBrowser1.Url = New Uri("http://www.microsoft.com")`
Navigate method	Execute this method at run time to navigate to the desired page. `WebBrowser1.Navigate(New Uri("http://www.microsoft.com"))`
DocumentCompleted event	A page has finished loading. You can use this event to add the page to the Items property of the combo box. `ToolStripComboBox1.Items.Add(WebBrowser1.Url)`

DocumentTitleChanged event	A page with a new title finished loading. Use this event to change the form's title bar to the Web page's title. `Me.Text = WebBrowser1.DocumentTitle`
DocumentTitle property	Retrieves the title of the current Web page.

Notice the use of "Uri" in the preceding table. A Uniform Resource Identifier (URI) is a Web address that is more generic than "URL". The WebBrowser control requires that all URLs be instances of the Uri class.

A WebBrowser Program

The following Windows program displays a Web page in a WebBrowser control. The form has a ToolStrip control with a ToolStripComboBox and a ToolStripButton to aid navigation. When the user enters a new URL in the text portion of the combo box, he or she can either press Enter or click the *Go* button on the toolbar. The ToolStripComboBox_KeyUp event procedure checks for the Enter key, and the ToolStripButton_Click event procedure checks for a click on the button. Figure 14.15 shows the completed Windows Form with a Web page displayed.

Figure 14.15

This Windows Form displays a Web page in a WebBrowser control. A ToolStrip control contains a ToolStripComboBox item and a ToolStripButton item.

The Program Code

```
'Program:        Ch14WebBrowser
'Date:           June 2008
'Description:    Add Web browser to a Windows Form using the WebBrowser control.
'Note:           The computer must have an established link to the Internet for
'                this program to work.

Public Class WebBrowserForm
    Private Sub WebBrowser1_DocumentCompleted(ByVal sender As Object, _
      ByVal e As System.Windows.Forms.WebBrowserDocumentCompletedEventArgs) _
      Handles WebBrowser1.DocumentCompleted
        ' New document loaded. Add the URL to the combo box.

        ToolStripComboBox1.Text = WebBrowser1.Url.ToString()
        ToolStripComboBox1.Items.Add(ToolStripComboBox1.Text)
    End Sub

    Private Sub WebBrowser1_DocumentTitleChanged(ByVal sender As Object, _
      ByVal e As System.EventArgs) Handles WebBrowser1.DocumentTitleChanged
        ' Change the form's title bar when the document changes.

        Me.Text = WebBrowser1.DocumentTitle
    End Sub

    Private Sub ToolStripButton1_Click(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles ToolStripButton1.Click
        ' Go button clicked; navigate to requested page.

        Try
            If Not ToolStripComboBox1.Text.ToUpper.StartsWith("HTTP://") Then
                ToolStripComboBox1.Text = "HTTP://" & ToolStripComboBox1.Text
            End If
            ' WebBrowser1.Navigate(New Uri(ToolStripComboBox1.Text))
            WebBrowser1.Url = New Uri(ToolStripComboBox1.Text)
        Catch
            MessageBox.Show("Unable to locate the requested page.")
        End Try
    End Sub

    Private Sub ToolStripComboBox1_KeyUp(ByVal sender As Object, _
      ByVal e As System.Windows.Forms.KeyEventArgs) _
      Handles ToolStripComboBox1.KeyUp
        ' Check for Enter key and navigate to the requested URL.

        If e.KeyCode = Keys.Enter Then
            ToolStripButton1_Click(sender, e)
        End If
    End Sub
End Class
```

Checking for the Enter Key

You may have noticed a strange statement in the previous section:

```
If e.KeyCode = Keys.Enter Then
```

This statement checks to see if the key pressed is the Enter key.

As you learned earlier in this chapter, you can check for the key that the user entered in a control's KeyDown, KeyPress, or KeyUp event procedure. But keystrokes that ordinarily cause an action to occur, such as the Tab key and the Enter key, generate only a KeyUp event.

The `e` argument of the KeyUp event procedure is KeyEventArgs, which has a KeyCode and a KeyData property. These properties hold a numeric representation of the key pressed, but you can use the constants in the Keys enumeration to call the keys by name. For example, the Enter key has a KeyCode of 13. You can check for the Enter key with either of these statements:

```
If e.KeyCode = 13 Then
```

or

```
If e.KeyCode = Keys.Enter Then
```

In the program in the previous section, the user is expected to type a URL into the combo box and press Enter or click a button. To check for the Enter key, you need to code the combo box's KeyUp event procedure. Notice that the line of code compares the event argument `e` with the desired Keys constant.

```
Private Sub ToolStripComboBox1_KeyUp(ByVal sender As Object, _
  ByVal e As System.Windows.Forms.KeyEventArgs) _
  Handles ToolStripComboBox1.KeyUp
      ' Check for Enter key and navigate to entered URL.

      If e.KeyCode = Keys.Enter Then
          ToolStripButton1_Click(sender, e)
      End If
End Sub
```

XML Data Files

More and more documents are being stored as XML files. In Chapter 10 we discussed XML as a part of database files. The same format is also used for word processing and other types of office files.

There are many advantages to using XML rather than other file formats. XML is a platform-independent format that is not tied to a specific language or vendor. Because it is text based, you can view and edit the file contents with text-edit tools. It is easy to make changes, such as adding fields. XML is Unicode compliant and can be used internationally.

Nodes, Elements, and Attributes

The following section describes the terminology and structure of XML files using books.xml, a sample file from Microsoft that also is included in your StudentData folder. Here is a listing of books.xml for reference. The terminology follows the file listing.

```
<?xml version='1.0'?>
<!-- This file represents a fragment of a book store inventory database -->
<bookstore>
  <book genre="autobiography" publicationdate="1981" ISBN="1-861003-11-0">
    <title>The Autobiography of Benjamin Franklin</title>
    <author>
      <first-name>Benjamin</first-name>
      <last-name>Franklin</last-name>
    </author>
    <price>8.99</price>
  </book>
  <book genre="novel" publicationdate="1967" ISBN="0-201-63361-2">
    <title>The Confidence Man</title>
    <author>
      <first-name>Herman</first-name>
      <last-name>Melville</last-name>
    </author>
    <price>11.99</price>
  </book>
  <book genre="philosophy" publicationdate="1991" ISBN="1-861001-57-6">
    <title>The Gorgias</title>
    <author>
      <name>Plato</name>
    </author>
    <price>9.99</price>
  </book>
</bookstore>
```

The first things you notice when looking at an XML file are the tags. The tags delineate **elements** of the file. The basic structure is a tree, starting with the root **node** (a file can have only one) and branching out in child nodes. A child also can contain child nodes. Nodes that are at the same level are referred to as ***siblings***.

Within a node there may be several different values assigned to **attributes**. The value may be placed in either single quotes or double quotes. In the following line, genre, publicationdate, and ISBN are attributes.

```
<book genre="autobiography" publicationdate="1981" ISBN="1-861003-11-0">
```

Table 14.1 describes the elements in the books.xml file.

For more information about XML and terminology, refer to the W3C recommendations. You can find recommendations at http://www.w3.org/TR/REC-xml/#sec-terminology.

VB Tools for Reading XML Files

VB 2008 includes some new tools that make working with XML files easier than in the past. In this section you will see XDocument objects, XElement objects, XML literals, and how to use LINQ TO XML queries.

Loading an XML File into an XDocument Object

You can use the `Load` method of an XDocument to read an XML file.

XML File Terminology Table 14.1

Term	Meaning	Example from books.xml
< >	Start-tag and end-tag	`<price></price>`

Element	Contents within a set of tags.	`<title>The Gorgias</title>`
		`<author>`
		`  <name>Plato</name>`
		`</author>`

Node	A branch on the tree; the root node is the most outside with the child nodes inside.	Root node `<bookstore>` Child nodes `<book>` `<title>` and `<author>` are child nodes of `<book>`
Sibling	Nodes at the same level.	`<title>` and `<author>`
Attribute	Name values embedded within an element; the name of the attribute is assigned a value enclosed in either single or double quotes.	`<book genre="autobiography"` `publicationdate="1981" ISBN="1-861003-11-0">`
Text	Value placed within tags.	`<first-name>Benjamin</first-name>`
Comment	Used for remarks only.	`<!-- This file represents a fragment of a book store inventory database -->`

The XDocument.Load Method—General Forms

General Forms

```
Dim Identifier = XDocument.Load(Filename)
Dim Identifier As XDocument = XDocument.Load(Filename)
```

For the Filename entry, you can specify a complete path or a URI; otherwise the `Load` method looks in the current directory, which is bin\Debug in your VB project.

Notice in the first format that the data type is not specified. The VB editor's new type inference takes care of determining and assigning a strong data type, even when Option Strict is turned on.

The XDocument.Load Method—Examples

Examples

```
Dim BookXDocument = XDocument.Load("books.xml")
Private CustomerXDocument As XDocument = XDocument.Load("C:\Data\customers.xml")
Dim InventoryDocument = XDocument.Load(CurDir() & "inventory.xml")
```

The third example uses the `CurDir()` method to specify the current directory. You also can use `System.IO.Directory.GetCurrentDirectory()`, as you have in previous programs.

The following Sub procedure displays the books.xml file in the Output window, which you can view with *View / Other Windows / Output*:

```
Private Sub ReadFileButton_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles ReadFileButton.Click
    ' Read the XML file into an XDocument and display the file in _
      the Output window.
```

```
    Dim BookXDocument = XDocument.Load("books.xml")
    Console.WriteLine(BookXDocument)
End Sub
```

Output

```
<!-- This file represents a fragment of a book store inventory database -->
<bookstore>
  <book genre="autobiography" publicationdate="1981" ISBN="1-861003-11-0">
    <title>The Autobiography of Benjamin Franklin</title>
    <author>
      <first-name>Benjamin</first-name>
      <last-name>Franklin</last-name>
    </author>
    <price>8.99</price>
  </book>
  <book genre="novel" publicationdate="1967" ISBN="0-201-63361-2">
    <title>The Confidence Man</title>
    <author>
      <first-name>Herman</first-name>
      <last-name>Melville</last-name>
    </author>
    <price>11.99</price>
  </book>
  <book genre="philosophy" publicationdate="1991" ISBN="1-861001-57-6">
    <title>The Gorgias</title>
    <author>
      <name>Plato</name>
    </author>
    <price>9.99</price>
  </book>
</bookstore>
```

Loading an XML File into an XElement Object

In addition to using an XDocument, you also can load an XML file into an XElement object. The difference between the two is that the XDocument contains the information about the document from the top of the file, while the root node is the first item in an XElement object.

```
Dim BookData = XElement.Load("books.xml")
```

Specifying XML Elements in VB

In VB 2008 you can specify the data elements in an XML file by name, referred to as XML literals. VB uses a three-axis model to refer to the elements. The axes, illustrated in Figure 14.16, represent child elements, attributes, and descendants.

Child Elements

To refer to a child axis member in an XML document, use *ObjectName.<ChildElementName>*. Using the BookData XElement object from the previous example, we can refer to the book child element as `BookData.<book>`.

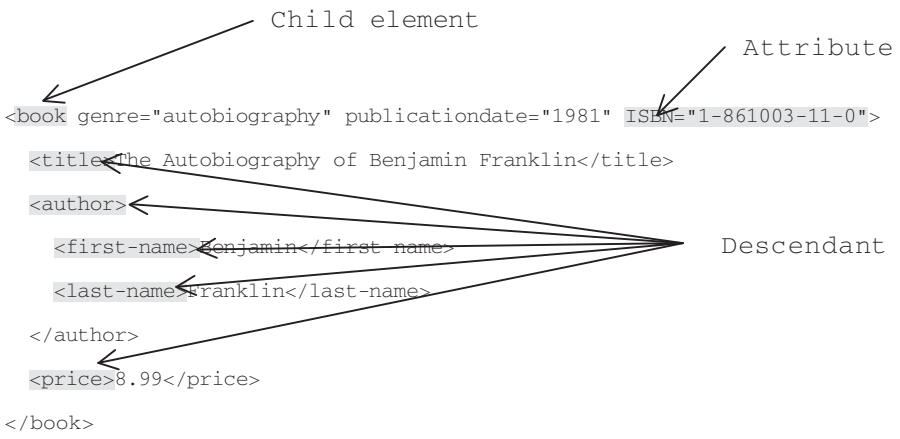


Figure 14.16

The VB three-axis model for referring to elements in an XML document.

A LINQ to XML query for the book element is written as:

```
Dim MyQuery = From book In BookData.<book> _
```

Attribute Elements

The attributes for book are genre, publicationdate, and ISBN. To specify an attribute, use the .@ notation. The following query accesses the ISBN attribute:

```
Dim MyQuery = From book In BookData.<book> _
     Select book.@ISBN   ' Gets a list of ISBN attributes.
```

Descendant Elements

The third axis is descendant, such as title, author, and price in the book.xml file. The notation that tells VB to search for a descendant is three dots, with the attribute name enclosed in <> tag brackets.

```
Dim MyQuery = From book In BookData.<book> _
     Select book...<price>.Value   ' Gets the price.
```

LINQ Queries

You can use the axes notation on the `In` clause of LINQ as well as in the `Select` clause.

```
Dim MyQuery = From book In BookData...<price> _
     Select book.Value   ' Gets the price.
```

LINQ offers many operators beyond what we have covered up to this point. The next two examples demonstrate `Order By`, which is used for sorting, and `Where`, which is used for conditions.

```
' LINQ query that sorts by book title:
Dim MyQuery = From book In BookData.<book> _
  Order By book...<title>.Value _
  Select book...<title>.Value
```

```
' LINQ query that selects books with price > 10.
Dim MyQuery = From book In BookData.<book> _
  Where book...<price>.Value > 10 _
  Select book...<title>.Value
```

LINQ to XML Program Examples

The following program reads the books.xml file, uses a LINQ to XML query, and loads the resulting list of titles into a list box (Figure 14.17). Extra queries are included but commented out to illustrate other queries.

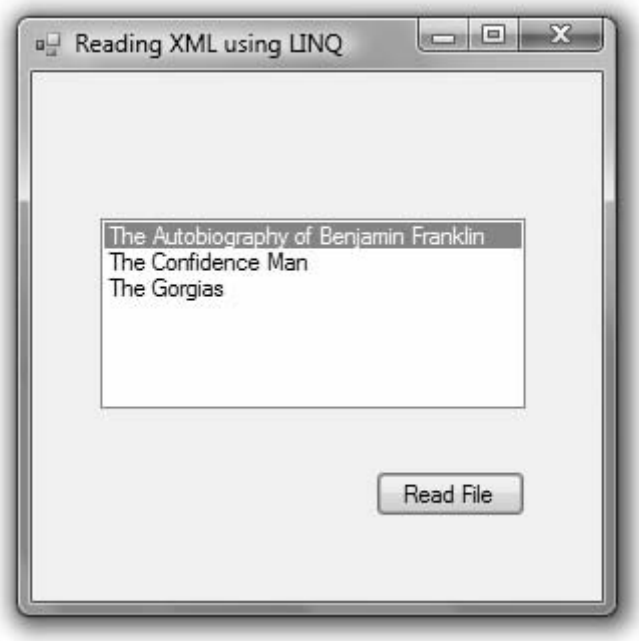


Figure 14.17

The book titles from books.xml are loaded into a list box using LINQ to XML and XML literals.

```
'Project:        Ch14XmlLiterals
'Programmer:     Bradley/Millspaugh
'Date:           June 2008
'Description:    Read titles from an xml file into a list box.

Public Class XmlListForm

    Private Sub ReadFileButton_Click(ByVal sender As System.Object, _
       ByVal e As System.EventArgs) Handles ReadFileButton.Click
        ' Read the XML file into an XDocument and display the file in
        ' the Output window.
        ' Dim BookXDocument = XDocument.Load("books.xml")
        ' Console.WriteLine(BookXDocument)

        ' Read the XML file into an XElement and display the file in
        ' the Output window.
        ' Dim BookData = XElement.Load("books.xml")
        ' Console.WriteLine(BookData)

        ' Read the XML file into an XElement and use LINQ to query the data.
        Dim BookData = XElement.Load("books.xml")
```

```
        Dim MyQuery = From book In BookData.<book> _
          Select book...<title>.Value ' Gets the book titles.

        'Dim MyQuery = From book In BookData.<book> _
        '  Select book.@ISBN   ' Gets a list of ISBN attributes

        'Dim MyQuery = From book In BookData.Elements() _
        '  Select book   ' Gets entire node for each book.

        'Dim MyQuery = From book In BookData...<price> _
        '  Select book.Value   ' Gets the price.

        'Dim MyQuery = From book In BookData.<book> _
        '  Select book...<price>.Value   'Gets the price

        'Dim MyQuery = From book In BookData.<book> _
        '  Select book...<author>.Value

        'Dim MyQuery = From book In BookData.<book> _
        '  Where book...<price>.Value > 10 _
        '  Select book...<title>.Value

        'Dim MyQuery = From book In BookData.<book> _
        '  Order By book...<title>.Value _
        '  Select book...<title>.Value

        TitlesListBox.DataSource = MyQuery.ToList
    End Sub
End Class
```

Of course, you can select multiple fields and display in a control with multiple columns such as a DataGridView (Figure 14.18).

Figure 14.18

Child, element, and attribute items from books.xml are loaded into a DataGridView using LINQ to XML and XML literals.

```
'Project:        Ch14DataGridView
'Programmer:     Bradley/Millspaugh
'Date:           June 2008
'Description:    Read book information from the books.xml file into a _
'                data grid view.

Public Class BookForm
    Private Sub BookForm_Load(ByVal sender As System.Object, _
      ByVal e As System.EventArgs) Handles MyBase.Load
        ' Read the books.xml file from the current directory.

        Dim BookData = XElement.Load("books.xml")

        Dim MyQuery = From book In BookData.<book> _
          Select book...<title>.Value, book...<author>.Value, _
          book...<price>.Value, book.@ISBN

        BooksDataGridView.DataSource = MyQuery.ToList
        BooksDataGridView.Columns(3).Width = 250
    End Sub
End Class
```

Writing and Reading an XML File

You can write an XML file from a program using an XmlWriter object. The XmlWriter has many methods that can write properly formed XML files, with the elements and attributes identified by tags.

The following example replaces the text file from Ch11HandsOn with an XML file. The program reads the XML file, loads the CoffeeComboBox when the form loads, and gives the user the option of saving the list when the list has changed.

Only two procedures from Ch11HandsOn have changed: The Form_Load and the SaveFlavorListToolStripMenuItem_Click. Also, an `Imports System.Xml` statement replaces the `Imports System.IO` statement.

Warning: The XmlWriter class is part of the .NET 3.5 platform. If you used the Upgrade Wizard to upgrade an older version of the program, it targets an older version of the platform. Begin a new project in Visual Studio 2008 to target .NET 3.5 when you want to use the XmlWriter.

The XML Version of the ComboBox Save and Read Program

Add an `Imports` statement to the top of the file:

```
Imports System.Xml
```

Load the ComboBox in the Form_Load event procedure:

```
Private Sub FlavorsForm_Load(ByVal sender As Object, _
  ByVal e As System.EventArgs) Handles Me.Load
    ' Load the items in the CoffeeComboBox list.
    Dim ResponseDialogResult As DialogResult
```

```
    Try
        ' Read the Xml file.
        Dim FlavorFile As XElement = XElement.Load("Flavors.xml")
        Dim FlavorQuery = From Flavor In FlavorFile.<Flavor> _
          Select Flavor.Value

        For Each FlavorString As String In FlavorQuery
            CoffeeComboBox.Items.Add(FlavorString)
        Next
        IsDirtyBoolean = False
    Catch ex As Exception
        ' File missing.
        ResponseDialogResult = MessageBox.Show("Create a new file?", _
          "File Not Found", MessageBoxButtons.YesNo, _
          MessageBoxIcon.Question)
        If ResponseDialogResult = DialogResult.No Then
            ' Exit the program.
            Me.Close()
        End If
    End Try
End Sub
```

Save the XML file in the *Save* menu item's routine:

```
Private Sub SaveFlavorListToolStripMenuItem_Click(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles SaveFlavorListToolStripMenuItem.Click
    ' Save the flavor list in an XML file.

    Try
        Dim AWriter As XmlWriter = XmlWriter.Create("Flavors.xml")
        AWriter.WriteStartElement("Coffee")
        For ItemIndex As Integer = 0 To CoffeeComboBox.Items.Count - 1
            AWriter.WriteElementString("Flavor", _
              CoffeeComboBox.Items(ItemIndex).ToString)
        Next ItemIndex
        AWriter.WriteEndElement()
        AWriter.Flush()
    Catch
        MessageBox.Show("Unable to create the file.")
    End Try
    IsDirtyBoolean = False
End Sub
```

The XML File

The Flavors.xml file created by the program:

```
<?xml version="1.0" encoding="utf-8"?>
<Coffee>
  <Flavor>Chocolate Almond</Flavor>
  <Flavor>Espresso Roast</Flavor>
  <Flavor>Jamaica Blue Mountain</Flavor>
  <Flavor>Kona Blend</Flavor>
  <Flavor>Vanilla Nut</Flavor>
</Coffee>
```

Windows Presentation Foundation (WPF)

One of the coolest new features in Visual Studio 2008 is **Windows Presentation Foundation**. WPF provides the ability to create richer user interfaces for multiple platform development. Windows Vista uses WPF technology to bring a better multimedia experience to the operating system. The designing capability of WPF is available in Visual Studio as well as in the Microsoft Expression Studio, which consists of Expression Web, Expression Blend, Expression Design, and Expression Media. Microsoft Silverlight (http://silverlight.net/) is a scaled-down version of WPF technology for a rich Web-based interface and works with all leading browsers and on multiple platforms, such as Macintosh. These products offer the ability to integrate vector-based graphics, media, text, animation, and overlays into the Web interface.

When you create a Web page, there are essentially two different tasks: the interface and the code that runs the application. Often the person or artist who creates the interface is referred to as the designer. Making the page useful by creating the logic for database connection and programming is done by a developer (programmer).

Expression Blend allows a Web page designer to create an interface that can be turned over to a developer for adding the code. In Visual Studio, you may have noticed that when you create a new project, there are templates for a WPF application and for WPF Browser Applications (Figure 14.19).

The user interface in WPF applications uses XAML (pronounced "zammel") code rather than HTML. **XAML (Extensible Application Markup Language)** is an XML-based language that is much more interactive than the traditional HTML. The term *XBAP* is used to refer to a **XAML Browser Application** that runs in an Internet browser. You can check out some of the existing business applications at http://blogs.msdn.com/chabrook/archive/2007/02/20/cool-wpf-applications.aspx.

We can still write our programs in VB and Visual Studio or Visual Web Developer to supplement the XAML interface. The new technology also allows us to create hybrid applications. You can add WPF features to your Windows Form applications, and the Windows controls that you have learned about can be added to a WPF page.

We will examine both a Windows Form with WPF features and a WPF application.

WPF Interoperability

Using WPF Interoperability you can use WPF controls in a Windows Form application. The VB toolbox for a Windows project has a category for WPF Interoperability (Figure 14.20). The only control in the group that appears by default is the ElementHost. This control is a container that allows you to add other WPF controls to the Windows Form. Many WPF controls are available,

Figure 14.19

You can use the WPF Application and WPF Browser Application templates to create applications in Visual Studio.

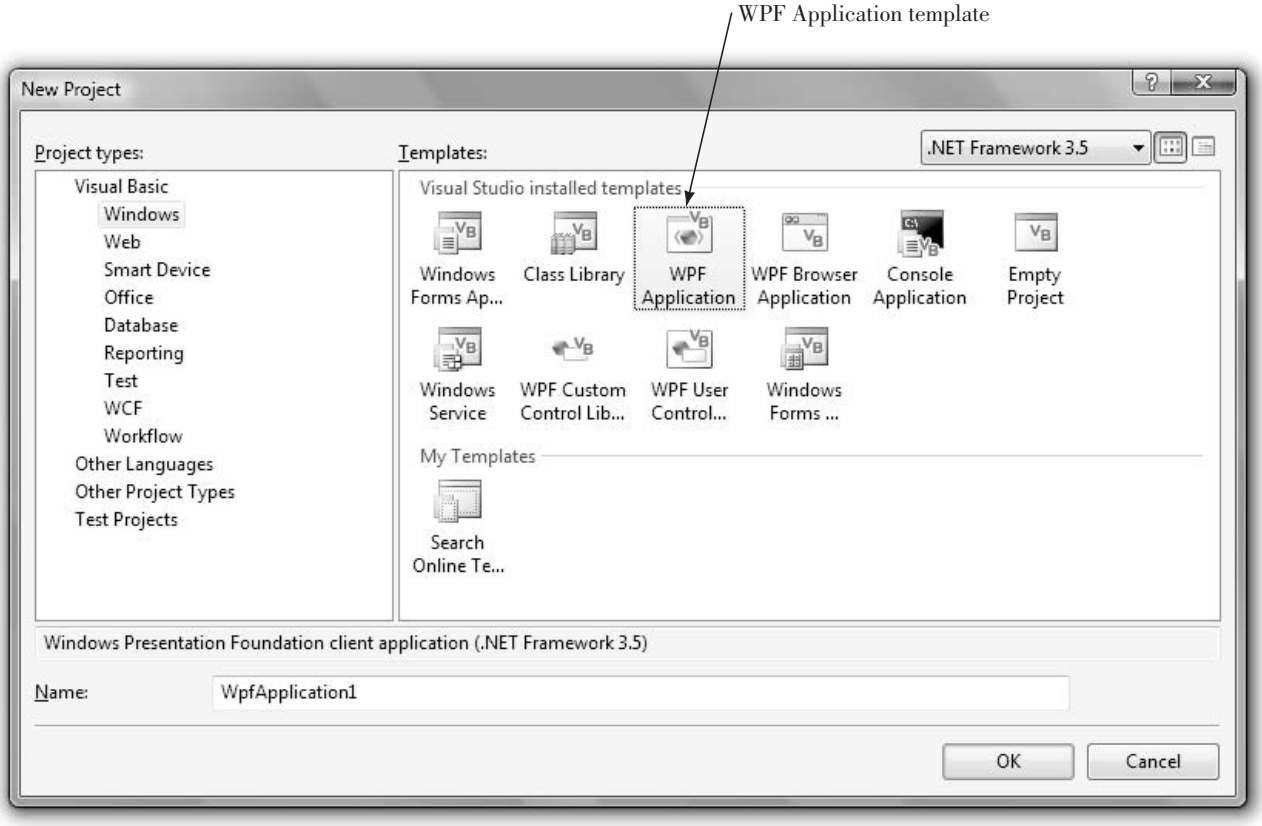
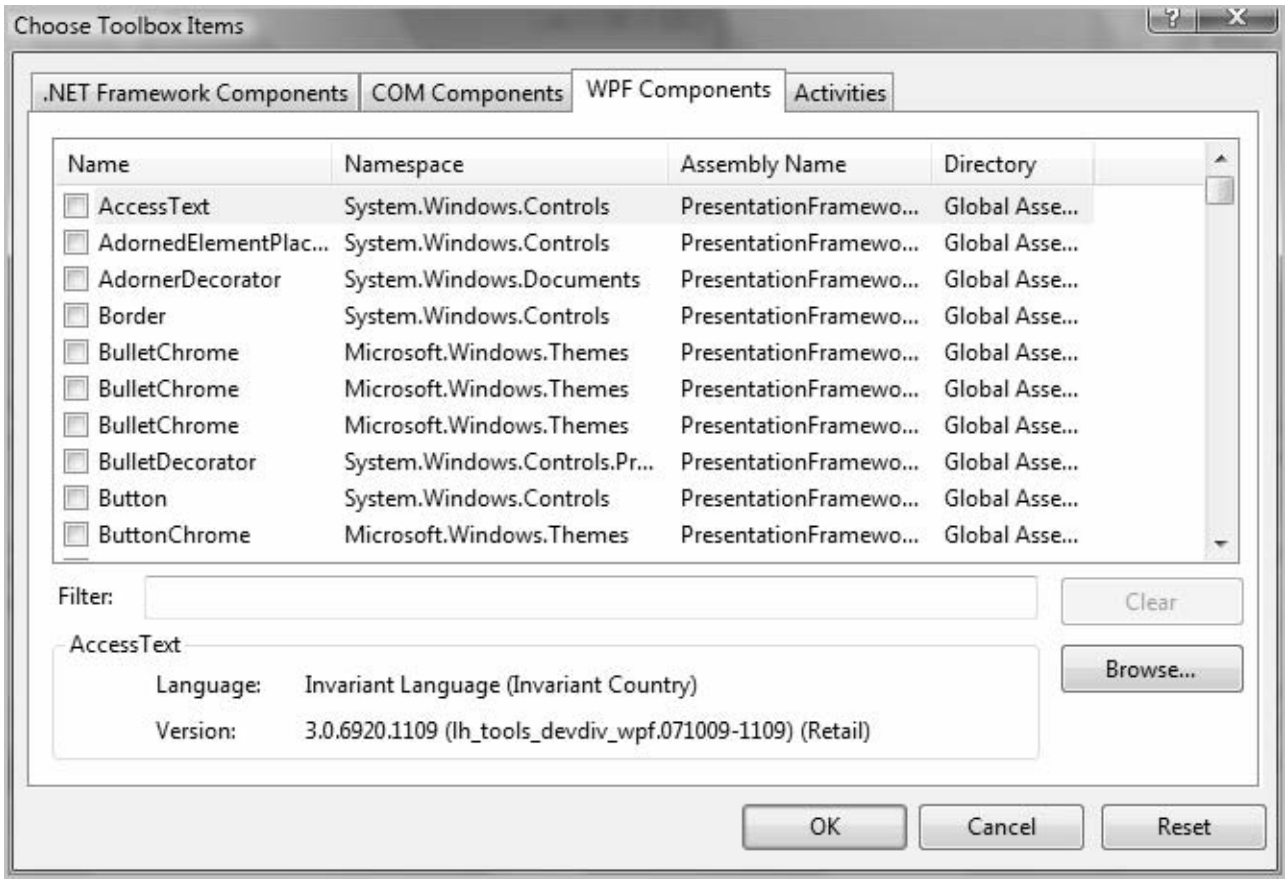


Figure 14.20

The toolbox for a Windows Form application has an ElementHost control in the WPF Interoperability section, which allows you to add WPF controls to a Windows application.

Figure 14.21

See the list of available WPF controls on the WPF Components tab of the Choose Toolbox Items dialog box.



and the list continues to grow. View the list by right-clicking in the toolbox, selecting *Choose items*, and then clicking on the WPF tab (Figure 14.21). You do not need to add the controls to the toolbox, as you add the controls at run time rather than design time.

To use WPF Interoperabiltiy, you add the ElementHost control to a Windows Form and then add the WPF controls in code. Your file must include an `Imports` statement for `System.Windows.Controls`.

You may have noticed a control that allows a part of the page to show or be hidden. This is a WPF control called an Expander. The Expander's header property indicates the words to display on the form: "More" in Figure 14.22. When the user clicks to expand the control, the value of the Content property displays.

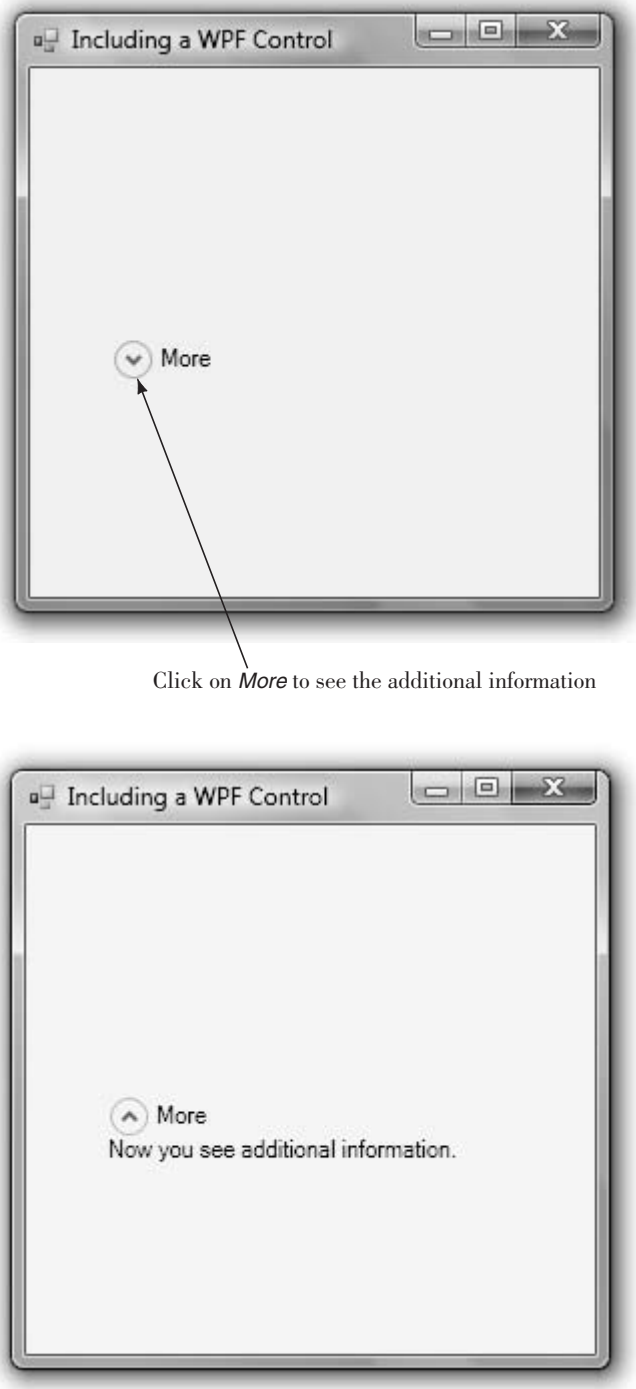


Figure 14.22

An Expander control on a Windows Form, using WPF Interoperability. When the user clicks on "More", the additional information displays.

Adding a WPF Control to a Windows Form—Step-by-Step

In the following step-by-step exercise, you will place a WPF Expander control on a Windows Form.

Set Up the Windows Project

STEP 1: Create a new project called Ch14WPFInterop.

STEP 2: Name the form WPFInteropForm, and set the Text property to "Including a WPF Control".

STEP 3: Add an ElementHost control to the form, keeping the default name ElementHost1.

Write the VB Code

STEP 1: In the Editor window, add an `Imports` statement to the top of the file:

```
Imports System.Windows.Controls
```

STEP 2: Add the following code in the Form_Load event procedure.

```
Private Sub WPFInteropForm_Load(ByVal sender As System.Object, _
  ByVal e As System.EventArgs) Handles MyBase.Load
    Dim MoreExpander As New Expander

    With MoreExpander
      .Header = "More"
      .Content = "Now you see additional information."
    End With

    ElementHost1.Child = MoreExpander
End Sub
```

Run the Program

STEP 1: Run the program. You can click on either the word "More" or the arrow icon to see the additional information.

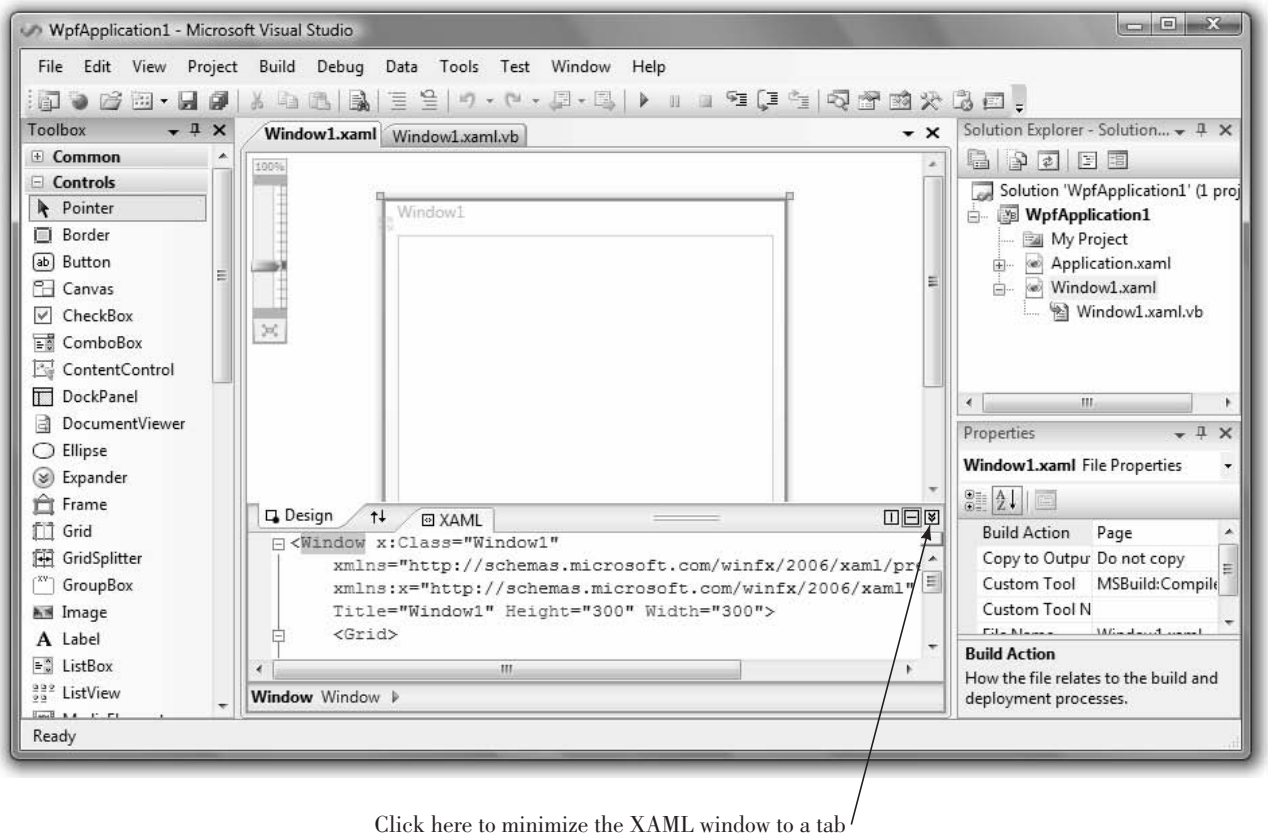
Writing a WPF Application

To create a WPF application, you select a different template when you create a new project (refer to Figure 14.19).

After creating a new project, examine the layout of the IDE. You will find that it resembles the layout for an ASP.NET application for creating a Web site. The Document window is split, showing the XAML and the design (Figure 14.23). Since you are not going to write in XAML, you can collapse the XAML screen; it doesn't really close; instead it appears as a tab at the bottom of the Design window. You can control the size of the WPF form using the adjuster bar on the left of the Design window.

Figure 14.23

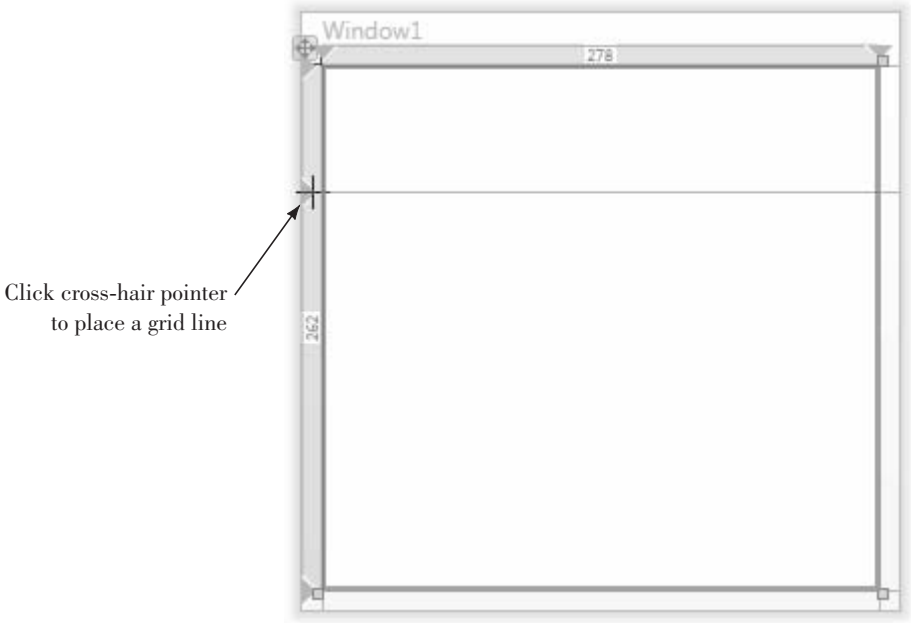
The IDE for a WPF Application. To design the user interface visually, close the XAML window.



Designing the layout of a WPF window is similar to a Web page—both use flow layout, and you must take steps to place controls where you want them. For Web pages, you probably use a table to lay out the controls on the page. For a WPF window, you do not need to set up a table; if you wish you can use the grid container that is automatically added to a new window. The grid container displays with a blue border on the left and the top. If you place your cursor inside the blue border, the mouse pointer changes to a cross-hair (Figure 14.24), and you can click to set gridlines of whatever height and width that you wish.

Figure 14.24

Click in the blue borders to create grid lines in the grid container. You also can drag the grid lines to new locations and drag them off the window to remove them.



Next look at the toolbox. You will notice many familiar-sounding controls. The controls have the same functionality and feel as the equivalent Windows Form controls but have many extra properties. Notice the Expander control that we used on the Windows Form ElementHost.

You also will find that some of the terminology is different. WPF creates a Window rather than a Form. There is no Text property; instead the window has a Title property and the other controls have a Content property.

Creating a WPF Hello World Application—Step-by-Step

We will create a Hello World application to give you a brief overview of some of the features of WPF.

Note: Although you can create this application in Windows XP, the great effects do not appear. You need to be running in Vista to see the special effects.

Set Up the Project

STEP 1: Create a new project using the WPF Application template.

STEP 2: Click the down-arrow in the upper-right corner of the XAML window to minimize it into a tab at the bottom of the Document window.

STEP 3: Do not change the name of the window but change the Title to "A Hello World Example".

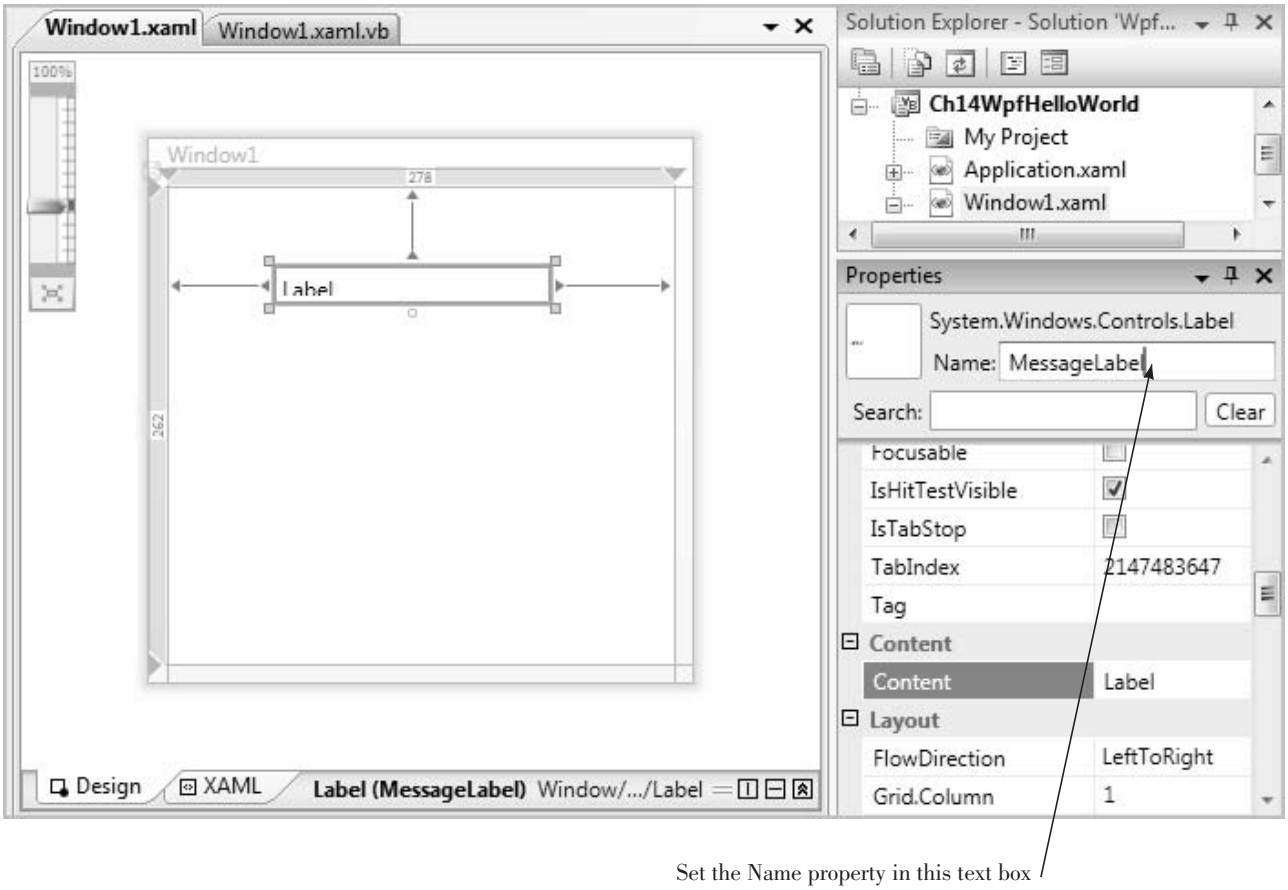
STEP 4: Save the project as Ch14WpfHelloWorld.

Add Controls

STEP 1: Add a Label and set the Name property to MessageLabel, which you set in a text box at the top of the Properties window (Figure 14.25).

Figure 14.25

Set the Name property of controls in the text box at the top of the Properties window.



STEP 2: Set the BorderThickness of the label to 3.

STEP 3: Expand the Brushes property, drop down the list for BorderBrush, and select BurlyWood. *Note*: if the drop-down list is empty, type "BurlyWood" for the property.

STEP 4: Add two buttons, naming them DisplayButton and ExitButton, with the Content property set to Display and Exit.

STEP 5: Select both of the button controls and set the following properties.

STEP 6: Under Appearance, expand *More Properties*, then set the BitmapEffect to DropShadowBitmapEffect and beneath BitmapEffect set the Color to CornflowerBlue

STEP 7: Under Brushes, set the Background to BurlyWood and the OpacityMask to CornflowerBlue. *Note*: If the OpacityMask list appears empty, type in "CornflowerBlue."

STEP 8: Select *Hand* from the Cursor property drop-down list. Note that the *Cursor* drop-down list is not in alphabetic order; you must search the list to find *Hand*.

Code the Buttons

STEP 1: Write the code for the *Display* button. You can double-click the control to access the xaml.vb Code Editor window, just as you do in a Windows application.

```
Private Sub DisplayButton_Click(ByVal sender As Object, _
  ByVal e As System.Windows.RoutedEventArgs) Handles DisplayButton.Click
    ' Display Hello World in the label.

    MessageLabel.Content = "Hello World"
End Sub
```

STEP 2: Write the code for the *Exit* button.

```
Private Sub ExitButton_Click(ByVal sender As System.Object, _
  ByVal e As System.Windows.RoutedEventArgs) Handles ExitButton.Click
    ' End the program.

    Me.Close()
End Sub
```

STEP 3: Write the remarks at the top of the file.

```
'Program:        Ch14WPFHelloWorld
'Programmer:     Bradley/Millspaugh
'Date:           June 2008
'Description:    Displays Hello World in a label.
```

Run the Program

As you move your cursor over the buttons, the Opacity property causes the color to change to blue. Also notice the cursor that we set. You can easily add a ToolTip to the button. There is no need to drag any extra components; the ToolTip property is already on each control.

Problems? If you are running in Windows XP, you may receive an error message that Option Strict is on and a conversion cannot be made. Double-click the error message to open the MyWpfExtension.vb file, scroll to the top of the file, and add `Option Strict Off`. Then rerun the program.

The Role of Expression Blend

Earlier we mentioned that the XAML code is the same for developers in Visual Studio and for designers in Expression. The project that we just created could be opened in Expression, for a designer to add even more dramatic features. Watch the video at http://channel9.msdn.com/Showpost.aspx?postid=359715 for more information.

Summary

1. An ErrorProvider component can provide an icon and popup error message next to the field that does not pass validation. Specify the text box and the message in the ErrorProvider `SetError` method.
2. A text box MaxLength property limits the number of characters the user is allowed to enter into the control.
3. The CharacterCasing property of a text box can automatically convert user input to uppercase or lowercase.
4. You can validate individual fields in the Validating event procedure for the controls. The Validating event occurs when the user attempts to move the focus to another control that has its CausesValidation property set to True.
5. VB code snippets are small samples of code that illustrate coding techniques. You can add code snippets in the editor.
6. Visual Studio includes many sample programs and quick-start tutorials.
7. A multiple document interface (MDI) contains parent and child forms. Closing the parent also closes all child forms. The child forms stay within the bounds of the parent form.
8. To create an MDI parent form, set a form's IsMdiContainer property to True. To create a child form, instantiate a new form object and set its MdiParent property to the parent form in code.
9. MDI applications generally have a *Window* menu, which displays a list of open child windows and provides choices for arranging the child windows.
10. To create a toolbar, add a ToolStrip control and add buttons to the Items collection.
11. A toolbar provides shortcuts to menu options.
12. A status bar contains information for the user along the bottom of a form. After adding a StatusStrip control to a form, add labels to its Items collection.
13. The date can be assigned to the Text property of a ToolStripStatusLabel during the Form_Load event procedure, but the time display requires an update routine using a Timer component.
14. The DateTimePicker and MonthCalendar controls have accurate calendars for displaying and inputting dates.
15. The WebBrowser control provides the ability to display Web pages from a Windows Form.
16. You can check the `e` (KeyEventArgs) argument of a control's KeyUp event procedure to determine which key was pressed. The e.KeyCode and e.KeyData properties hold a numeric code for the key, which you can check using the constants in the Keys enumeration.
17. XML files are used to store data as text identified by tags. The files are platform independent and extremely flexible.
18. XML files consist of nodes, elements, and attributes. Each file can have one root node and many child nodes. Child nodes at the same level are called ***siblings***.
19. Two objects that you can use to read an XML file are XDocument and XElement. You can use a LINQ to XML query to select data elements using a three-axis model to specify the individual items. The axes are child elements, attribute elements, and descendent elements.
20. You can save data into an XML file using an XmlWriter object, which inserts the correct tags into the file.

21. Windows Presentation Foundation (WPF) can be used to create rich user interfaces, such as those in Windows Vista.
22. A WPF user interface is coded in XAML; a XAML browser application is called XBAP.
23. Using WPF Interoperability you can add an ElementHost control and WPF controls to a Windows Form. WPF controls are added to the ElementHost at run time.
24. WPF applications are similar to Web applications in that they are created as two files: one for the user interface and one for the programming logic.

Key Terms

attribute *585*
CausesValidation property *566*
CharacterCasing property *565*
child form *571*
code snippets *570*
DateTime structure *577*
element 585
ErrorProvider component *562*
field-level validation *566*
IsMdiContainer property *572*
`LayoutMdi` method *574*
MaxLength property *565*
MdiWindowListItem property *573*
multiple document interface (MDI) *571*
node 585
Now property *577*
parent form *571*
`SetError` method *562*
sibling 585
single document interface (SDI) *571*
status bar *577*
StatusStrip control *577*
toolbar *575*
ToolStrip control *575*
ToolStripStatusLabel object *577*
WebBrowser control *581*
Windows Presentation Foundation (WPF) *593*
XAML (Extensible Application Markup Language) *593*
XBAP (XAML *593*

Review Questions

1. Explain how to use an ErrorProvider component when validating the value in a text box.
2. What properties of a text box determine the number of characters a user can enter and the case (upper or lower) of the input?
3. What are code snippets? How might they be used?
4. What is meant by ***MDI***?
5. What are the advantages of having parent and child forms?
6. What are the layouts available for arranging child windows?
7. How can a child form be created? a parent form?
8. What steps are necessary to create a toolbar and have its buttons execute menu procedures?
9. What must be done to create a status bar? to display the current time on the status bar? to keep the time display current?
10. Describe two controls that you can use for displaying dates on a form.
11. What property is used to navigate to a Web page at design time using the WebBrowser control? How is this task accomplished at run time?

12. What is the advantage of using XML files over other file types?
13. What is WPF? How does it apply to Windows and Web applications?

Programming Exercises

14.1 Convert any of your earlier programs that use message boxes for error messages to use an ErrorProvider component. Remove all error message boxes from the program and display meaningful messages in the popup Error Text.

14.2 Write an MDI project that is a simple text editor. Allow the user to open multiple documents, each in a separate child form. For the text editor, use one big TextBox control with its Multiline property set to True or a RichTextBox control. Set the control's Anchor property to all four edges so the control fills its form.

The user should be able to load and save a file in each form. Use the file handling that you learned about in Chapter 11 and display the name of the file in the form's title bar.

14.3 Add a toolbar and a status bar to a previous project to provide shortcuts to the menu items.

14.4 Add a toolbar and a status bar to the calendar program from this chapter.

14.5 Create an application for displaying movie listings. Add a WebBrowser control that navigates to a page showing the movies.

14.6 Convert your text file project from Chapter 11 to use an XML file.

14.7 Write Project 1.5, the diner features of the day, as a WPF Application. Add features for the buttons. Note that some of the features will not work in WPF, such as keyboard access and printing.

Case Studies

Note: For help in basing a new project on an existing project, see "Basing a New Project on an Existing Project" in Chapter 5 or "Copy and Move Projects" in Appendix C.

VB Mail Order

Convert any of your earlier VB Mail Order programs that use message boxes for error messages to use an ErrorProvider component. Remove all error message boxes from the program and display meaningful messages in the popup Error Text.

Add a toolbar and a status bar to the project to provide shortcuts to the menu items.

VB Auto Center

Convert any of your earlier VB Auto Center programs that use message boxes for error messages to use an ErrorProvider component. Remove all error message boxes from the program and display meaningful messages in the popup Error Text.

Add a toolbar and a status bar to the project to provide shortcuts to the menu items.

Video Bonanza

Convert any of your earlier Video Bonanza programs that use message boxes for error messages to use an ErrorProvider component. Remove all error message boxes from the program and display meaningful messages in the popup Error Text.

Add a toolbar and a status bar to the project to provide shortcuts to the menu items.

Very Very Boards

Convert any of your earlier Very Very Boards programs that use message boxes for error messages to use an ErrorProvider component. Remove all error message boxes from the program and display meaningful messages in the popup Error Text.

Add a toolbar and a status bar to the project to provide shortcuts to the menu items.

APPENDIX

A

Answers to Feedback Questions

Feedback 1.1

These exercises are designed to help users become familiar with the Help system. There are no "correct" answers.

Feedback 2.1

Property	Setting
Name	IconPictureBox
BorderStyle	Fixed3D
SizeMode	StretchImage
Visible	True

Feedback 2.2

1.
```
With CompanyTextBox
     .Clear()
     .Focus()
End With
```
2.
```
CustomerLabel.Clear()
OrderTextBox.Focus()
```
3. (a) Places a check in the check box.
   (b) Radio button is selected.
   (c) Makes the picture invisible.
   (d) Makes the label appear sunken.
   (e) Assigns the text value in CityTextBox.Text to the text value of CityLabel.Text.

Feedback 3.1

1. The name is valid; however, the data type should be specified.
2. Invalid. Identifiers cannot contain special characters such as "#".
3. Invalid. An identifier cannot contain blank spaces.
4. Invalid. Periods are used to separate items such as Object.Property.
5. Invalid. Identifiers cannot contain embedded special characters such as "$".
6. Invalid. *Sub* is a reserved word.
7. The name is valid; however, it does not indicate anything about what the variable is used for.
8. Invalid. *Text* is a property name and should not be used as a variable name. Also, it does not specify a data type.
9. The name is valid; however, the data type should be specified.
10. Valid.
11. Valid.
12. Valid.

Feedback 3.2

Note: Answers may vary; make sure that the data type is included in each name.

1. (a) HoursDecimal
   (b) EmployeeNameString
   (c) DepartmentNumberString
2. (a) QuantityInteger
   (b) DescriptionString
   (c) PartNumberString
   (d) CostDecimal
   (e) SellingPriceDecimal

Feedback 3.3

Note: Answers may vary; make sure the data type is included in each name.

1. `Private TotalPayrollDecimal As Decimal`
   Declared at the module level.
2. `Const SALES_TAX_Decimal As Decimal = .08D`
   Declared at the module level.
3. `Private ParticipantCountInteger As Integer`
   Declared at the module level.

Feedback 3.4

1. 18
2. 1
3. 6
4. 5
5. 22
6. 2048
7. 22
8. 38

Feedback 3.5

1. (a) `CountInteger = CountInteger + 5`
   (b) `CountInteger += 5`
2. (a) `BalanceDecimal = BalanceDecimal – WithdrawalDecimal`
   (b) `BalanceDecimal –= WithdrawalDecimal`
3. (a) `PriceDecimal = PriceDecimal * CountInteger`
   (b) `PriceDecimal *= CountInteger`

Feedback 3.6

1. `AveragePayTextBox.Text = AveragePayDecimal.ToString("C")`
   $123.46
2. `QuantityTextBox.Text = QuantityInteger.ToString()`
   176123
3. `TotalTextBox.Text = TotalCollectedDecimal.ToString("N")`

Feedback 4.1

1. True
2. True
3. True
4. False
5. False
6. True
7. True
8. False
9. True
10. True

Feedback 4.2

1. FrogsRadioButton will be checked.
2. "It's the toads and the polliwogs"
3. "It's true"
4.
```
If Integer.Parse(OrangesTextBox.Text) _
  > Integer.Parse(ApplesTextBox.Text) Then
    MostTextBox.Text = "Oranges"
ElseIf Integer.Parse(ApplesTextBox.Text) _
  > Integer.Parse(OrangesTextBox.Text) Then
    MostTextBox.Text = "Apples"
Else
    MostTextBox.Text = "They're equal"
End If
```
5.
```
If BalanceDecimal > 0 Then
    FundsCheckBox.Checked = True
    BalanceDecimal = 0
    CountInteger += 1
Else
    FundsCheckBox.Checked = False
End If
```

Feedback 4.3

1.
```
Select Case TempInteger
  Case Is <= 32
    CommentTextBox.Text = "Freezing"
  Case Is > 80
    CommentTextBox.Text = "Hot"
  Case Else
    CommentTextBox.Text = "Moderate"
End Select
```
2.
```
Select Case CountInteger
  Case 0
    MessageBox.Show("No items entered.")
  Case 1 To 10
    MessageBox.Show("1 – 10 items entered.")
  Case 11 To 20
    MessageBox.Show("11 – 20 items entered.")
  Case Else
    MessageBox.Show("More than 20 items were entered.")
End Select
```

Feedback 5.1

1. Function procedure; a value will be returned.
2.
```
Private Function Average(ByVal ValueOneInteger As Integer, _
  ByVal ValueTwoInteger As Integer, _
  ByVal ValueThreeInteger As Integer) As Integer
```
   Note: `ByVal` is optional; the editor will add it for you.
3. `Return (ValueOneInteger + ValueTwoInteger + ValueThreeInteger) / 3`
4. The answer appears on a `Return` statement or is assigned to the variable with the same name as the function.

Feedback 6.1

1. `Const FAT_CALORIES_Integer As Integer = 9`
   Declared at the module level.
2. `Friend HighestNameString As String`
   Declared at the module level.
3. `Friend Const COMPANY_NAME_String As String = "Bab's Bowling Service"`
   Declared at the module level.
4. `Friend TotalAmountDecimal As Decimal`
   Declared at the module level.

5. `Friend PersonCountInteger As Integer`
   Declared at the module level.
6. `Dim TotalString As String`
   Declared at the local level.

Feedback 7.1

1. Alphabetizes the items in a list box or combo box.
2. Stores the index number of the currently selected (highlighted) item; has a value of –1 if nothing is selected.
3. Is a collection that holds the objects, usually text, of all list elements in a list box or combo box.
4. Determines whether or not a combo box will also have a text box for user input. It also determines whether or not the list will drop down.
5. Stores the number of elements in a list box or combo box.
6. Adds an element to a list at run time.
7. Adds an element to a list and inserts the element in the chosen position (index).
8. Clears all elements from a list box or combo box.
9. Removes an element from the list by referring to its index.
10. Removes an element from a list by looking for a given string.

Feedback 7.2

```
ItemFoundBoolean = False  ' Set the initial value of the found switch to False.
ItemIndexInteger = 0  ' Initialize the counter for the item index.
' Loop through the items until the requested item is found
' or the end of the list is reached.
Do Until ItemFoundBoolean Or ItemIndexInteger = ItemsListBox.Items.Count
   ' Check if the text box entry matches the item in the list.
   If NewItemTextBox.Text = _
     ItemsListBox.Items(ItemIndexInteger).ToString() Then
       ItemFoundBoolean = True  ' Set the found switch to True.
   Else   'Otherwise...
       ItemIndexInteger += 1  ' Increment the counter for the item index.
   End If
Loop
```

Feedback 7.3

1. (a) There should not be a comma after the test value.
   (b) The variable named on the `Next` statement must match the one on the `For` statement, IndexInteger in this case.

(c) The item following the word `For` must be a variable, and the same variable must be used on the `Next` statement. 4 is not a proper variable name, and `For` is a reserved word.
(d) Valid.
(e) Valid.
(f) This loop will never be executed; it needs to have a negative `Step` argument.

2. (a) Will be executed 3 times; CountInteger will have an ending value of 4.
(b) Will be executed 4 times; CountInteger will have an ending value of 14.
(c) Will be executed 10 times; CountInteger will have an ending value of 0.
(d) Will be executed 7 times; CounterDecimal will have an ending value of 6.5.
(e) Will never be executed because the starting value is already greater than the test value; CountInteger will have an ending value of 5.

Feedback 7.4

1. A component used to set up output for the printer. Add the component to the form's component tray at design time. Begin the printing process by executing the `Print` method of the component; the component's PrintPage event occurs.
2. Starts the printing process. Belongs in the Click event procedure for the *Print* button or menu item.
3. The PrintPage event is a callback that occurs once for each page to print. The PrintPage event procedure contains all the logic for printing the page.
4. Sends a line of text to the graphics object. The `DrawString` method is used in the PrintPage event procedure.
5. An argument passed to the PrintPage event procedure. Holds items of information such as the page margins.
6. MarginBounds.Left is one of the properties of the PrintPageEventArgs argument passed to the PrintPage event procedure. The property holds the left margin and can be used to set the X coordinate to the left margin.
7. A component that allows the user to view the document in *Print Preview*. The component is added to the component tray at design time. In the event procedure where the user selects *Print Preview*, the print document is assigned to this component.

Feedback 8.1

1. Valid.
2. Valid.
3. Valid.
4. Invalid; beyond the range of the array.
5. Valid.
6. Invalid; negative number.
7. Gives a decimal number, but Visual Basic will round the fraction and use that integer.
8. Valid.

Feedback 8.2

1.
```
Structure Student
  Dim LastNameString As String
  Dim FirstNameString As String
  Dim StudentNumberString As String
  Dim UnitsCompletedDecimal As Decimal
  Dim GpaDecimal As Decimal
End Structure
```
2.
```
Dim InfoStudent(99) As Student
```
3.
```
Structure Project
  Dim ProjectNameString As String
  Dim FormNameString As String
  Dim FolderNameString As String
End Structure
```
4.
```
Dim MyProject As Project
```
5.
```
Dim OurProjects(99) As Project
```

Feedback 8.3

1.
```
Dim TemperatureDecimal(2, 4) As Decimal
```
2.
```
For ColumnInteger = 0 To 4
    TemperatureDecimal(0, ColumnInteger) = 0
Next ColumnInteger
```
3.
```
For ColumnInteger = 0 To 4
    TemperatureDecimal(1, ColumnInteger) = 75
Next ColumnInteger
```
4.
```
For ColumnInteger = 0 To 4
    TemperatureDecimal(2, ColumnInteger) = TemperatureDecimal(0, ColumnInteger) _
      + TemperatureDecimal(1, ColumnInteger)
Next ColumnInteger
```
5.
```
For RowIndexInteger = 0 To 2
  For ColumnIndexInteger = 0 To 4
    e.Graphics.DrawString(TemperatureDecimal(RowIndexInteger, _
      ColumnIndexInteger).ToString(), PrintFont, Brushes.Black, _
      PrintXSingle, PrintYSingle)
    PrintXSingle += 200
  Next ColumnIndexInteger

  ' Begin a new line.
  PrintXSingle = e.MarginBounds.Left
  PrintYSingle += lineHeightSingle
Next RowIndexInteger
```

Feedback 9.1

1. The .aspx file holds the specifications for the user interface that are used by the server to render the page. The .aspx.vb file holds the Visual Basic code that you write to respond to events.
2. Right-click on the .aspx file or on the page in the Document window and select *View in Browser*.
3. Web server controls do not directly correspond to HTML controls but are rendered differently for different browsers in order to achieve the desired look and feel. You cannot write any server-side programming logic for HTML controls. As you submit forms to the server, any HTML controls pass to the server and back as static text. You might want to use HTML controls if you have existing HTML pages that are working and you want to convert to ASP.NET for additional capabilities.

Feedback 9.2

1. Manually move to the bottom of the page using the Enter key or create a table and add the button to a cell.
2. An HTML control doesn't need any server-side programming. The Web server Table control is generally used when you want to write code to add rows, columns, or controls at run time.
3. Store images in the Web site folder.

Feedback 9.3

1. The NavigateUrl property.
2. Add a HyperLink control to both pages. Set the NavigateUrl of each to point to the other page.

Feedback 9.4

Attach a RequiredFieldValidator control so that the field cannot be left blank. Attach a RangeValidator to check if the input falls within the specified range by setting the MinimumValue = 0 and the MaximumValue = 1000. Set the RangeValidator Type property to Integer, to validate that the entry can be converted to a numeric integer.

Feedback 9.5

The Page_Load event occurs and the page is redisplayed for every round-trip to the server. If you have initialization code in the Page_Load event procedure, you don't want to perform the initialization each time the procedure executes.

Feedback 10.1

1. The *file* is the database.
   The *table* contains the *rows* and *columns*, which hold the information about your friends.
   Each *row*/*record* contains information about an individual friend.
   A *column* or *field* contains an element of data, such as the name or phone number.
   The *key field* is the field used to organize the file; it contains a unique value that identifies a particular record, for example, the telephone number field.
2. XML is stored as text, which can pass through Internet firewalls and can be edited using any text editor.

Feedback 10.2

The binding source object creates a link between the original data source and the program. The table adapter passes information back and forth between the data source and the dataset. The dataset holds a copy of the data retrieved from the data source and is used in your program to access the data, either field by field (for labels and text boxes) or by connecting it to a grid.

Feedback 10.3

1. The smart tag in the Data Sources window allows you to select DataGrid-View or Details view.
2. In the Data Sources window, select *Details* on the smart tag and drag the table to the form. To change to a label, open the smart tag on the text box and select *Label*.
3. Set the DataSource property of the combo box to the binding source used by the other controls. Set the DisplayMember property to the data field to display in the combo box.
4. To sort the list, modify the SQL `SELECT` statement used by the table adapter.

Feedback 10.4

1. Language integrated query; allows the programmer to write queries in the program code.
2. LINQ can be used to query databases, XML files, or any data defined as an object.
3. The VB compiler supplies (or infers) the data type for a variable that does not have a type declared.

Feedback 11.1

1. `Dim InventoryStreamWriter As New StreamWriter("Inventory.txt")`
2. `InventoryStreamWriter.WriteLine(DescriptionTextBox.Text)`
3. The declaration for the StreamReader object needs to be in a `Try/Catch` block in case the file does not exist. The declaration for the StreamWriter object does not need to be in a `Try/Catch` block because, in this case, the program is generating a file, not trying to locate one; however, if you are using a full qualifying pathname, then you should put the StreamWriter declaration in a `Try/Catch` block.
4.
```
If InventoryStreamReader.Peek <> –1 Then
  DescriptionLabel.Text = InventoryStreamReader.ReadLine()
  ProductNumberLabel.Text = InventoryStreamReader.ReadLine()
End If
```

Feedback 11.2

1. `Text Files (*.txt)|*.txt`
2. `OpenFileDialog1.InitialDirectory = Directory.GetCurrentDirectory()`
3.
```
If PhoneStreamWriter IsNot Nothing Then
  PhoneStreamWriter.Close()
End If
```

Feedback 11.3

1.
```
With NamesListBox
  For IndexInteger As Integer = 0 To .Items.Count – 1
    NamesStreamWriter.WriteLine(.Items(IndexInteger))
  Next IndexInteger
End With
```
2. The above code should be placed in a Save procedure that should be called from the form's FormClosing event procedure.
3.
```
Try
  Dim NamesStreamReader As New StreamReader("Names.txt")
  Do Until NamesStreamReader.Peek = –1
    NamesListBox.Items.Add(NamesStreamReader.ReadLine())
  Loop
  NamesStreamReader.Close()
Catch
```

Feedback 12.1

1. An object is an instance of a class. A class defines an item type (like the cookie cutter defines the shape), whereas the object is an actual instance of the class (as the cookie made from the cookie cutter).
2. TheProduct is an object, an instance of the Product class.
3. The numeric value of QuantityTextBox is assigned to the Quantity property of TheProduct.
4.
```
Private LastNameString As String
Private FirstNameString As String
Private StudentIDNumberString As String
Private GpaDecimal As Decimal
```
These statements appear at the module level.
5.
```
Property LastName() As String
  Get
    Return LastNameString
  End Get
  Set(ByVal value As String)
    LastNameString = value
  End Set
End Property
```
6.
```
ReadOnly Property GPA() As Decimal
  Get
    Return GpaDecimal
  End Get
End Property
```

Feedback 13.1

1.
```
Dim xInteger As Integer
Dim yInteger As Integer
yInteger = Convert.ToInt32(Me.Height)
xInteger = Convert.ToInt32(Me.Width / 2)
e.Graphics.DrawLine(Pens.Green, xInteger, 0, xInteger, yInteger)
```
2.
```
e.Graphics.DrawEllipse(Pens.Green, xInteger, yInteger, 100F, 100F)
e.Graphics.DrawEllipse(Pens.Blue, xInteger + 25, yInteger + 25, 50F, 50F)
```
3.
```
Dim FirstPoint As New Point(20, 20)
Dim SecondPoint As New Point(100, 100)
Dim ThirdPoint As New Point(200, 50)
e.Graphics.DrawLine(Pens.Green, FirstPoint, SecondPoint)
e.Graphics.DrawLine(Pens.Green, SecondPoint, ThirdPoint)
e.Graphics.DrawLine(Pens.Green, ThirdPoint, FirstPoint)
```

Feedback 13.2

1.
```
Static xInteger As Integer = CommandButton.Left – 10
Static yInteger As Integer = CommandButton.Top
Static WidthInteger As Integer = CommandButton.Width
Static HeightInteger As Integer = CommandButton.Height
CommandButton.SetBounds(xInteger, yInteger, WidthInteger, HeightInteger)
```
or
```
With CommandButton
   .SetBounds(.Left – 10, .Top, .Width, .Height)
End With
```
2. A little less than half a second.
3. The Tick event fires each time the specified interval has elapsed.

Feedback 13.3

1.
```
Private Sub TaskListBox_DragEnter(ByVal sender As Object, _
  ByVal e As System.Windows.Forms.DragEventArgs) _
  Handles TaskListBox.DragEnter
     ' Set the desired DragDrop effect.
     e.Effect = DragDropEffects.Copy
End Sub
```
2.
```
Private Sub TaskListBox_DragDrop(ByVal sender As Object, _
  ByVal e As System.Windows.Forms.DragEventArgs) _
  Handles TaskListBox.DragDrop
     ' Add the item to the list box.

     TaskListBox.Items.Add(e.Data.GetData(DataFormats.Text).ToString()
     TaskTextBox.Clear()
End Sub
```

Feedback 14.1

1. When the code is placed inside a `Catch` block, it will place an icon next to the QuantityTextBox control when the user inputs invalid data. The message appears as a ToolTip when the user places the pointer over the icon.
2. The MaxLength and CharacterCasing properties.
   - MaxLength: Sets a maximum number of characters that may be entered into a text box. A beep occurs if the user attempts to exceed the maximum.
   - CharacterCasing: Automatically converts data entry to uppercase, lowercase, or normal.
3. With field-level validation the user is notified of an error as the focus leaves a field, rather than waiting until a button's Click event occurs.

Feedback 14.2

1.
```
Dim AboutChildForm As New AboutForm()
AboutChildForm.MdiParent = Me
AboutChildForm.Show()
```
2. Add an event to the `Handles` clause for the *Exit* and *About* menu items.
3. Add a timer component; set the Interval property and include the following statement in the timer's Tick event procedure and the Form_Load event procedure.

```
CurrentTimeToolStripStatusLabel.Text = Now.ToLongTimeString()
```

Feedback 14.3

1.
```
AppointmentDateTime = AppointmentDateTimePicker.Value
```
2. Hour; Millisecond; Minute; Second; Month; Day; Year; Now
3. All of the above properties are available for the Now property.

APPENDIX

B

Methods and Functions for Working with Dates, Financial Calculations, Mathematics, and String Operations

Visual Basic and the .NET Framework include many functions and methods that you can use in your projects. This appendix introduces some functions and methods for handling dates, for performing financial calculations and mathematical operations, for converting between data types, and for performing string operations.

Working with Dates

Chapter 14 has a section introducing dates and the Calendar control. You can use the date functions and the methods of the DateTime structure to retrieve the system date, break down a date into component parts, test whether the contents of a field are compatible with the Date data type, and convert other data types to a Date.

The DateTime Structure

When you declare a variable of Date data type in VB, the .NET Common Language Runtime uses the DateTime structure, which has an extensive list of properties and methods. You can use the shared members of the DateTime structure (identified by a yellow *S* in the MSDN Help lists) without declaring an instance of Date or DateTime. For example, to use the Now property:

```
TodayDateTime = Now
```

Following is a partial list of some useful properties and methods of the DateTime structure:

Property or Method	Purpose
`Add`	Add the specified number to an instance of a date/time. Variations include `AddDays`, `AddHours`, `AddMilliseconds`, `AddMinutes`, `AddMonths`, `AddSeconds`, `AddTicks`, and `AddYears`.
Date	Date component.
Day	Integer day of month; 1-31
DayOfWeek	Integer day; Enum expression for each day in the form of DayOfWeek.Sunday.
DayOfYear	Integer day; 1-366
Hour	Integer hour; 0-23
Minute	Integer minutes; 0-59
Second	Integer seconds; 0-59
Month	Integer month; 1 = January.
Now	Retrieve system date and time.

Property or Method	Purpose
`Subtract`	Finds the difference between date/time values; returns a TimeSpan object.
Today	Retrieve system date.
Year	Year component.
`ToLongDateString`	Date formatted as long date. (U.S. default: Wednesday, May 04, 2005)
`ToLongTimeString`	Date formatted as long time. (U.S. default: 12:00:00 AM)
`ToShortDateString`	Date formatted as short date. (U.S. default: 5/4/2005)
`ToShortTimeString`	Date formatted as short time. (U.S. default: 12:00 AM)

Retrieving the System Date and Time

You can retrieve the system date and time from your computer's clock using the Now property or the Today property. Now retrieves both the date and time; Today retrieves only the date.

Examples

```
Dim DateAndTimeDate As Date
DateAndTimeDate = Now

Dim TodaysDate As Date = Today
```

To display the values formatted:

```
DateAndTimeTextBox.Text = DateAndTimeDate.ToLongDateString()
DateTextBox.Text = TodaysDate.ToShortDateString()
NowTextBox.Text = Now.ToShortDateString()
```

In addition to the date formatting methods, you also can format dates and times with the `ToString` method by using an appropriate format specifier. The table below lists some of the format specifiers. See "Date and Time Format Strings" in MSDN for a complete list. The actual format depends on the local format for the system.

Format Specifier	Description	Example for U.S. Default Setting
d	Short date pattern	5/5/2008
D	Long date pattern	Thursday, May 5, 2008
t	Short time pattern	12:00 AM
T	Long time pattern	12:00:00 AM
f	Full date/time (short)	Thursday, May 05, 2008 12:00 AM
F	Full date/time (long)	Thursday, May 05, 2008 12:00:00 AM

Examples of formatting using `ToString`:

```
DateAndTimeTextBox.Text = DateAndTimeDate.ToString("D")
TodayTextBox.Text = Today.ToString("d")
```

User-Defined Date Formatting

Visual Basic provides format characters that you can use to create custom formatting for dates. Note that the format characters are case sensitive.

Character	Purpose
/	Separator; the actual character to print is determined by the date separator specified for your locale.
d	Day; displays without a leading zero.
dd	Day; displays with a leading zero.
ddd	Day; uses a three-letter abbreviation for the day, such as Mon for Monday.
dddd	Day; spelled out, such as Monday.
M	Month; displays without a leading zero.
MM	Month; displays with a leading zero.
MMM	Month; uses a three-letter abbreviation for the month name, such as Jan for January.
MMMM	Month; spelled out, such as January.
y	Year; displays as two characters without a leading zero.
yy	Year; displays as two characters with a leading zero.
yyy *or* yyyy	Year; displays as four characters.

Examples using January 1, 2008:

Format	Result
M/d/yy	1/1/08
MM/dd/yy	01/01/08
MMMM d, yyyy	January 1, 2008

Date Variables

The Date data type may hold values of many forms that represent a date. Examples could be May 25, 2008, 5/25/08, or 5-25-2008. When you assign a literal value to a Date variable, enclose it in # signs:

```
Dim TheDate As Date
TheDate = #5/25/2008#
```

Converting Values to a Date Format

If you want to store values in a Date data type, you need to convert the value to a Date type. The `Date.Parse` method and the `Convert.ToDateTime` method convert a value to Date type but throw an exception if they are unable to create a valid date from the argument. Use a `Try` block to make sure you have a valid date value and catch the exception.

```
Try
  TheDate = Date.Parse(DateTextBox.Text)
Catch
  MessageBox.Show("Invalid date.")
End Try
```

Finding the Difference between Dates

You can use the `Subtract` method to find the difference between two Date objects. The result is in the format of days, hours, minutes, and seconds. Perhaps you only want the number of days between two dates. The .NET Framework includes the TimeSpan class that stores the time differences with the properties that you need.

```
Dim EnteredDate As Date

EnteredDate = Date.Parse(DateTextBox.Text)
Dim DaysTimeSpan As TimeSpan = EnteredDate.Subtract(Today)
DateDifferenceTextBox.Text = DaysTimeSpan.Days.ToString()
```

The user enters a date into a text box. That Date object uses its `Subtract` method to compare to today's date.

A similar `Add` method allows you to set a date at a specified time in the future.

```
Dim NextWeekDate As Date

' Add methods require Double arguments.
NextWeekDate = Today.AddDays(7D)
NextWeekTextBox.Text = "Next week is: " & NextWeekDate.ToString("D")
```

Checking for the Day of the Week

Sometimes a program may need to check for the day of the week. Maybe you have a set day for a meeting or perhaps the rates differ on weekends compared to weekdays.

```
If EnteredDate.DayOfWeek = DayOfWeek.Saturday Or _
  EnteredDate.DayOfWeek = DayOfWeek.Sunday Then
    WeekendCheckBox.Checked = True
Else
    WeekendCheckBox.Checked = False
End If
```

Financial Functions

Visual Basic provides functions for many types of financial and accounting calculations, such as payment amount, depreciation, future value, and present value. When you use these functions, you eliminate the need to know and code the actual formulas yourself. Each financial function returns a value that you can assign to a variable, or to a property of a control. The functions belong to the Microsoft.VisualBasic Financial module namespace.

Category	Purpose	Function

Depreciation	Double-declining balance.
	Straight line.
	Sum-of-the-years' digits.
		`DDB`
		`SLN`
		`SYD`

Payments	Payment.
	Interest payment.
	Principal payment.
		`Pmt`
		`IPmt`
		`PPmt`

Return	Internal rate of return. Rate of return when payments and receipts are at different rates.	`IRR` `MIRR`
Rate	Interest rate.	`Rate`
Future value	Future value of an annuity.	`FV`
Present value	Present value. Present value when values are not constant.	`PV` `NPV`
Number of periods	Number of periods for an annuity. (Number of payments)	`NPer`

You must supply each function with the necessary arguments. You specify the name of the function, followed by parentheses that enclose the arguments.

IntelliSense helps you type the arguments of functions. When you type the parentheses, the arguments appear in order. The one to be entered next is in bold. The order of the arguments is important because the function uses the values in the formula based on their position in the argument list. For example, the following `Pmt` function has three arguments: the interest rate, the number of periods, and the amount of the loan. If you supply the values in a different order, the `Pmt` function will calculate with the wrong numbers.

The Pmt Function

You can use the `Pmt` function to find the amount of each payment on a loan if the interest rate, the number of periods, and the amount borrowed are known.

The Pmt Function—General Form

General Form

```
Pmt(InterestRatePerPeriod, NumberOfPeriods, AmountOfLoan)
```

The interest rate must be specified as Double and adjusted to the interest rate per period. For example, if the loan is made with an annual rate of 12 percent and monthly payments, the interest rate must be converted to the monthly rate of 1 percent. Convert the annual rate to the monthly rate by dividing by the number of months in a year (AnnualPercentageRate / 12).

The number of periods for the loan is the total number of payments. If you want to know the monthly payment for a five-year loan, you must convert the number of years to the number of months. Multiply the number of years by 12 months per year (NumberOfYears * 12).

The `Pmt` function requires Double arguments and returns a Double value.

The Pmt Function—Example

Example

```
Try
   MonthlyRateDouble = Double.Parse(RateTextBox.Text) / 12
   MonthsDouble = Double.Parse(YearsTextBox.Text) * 12
   AmountDouble = Double.Parse(AmountTextBox.Text)
   MonthlyPaymentDouble = -Pmt(MonthlyRateDouble, MonthsDouble, AmountDouble)
   MonthlyPaymentTextBox.Text = MonthlyPaymentDouble.ToString()
Catch
   MessageBox.Show("Invalid data.")
End Try
```

Notice in the example that the fields used in the payment function are from text boxes that the user can enter, and the answer is displayed formatted in a text box.

Also notice the minus sign when using the `Pmt` function. When an amount is borrowed or payments made, that is considered a negative amount. You need the minus sign to reverse the sign and make a positive answer.

The Rate Function

You can use the `Rate` function to determine the interest rate per period when the number of periods, the payment per period, and the original amount of the loan are known.

The Rate Function—General Form

General Form

```
Rate(NumberOfPeriods, PaymentPerPeriod, LoanAmount)
```

The `Rate` function requires Double arguments and returns a Double value.

The Rate Function—Example

Example

```
Try
   MonthsDouble = Double.Parse(YearsTextBox.Text) * 12
   PaymentDouble = Double.Parse(PaymentTextBox.Text)
   AmountDouble = Double.Parse(LoanAmountTextBox.Text)
   PeriodicRateDouble = Rate(MonthsDouble, -PaymentDouble, AmountDouble)
   AnnualRateDouble = PeriodicRateDouble * 12
   YearlyRateTextBox.Text = AnnualRateDouble.ToString("P")
Catch
   MessageBox.Show("Invalid data.")
End Try
```

Notice that the `Rate` function, like the `Pmt` function, needs a minus sign for the payment amount to produce a positive result.

Functions to Calculate Depreciation

If you need to calculate the depreciation of an asset in a business, Visual Basic provides three functions: the double-declining-balance (DDB) method, the straight-line (SLN) method, and the sum-of-the-years' digits (SYD) method.

The `DDB` function calculates the depreciation for a specific period within the life of the asset, using the double-declining-balance method formula. Once again, you do not need to know the formula but only in what order to enter the arguments. Incidentally, the salvage value is the value of the item when it is worn out.

The DDB (Double-Declining-Balance) Function—General Form

General Form

```
DDB(OriginalCost, SalvageValue, LifeOfTheAsset, Period)
```

The `DDB` function returns a Double value and requires Double arguments.

The DDB Function—Example

Example

```
CostDouble = Double.Parse(CostTextBox.Text)
SalvageDouble = Double.Parse(SalvageTextBox.Text)
YearsDouble = Double.Parse(YearsTextBox.Text)
PeriodDouble = Double.Parse(PeriodTextBox.Text)
DepreciationTextBox.Text = DDB(CostDouble, SalvageDouble, YearsDouble, _
  PeriodDouble).ToString("C")
```

The other financial functions work in a similar manner. You can use Help to find the argument list, an explanation, and an example.

Mathematical Functions

In Visual Studio, the mathematical functions are included as methods in the System.Math class. To use the methods, you must either import System.Math or refer to each method with the Math namespace.

For example, to use the Abs (absolute value) method, you can use either of these techniques:

```
AnswerDouble = Math.Abs(ArgumentDouble)
```

or

```
' At the top of the file.
Imports System.Math

' In a procedure.
AnswerDouble = Abs(ArgumentDouble)
```

A few functions are not methods of the Math class but are Visual Basic functions. These functions, such as Fix and Int, cannot specify the Math namespace.

A good way to see the list of math functions is to type "Math." in the Editor; IntelliSense will pop up with the complete list. The following table presents a partial list of the Math methods:

Method	Returns	Argument Data Type	Return Data Type
Abs(*x*)	The absolute value of *x*. $\|x\| = x$ if $x \geq 0$ $\|x\| = -x$ if $x \leq 0$	Overloaded: All numeric types allowed.	Return matches argument type.
Atan(*x*)	The angle in radians whose tangent is *x*.	Double	Double
Cos(*x*)	The cosine of *x* where *x* is in radians.	Double	Double
Exp(*x*)	The value of *e* raised to the power of *x*.	Double	Double
Log(*x*)	The natural logarithm of *x*, where $x \geq 0$.	Double	Double
Max(*x1, x2*)	The larger of the two arguments.	Overloaded: All types allowed. Both arguments must be the same type.	Return matches argument type.
Min(*x1, x2*)	The smaller of the two arguments.	Overloaded: All types allowed. Both arguments must be the same type.	Return matches argument type.
Pow(*x1, x2*)	The value of *x1* raised to the power of *x2*.	Double	Double
Round(*x*) Round(*x, DecimalPlaces*)	The rounded value of *x*, rounded to the specified number of decimal positions. *Note*: .5 rounds to the nearest even number.	Overloaded: Double or Decimal; Integer DecimalPlaces	Return matches argument type.
Sign(*x*)	The sign of *x*. –1 if $x < 0$ 0 if $x = 0$ 1 if $x > 0$	Overloaded: All numeric types allowed	Return matches argument type.
Sin(*x*)	The sine of *x* where *x* is in radians.	Double	Double
Sqrt(*x*)	The square root of *x* where *x* must be ≥ 0.	Double	Double
Tan(*x*)	The tangent of *x* where *x* is in radians.	Double	Double

Here are some useful VB mathematical functions:

Function	Returns	Argument Data Type	Return Data Type
`Fix(x)`	The integer portion of *x* (truncated).	Any numeric expression.	Integer
`Int(x)`	The largest integer ≤ *x*.	Any numeric expression.	Integer
`Rnd()`	A random number in the range 0–1 (exclusive).		Single

Working with Strings

Visual Basic provides many methods for working with text strings. Although several of the methods are covered in this text, many more are available.

Strings in Visual Studio are **immutable**, which means that once a string is created, it cannot be changed. Although many programs in this text seem to modify a string, actually a new string is created and the old string is discarded.

For string handling, you can use any of the many methods of the String class. You also can use the StringBuilder class, which is more efficient if you are building or extensively modifying strings, since the string *can* be changed in memory. In other words, a StringBuilder is *mutable* (changeable) and a String is *immutable*.

Following is a partial list of the properties and methods in the String class. For shared methods, you don't need to specify a String instance; for nonshared methods, you must attach the method to the String instance. Examples of shared methods and nonshared methods follow:

Shared Method

```
If Compare(AString, BString) > 0 Then
       ' Code to execute if true.
```

Nonshared Method

```
If AString.EndsWith("ed") Then
       ' Code to execute if true.
```

Method	Returns
`Compare(AString, BString)` (Shared)	Integer: Negative if *AString* < *BString* Zero if *AString* = *BString* Positive if *AString* > *BString*

Method	Returns
`Compare(AString, BString, IgnoreCaseBoolean)` (Shared)	Case insensitive if *IgnoreCaseBoolean* is True. Integer: Negative if *AString* < *BString* Zero if *AString* = *BString* Positive if *AString* > *BString*
`Compare(AString, StartAString, BString, StartBString, LengthInteger)` (Shared)	Compare substrings; start position indicates beginning character to compare for a length of *LengthInteger*. Integer: Negative if *AString* < *BString* Zero if *AString* = *BString* Positive if *AString* > *BString*
`Compare(AString, StartAString, BString, StartBString, LengthInteger, IgnoreCaseBoolean)` (Shared)	Case insensitive if *IgnoreCaseBoolean* is True. Compare substrings; start position indicates beginning character to compare for a length of *LengthInteger*. Integer: Negative if *AString* < *BString* Zero if *AString* = *BString* Positive if *AString* > *BString*
`EndsWith(AnyString)`	Boolean. True if the String instance ends with AnyString. Case sensitive.
`Equals(AnyString)`	Boolean. True if the String instance has the same value as *AnyString*. Case sensitive.
`IndexOf(AnyString)`	Integer. Index position in String instance that *AnyString* is found. Positive: String found at this position. Negative: String not found.
`IndexOf(AnyString, StartPositionInteger)`	Integer. Index position in String instance that *AnyString* is found, starting at *StartPositionInteger*. Positive: String found at this position. Negative: String not found.
`IndexOf(AnyString, StartPositionInteger, NumberCharactersInteger)`	Integer. Index position in String instance that *anyString* is found, starting at *StartPositionInteger*, for a length of *NumberCharactersInteger*. Positive: String found at this position. Negative: String not found.
`Insert(StartIndexInteger, AnyString)`	New string with *AnyString* inserted in the String instance, beginning at *StartIndexInteger*.
`LastIndexOf(AnyString)`	Integer. Index position of *AnyString* within String instance, searching from the right end.
`LastIndexOf(AnyString, StartPositionInteger)`	Integer. Index position of *AnyString* within String instance, searching leftward, beginning at *StartPositionInteger*.
`LastIndexOf(AString, StartPositionInteger, NumberCharactersInteger)`	Integer. Index position of *AString* within String instance, searching leftward, beginning at *StartPositionInteger*, for a length of *NumberCharactersInteger*.
`PadLeft(TotalLengthInteger)`	New String with String instance right justified; padded on left with spaces for a total length of *TotalLengthInteger*.

Method	Returns
`PadLeft(TotalLengthInteger, PadCharacter)`	New String with String instance right justified; padded on left with the specified character for a total length of *TotalLengthInteger*.
`PadRight(TotalLengthInteger)`	New String with String instance left justified; padded on right with spaces for a total length of *TotalLengthInteger*.
`PadRight(TotalLengthInteger, PadCharacter)`	New String with String instance left justified; padded on right with the specified character for a total length of *TotalLengthInteger*.
`Remove(StartPositionInteger, NumberCharactersInteger)`	New String with characters removed from String instance, beginning with *StartPositionInteger* for a length of *NumberCharactersInteger*.
`Replace(OldValueString, NewValueString)`	New String with all occurrences of the old value replaced by the new value.
`StartsWith(AnyString)`	Boolean. True if the String instance starts with *AnyString*. Case sensitive.
`Substring(StartPositionInteger)`	New String that is a substring of String instance; beginning at *StartPositionInteger*, including all characters to the right.
`Substring(StartPositionInteger, NumberCharactersInteger)`	New String; a substring of String instance, beginning at *StartPositionInteger* for the specified length.
AnyString`.ToLower()`	New String; the String instance converted to lowercase.
AnyString`.ToUpper()`	New String; the String instance converted to uppercase.
AnyString`.Trim()`	New String; the String instance with all white-space characters removed from the left and right ends.
AnyString`.TrimEnd()`	New String; the String instance with all white-space characters removed from the right end.
AnyString`.TrimStart()`	New String; the String instance with all white-space characters removed from the left end.

Methods for Conversion between Data Types

Each of the following methods converts an expression to the named data type.

Function	Return Type
`Convert.ToBoolean(Expression)`	Boolean
`Convert.ToDateTime(Expression)`	Date
`Convert.ToDecimal(Expression)`	Decimal
`Convert.ToDouble(Expression)`	Double

Function	Return Type
`Convert.ToInt16(`*`Expression`*`)`	Short
`Convert.ToInt32(`*`Expression`*`)`	Integer
`Convert.ToInt64(`*`Expression`*`)`	Long
`Convert.ToSingle(`*`Expression`*`)`	Single
`Convert.ToString(`*`Expression`*`)`	String
`Convert.ToUInt16(`*`Expression`*`)`	Unsigned Short
`Convert.ToUInt32(`*`Expression`*`)`	Unsigned Integer
`Convert.ToUInt64(`*`Expression`*`)`	Unsigned Long

You also can use functions from the Visual Basic namespace for conversion. Note that the `Convert` methods shown above are used in all .NET languages; the following functions are for Visual Basic only.

Function	Return Type
`CBool(`*`Expression`*`)`	Boolean
`CDate(`*`Expression`*`)`	Date
`CDbl(`*`Expression`*`)`	Double
`CDec(`*`Expression`*`)`	Decimal
`CInt(`*`Expression`*`)`	Integer
`CLng(`*`Expression`*`)`	Long
`CObj(`*`Expression`*`)`	Object
`CShort(`*`Expression`*`)`	Short
`CSng(`*`Expression`*`)`	Single
`CStr(`*`Expression`*`)`	String
`CType(`*`Expression, NewType`*`)`	Specified type

Functions for Checking Validity

The Visual Basic namespace also contains functions that you can use to check for validity or type. These functions were used extensively in earlier versions of VB, but the preferred technique is to use the methods in the .NET Framework.

Function	Returns
`IsNumeric(`*`Expression`*`)`	Boolean: True if the expression evaluates as a valid numeric value.
`IsDate(`*`Expression`*`)`	Boolean: True if the expression evaluates as a valid date value.
`IsNothing(`*`ObjectExpression`*`)`	Boolean: True if the object expression currently does not have an instance assigned to it.

Functions for Formatting Output

In Chapter 3 you learned to format data using specifier codes with the `ToString` method. Visual Basic also has some formatting functions, which are included in the Visual Basic namespace. Using the `ToString` method, rather than the Visual Basic functions, is the preferred technique for compatibility among .NET languages.

Function	Effect
`FormatCurrency(`*`ExpressionToFormat`* `[, `*`NumberOfDecimalPositions`* `[, `*`LeadingDigit`* `[, `*`UseParenthesesForNegative`* `[, `*`GroupingForDigits`*`]]]])`	Format currency for output.
`FormatDateTime(`*`ExpressionToFormat`*`[, `*`NamedFormat`*`])`	Format dates and time for output.
`FormatNumber(`*`ExpressionToFormat`* `[, `*`NumberOfDecimalPositions`* `[, `*`LeadingDigit`* `[, `*`UseParenthesesForNegative`* `[, `*`GroupingForDigits`*`]]]])`	Format numbers with decimals, rounding as needed.
`FormatPercent(`*`ExpressionToFormat`* `[, `*`NumberOfDecimalPositions`* `[, `*`LeadingDigit`* `[, `*`UseParenthesesForNegative`* `[, `*`GroupingForDigits`*`]]]])`	Format percents for output.

APPENDIX

C

Tips and Shortcuts for Mastering the Environment

Set Up the Screen for Your Convenience

As you work in the Visual Studio integrated development environment (IDE), you will find many ways to save time. Here are some tips and shortcuts that you can use to become more proficient in using the IDE to design, code, and run your projects.

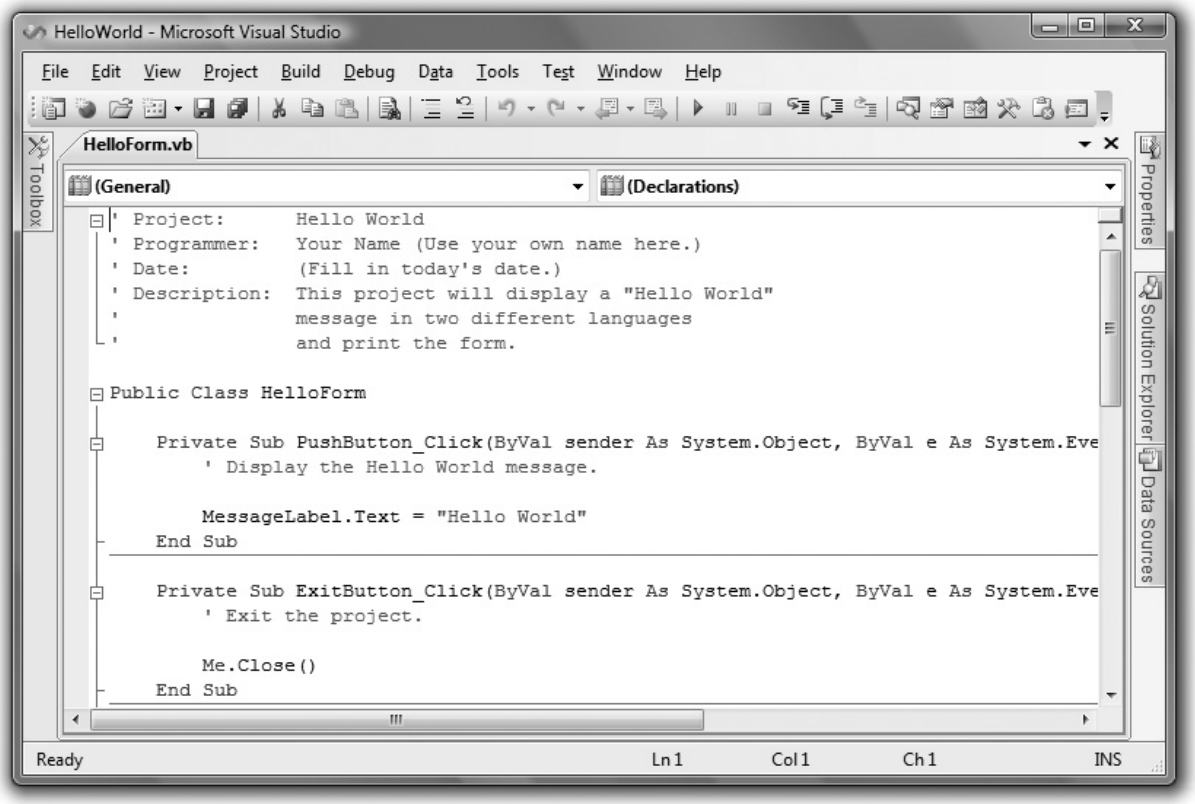
Close or Hide Extra Windows

Arrange your screen for best advantage. While you are entering and editing code in the Editor window, you don't need the toolbox, the Solution Explorer window, the Properties window, or any other extra windows. You can hide or close the extra windows and quickly and easily redisplay each window when you need it.

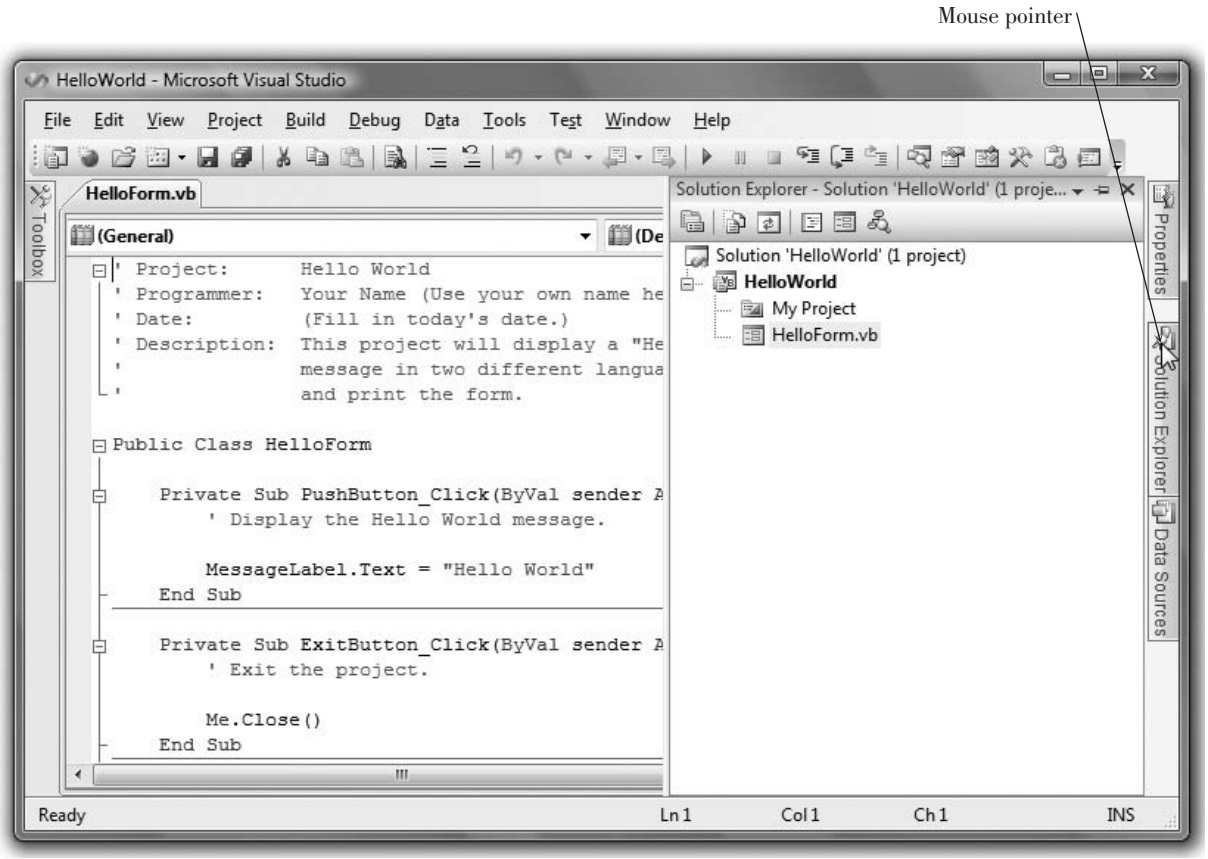
Hiding and Displaying Windows

You can use AutoHide on each of the windows in the IDE. Each window except the Document window in the center of the screen has a pushpin icon that you can use to AutoHide the window or "tack" it into place.

You can AutoHide each window separately, or select *Window / Auto Hide All*. In this screen, all extra windows are hidden.

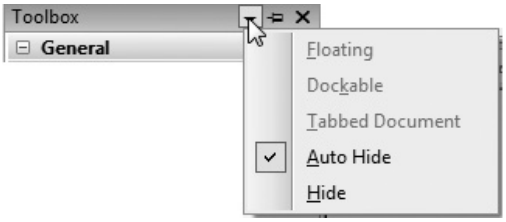


Point to the icon for one of the hidden windows to display it. In the next example, notice the mouse pointer on the *Solution Explorer* icon, which opens the Solution Explorer window temporarily. When you move the mouse pointer out of the window, it hides again.



To undo the AutoHide feature, display a window and click its pushpin icon.

Each of the IDE windows that has an AutoHide feature also has a drop-down menu from which you can choose to float, dock, AutoHide, hide, or make into a tabbed window. The tabbed window option is interesting: It makes the window tabbed in the center Document window.

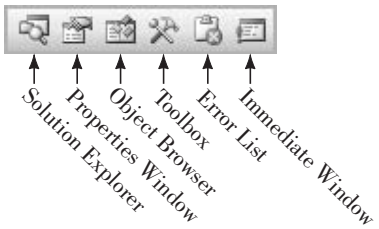


Closing Windows

You can close any window by clicking its Close button. You also can close any extra tabs in the Document window; click on the Close button to the right of the tabs to close the active document.

Displaying Windows

You can quickly and easily open each window when you need it. Each window is listed on the *View* menu, or use the buttons on the Standard toolbar.



Display Windows Using Keyboard Shortcuts

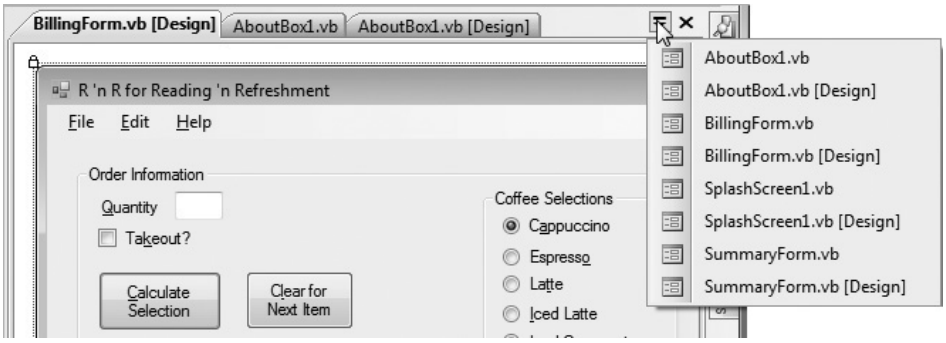
Solution Explorer window	Ctrl + Alt + L
Properties window	F4
Toolbox	Ctrl + Alt + X

Switch between Documents

When you have several tabs open in the Document window, you can switch by clicking on their tabs or use keyboard shortcuts.

To switch from a form's Editor window to a form's Design View and back again	F7
Cycle through open document tabs	Ctrl + F6
Cycle through all open windows	Ctrl + Tab

Visual Studio displays only as many tabs as fit in the current size of the Document window. If you have more documents open than displayed tabs, you can use the new drop-down list of open documents.



Use the Full Screen

When you are designing a form or editing code, you can work in full-screen mode. This gives you maximum screen space by getting rid of all extra windows. Unfortunately, it also hides all toolbars (the Text Editor toolbar can be a great timesaver while editing code). Select *View / Full Screen* to display in full-screen mode. A small *Full Screen* button appears, which you can use to switch back to regular display. You also can press Shift + Alt + Enter or select *View / Full Screen* a second time to toggle back. If you want to display the Text Editor toolbar while in full-screen mode, select *View / Toolbars / Text Editor*.

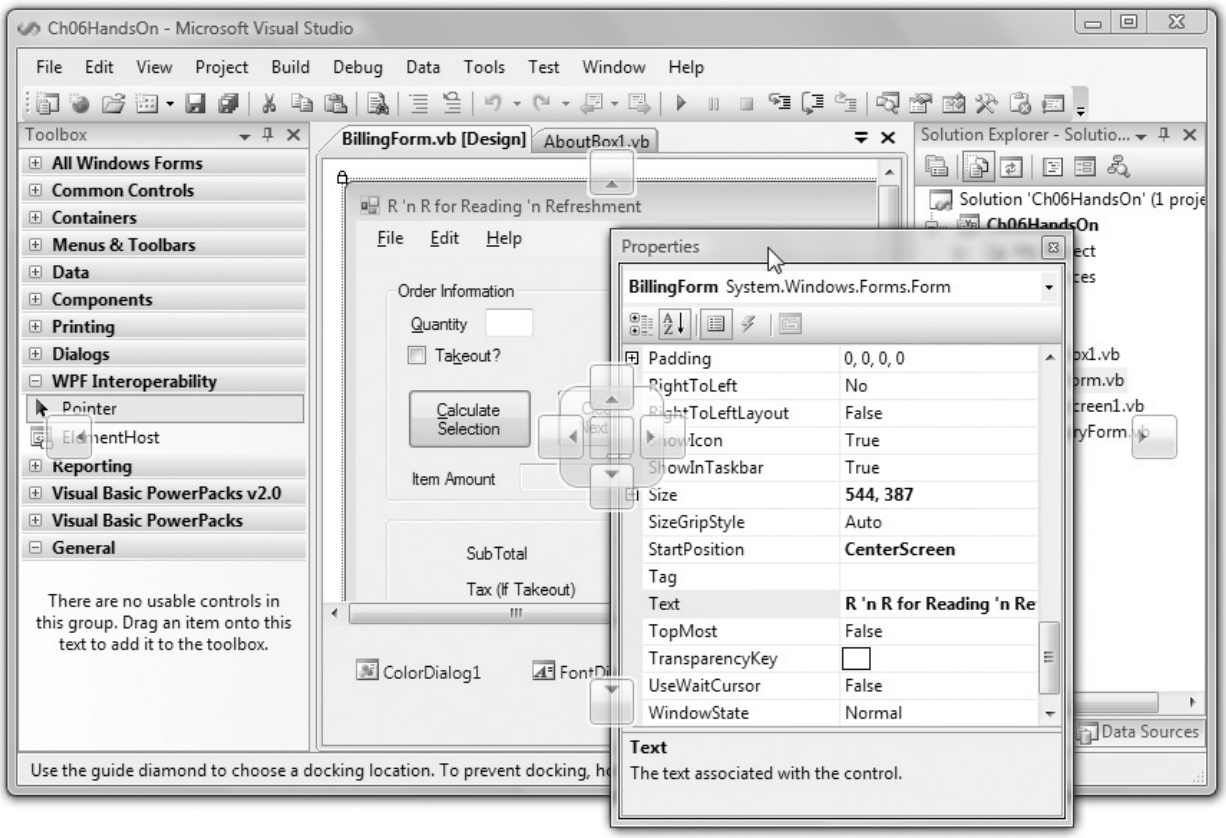
Modify the Screen Layout

For most operations, the Visual Studio Tabbed Document window layout works very well and is an improvement over the older VB 6 environment. However, if you prefer, you can switch to MDI (multiple document interface), which is similar to the style used in VB 6. Set this option in the *Tools / Options / Environment / General / Window layout*.

Each of the windows in the IDE is considered either a Tool window or a Document window. The Document windows generally display in the center of the screen with tabs. The rest of the windows—Solution Explorer, Properties window, Task List, Output, Server Explorer, and others—are Tool windows and share many characteristics. You can float each of the Tool windows, tab-dock them in groups, and move and resize individual windows or groups of windows.

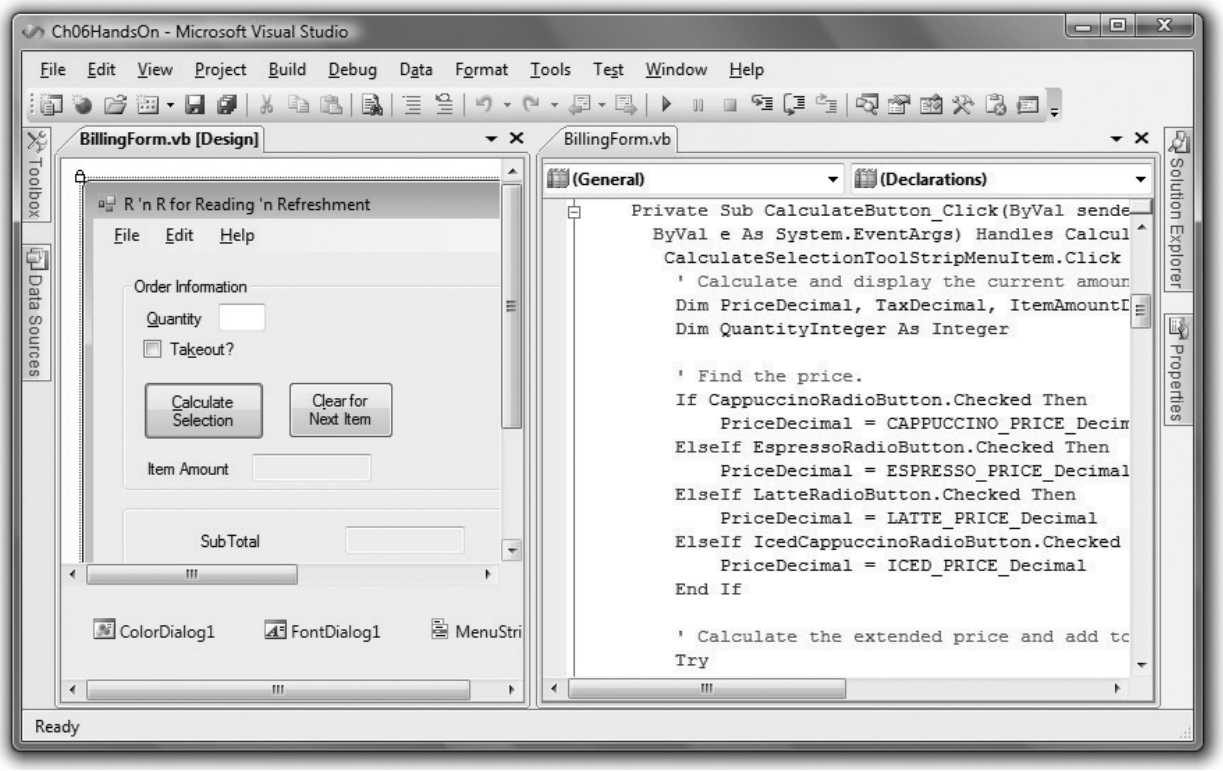
Dock Windows Using the Guide Diamonds

Guide diamonds are an improvement added to VS 2005. When you start dragging a dockable tool window, the diamonds appear to give you visual cues to help dock to the desired location. As you drag over the arrow, the corresponding area darkens. To tab-dock a window, you need to make the center of the diamond darken. Experiment!



Split the Screen Vertically

You can view the Editor window and the form design at the same time. With at least two tabs open, select *Window / New Vertical Tab Group*. You may want to close the extra windows to allow more room for the two large windows.



Reset the IDE Layout

To reset the IDE windows to their default locations, select *Window / Reset Window Layout*.

Set Options for Your Work

You can change many options in the VS IDE. Choose *Tools / Options* to display the *Options* dialog box. To see all the options that may be changed, make sure *Show all settings* is checked. You may want to click on each of the categories to see the options that you can select.

Note: If you are working in a shared lab, check with the instructor or lab technician before changing options.

Projects and Solutions. Set the default folder for your projects. It's best to leave the *Build* and *Run* options to automatically save changes but you may prefer to have a prompt or save them yourself.

Text Editor. You can set options for all languages or for Basic, which is Visual Basic. The following presume that you first select and expand the entry for *Basic*.

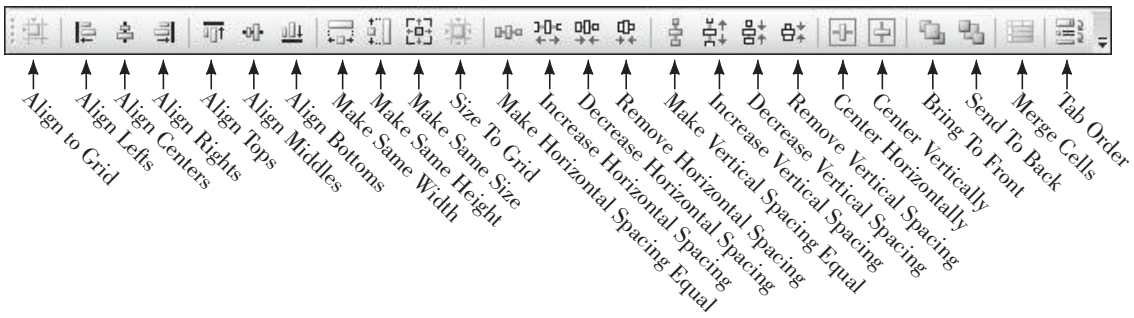
- *General*. Make sure that *Auto list members* is selected and *Hide advanced members* is deselected. You may want to turn on *Word wrap* so that long lines wrap to the next line instead of extending beyond the right edge of the screen.
- *Tabs*. Choose *Smart* indenting; *Tab size* and *Indent size* should both be set to 4.
- *VB Specific*. All options should be selected.

Use Shortcuts in the Form Designer

You can save time while creating the user interface in the Form Designer by using shortcuts.

Use the Layout Toolbar

The Layout toolbar is great for working with multiple controls. You must have more than one control selected to enable many of the buttons. The same options are available from the *Format* menu.

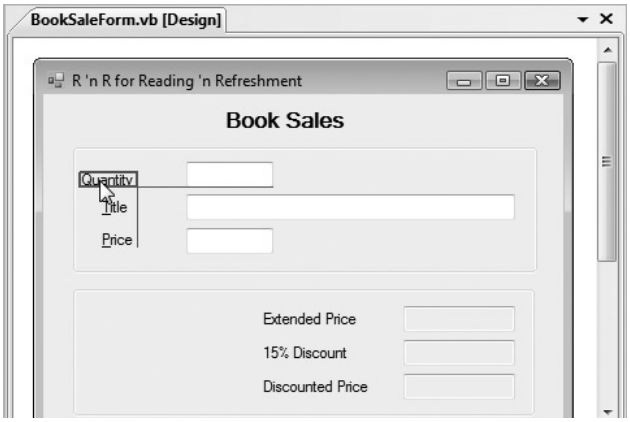


Nudge Controls into Place

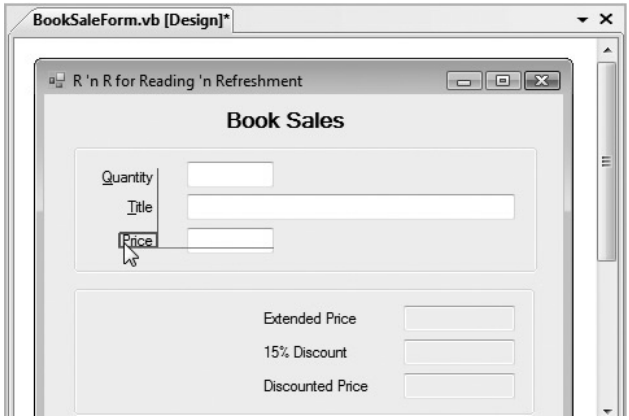
Sometimes it is difficult to place controls exactly where you want them. Of course, you can use the alignment options of the *Format* menu or the Layout toolbar. You also can nudge controls in any direction by selecting them and pressing one of the arrow keys. Nudging moves a control one pixel in the direction you specify. For example, the right arrow key moves a selected control one pixel to the right. You can also use Ctrl + an arrow key to align a control to the snap line of a nearby control.

Use Snap Lines to Help Align Controls

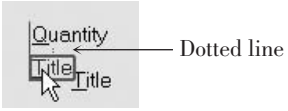
As you create or move controls on a form, snap lines pop up to help you align the controls, which can be a great help in creating professional-looking forms. Blue snap lines appear to align tops, bottoms, lefts, or rights of controls.



When you see a red line toward the lower edge of controls, that means that the baselines of the text within the controls are aligned.



The snap lines also can help you to standardize the vertical spacing between controls. As you drag a control up or down near another control, a small dotted line appears to indicate that the controls are the recommended distance apart.

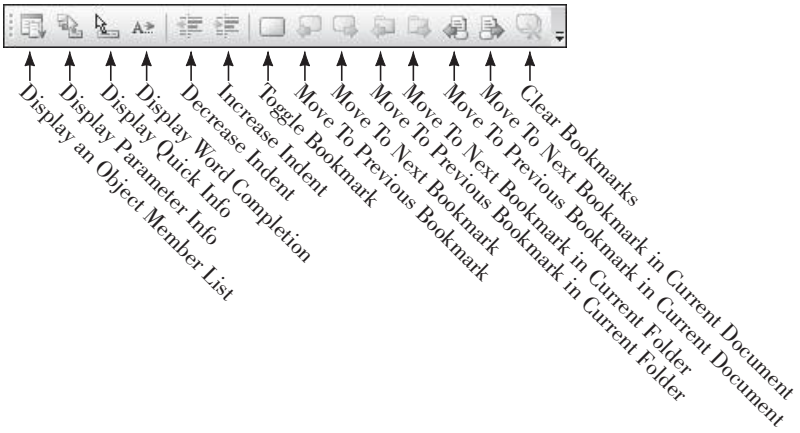


Use Shortcuts in the Editor

Several features of the Editor can save you time while editing code. These are summarized in the following sections.

Use the Text Editor Toolbar

By default the Text Editor toolbar displays when the Editor window is open.



You can save yourself considerable time and trouble if you become familiar with and use some of these shortcuts.

- *Comment Selected Lines*. Use this command when you want to convert some code to comments, especially while you are testing and debugging projects. You can remove some lines from execution to test the effect without actually removing them. Select the lines and click the *Comment Selected Lines* button (or type Ctrl + K, Ctrl + C); each line will have an apostrophe appended at the left end.
- *Uncomment Selected Lines*. This command undoes the *Comment Selected Lines* command. Select some comment lines and click the button (or press Ctrl + K, Ctrl + U); the apostrophes at the beginning of the lines are deleted.
- *Toggle Bookmark*. This button sets and unsets individual bookmarks. Bookmarks are useful when you are jumping around in the Editor window. Set a bookmark on any line by clicking in the line and clicking the *Toggle Bookmark* button (or type Ctrl + K, T); you will see a mark in the gray margin area to the left of the marked line. You may want to set bookmarks in several procedures where you are editing and testing code.
- *Move To Next Bookmark* (Ctrl + K, N) and *Move To Previous Bookmark* (Ctrl + K, P). Use these buttons to quickly jump to the next or previous bookmark in the code.
- *Clear All Bookmarks*. You can clear individual bookmarks with the *Toggle Bookmark* button or clear all bookmarks (Ctrl + K, Ctrl + L) using this button.

Use Keyboard Shortcuts When Editing Code

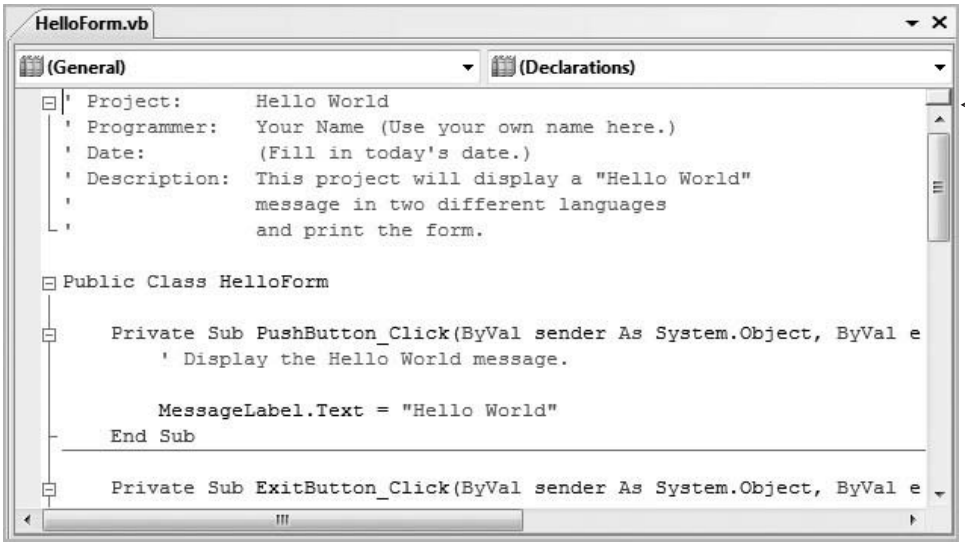
While you are editing code, save yourself time by using keyboard shortcuts. Note that these shortcuts are based on the default Visual Basic keyboard mapping. See *Tools / Options* and select *Show all settings*. Then select *Environment / Keyboard / Keyboard mapping scheme*. Drop down the list and select *Visual Basic 6*, if it isn't already selected.

Task	Shortcut
Delete from the insertion point left to the beginning of the word.	Ctrl + Backspace
Delete from the insertion point right to the end of the word.	Ctrl + Delete
Complete the word.	Ctrl + Spacebar *or* Alt + right arrow
Create an empty line above the current line. Insertion point can be anywhere in the line.	Ctrl + Enter
Create an empty line below the current line. Insertion point can be anywhere in the line.	Ctrl + Shift + Enter
Swap the two characters on either side of the insertion point (transpose character). Note that this shortcut does not work in VB Express.	Ctrl + T
Swap the current word with the word on its right (transpose word). Insertion point can be anywhere in the word.	Ctrl + Shift + T
Swap the current line with the next line (transpose line). Insertion point can be anywhere in the line.	Ctrl + Alt + T
Cut the current line to the clipboard with the insertion point anywhere in the line.	Ctrl + Y *(VS Prof. default keyboard)* Ctrl + L *(VB Express default keyboard)*
Jump to a procedure (insertion point on procedure name). Use this shortcut while working on the sub procedures and functions that you write. For example, when writing a call to a function, you might want to check the coding in the function. Point to the procedure name in the `Call` and press F12. If you want to return to the original position, set a bookmark before the jump.	F12
Jump to the top of the current code file.	Ctrl + Home
Jump to the bottom of the current file.	Ctrl + End
View the form's Designer window / Return to the Editor window.	F7

You will find that most of the editing and selecting keyboard shortcuts for Microsoft Word also work in the Editor window.

Split the Editor Window

You can view more than one section of code at a time by splitting the Editor window. Point to the Split bar at the top of the vertical scroll bar and drag the bar down to the desired location. To remove the split, you can either drag the split bar back to the top or double-click the split bar.



Use Drag-and-Drop Editing

You can use drag-and-drop to move or copy text to another location in the Editor window or to another project. To move code, select the text, point to the selection, and drag it to a new location. You can copy text (rather than move it) by holding down the Ctrl key as you drag.

Drag Commonly Used Code to the Toolbox

When you have some lines of code that you use frequently, you can select the text and drag it to the toolbox. Then when you need to insert the code, drag it from the toolbox to the Editor window. The text appears in the toolbox when the Editor window is open but not when a form is in design mode.

Caution: This shortcut should not be used on shared computers in a classroom or lab, as the text remains in the toolbox. Use it only on your own computer. You can delete previously stored text from the toolbox by right-clicking and selecting *Delete* from the context menu.

Rename Variables and Objects

Use the rename feature to automatically rename variables and objects. In the Editor window, right-click on a variable name or an object name and select *Rename*. In the *Rename* dialog box, you can enter the new name and the item is renamed everywhere in that form. For a multiform project, the *Rename* dialog box offers the choice of renaming in only the current form or all forms. This feature, called *Symbol Rename*, is part of a more robust feature called **refactoring**, which is available in some of the .NET languages. Refactoring allows the programmer to modify the name and class of variables and objects.

Use Context-Sensitive Help

The quickest way to get Help is to use context-sensitive Help. Click on a control or a line of code and press F1; Help displays the closest matching item it can locate. You also can get help on the IDE elements: Click in any area of the IDE and press Shift + F1; the Help explanation will be about using the current window or IDE element, rather than about the objects and language.

Copy and Move Projects

In a programming class, you often must move projects from one computer to another and must base one project on another one. To create a new project based on a previous one, you should copy the project folder. Then you can move and rename it as necessary.

Copy and Move a Project

You can copy an entire project folder from one location to another using the Windows Explorer. Make sure that the project is not open in Visual Studio and copy the entire folder.

To base one project on a previous project, take the following steps:

- Make sure the project is not open. *Note*: This is *extremely* important.
- Copy the folder to a new location using the Windows Explorer.
- Rename the new folder for the new project name, still using the Explorer.
- Open the new project (the copy) in the Visual Studio IDE.
- In the IDE's Solution Explorer, rename the solution and the project. The best way to do this is to right-click on the name and choose the *Rename* command from the shortcut menu. To rename the solution, you must display solution names: *Tools / Options / Projects and Solutions / General / Always show solutions.*
- Rename the forms, if desired. If you rename the startup form, you must open the Project Designer (*Project / ProjectName Properties* or double-click on *My Project* in the Solution Explorer) and set the Startup Object.
- Open the Project Designer and change the assembly name to match your new project name.

Warning: Do not try to copy a project that is open using the *Save As* command, attempting to place a copy in a new location.

Deploy Applications

When you are ready to distribute your programs to other computers, you use a process called **deployment**. You can choose to use either Windows Installer or **click-once deployment**.

To use Windows Installer, open the *Build* menu and select *Publish SolutionName*. Selecting the Publish option launches the Publish Wizard, which gives you the option of specifying a file path, a Web site, or an FTP server. Media options for distribution are CD-ROM or DVD, file share (network), or the Web. You also can have the program check for updates online.

If you deploy to a folder on your system, you will find a Setup.exe application inside of the folder. Try copying the folder to a CD and then install your program on another machine.

For a discussion of the various strategies for deployment, see "Deploying Applications and Components" in Help.

APPENDIX

D

Security

As a programmer, you must be aware of many aspects of security. You must not allow any unauthorized access to programs or data, but you must be able to access all needed resources while you are developing applications. For both sides of the security issue you need a basic understanding of security topics.

The .NET Framework includes many features for implementing security. And as time passes and hackers and virus writers discover ways to circumvent the security, Microsoft is forced to tighten security. Because of this fact, you may sometimes find that programs or procedures that worked previously no longer work after you apply updates to Windows, which include updates to the .NET Framework and CLR.

For programmers security means **information assurance**. The .NET Framework provides many object-oriented features to assist in the process. The topic of security can fill multiple books and courses; this appendix is intended as an introductory overview for programmers.

Authentication and Authorization

The two topics of authentication and authorization are frequently lumped together because they are so closely related. **Authentication** determines who the user is and **authorization** decides if the user has the proper authority to access information.

Authentication is based on credentials. When you are working with a Windows application, you only need to be concerned with Windows authentication. However, if your application is Web Forms–based (ASP.NET), authentication might be IIS Authentication, Forms-based (not recommended; it is an HTML request for credentials), or it might use Microsoft Passport, which is a centralized profile service for member sites. It is also possible to create a custom authentication method or use none at all. The settings in the Web.Config file determine the method of authentication.

The following is an excerpt from the automatically generated Web.Config file for an ASP.NET application:

```
<!—
  The <authentication> section enables configuration of the security authentication
  mode used by ASP.NET to identify an incoming user.
  —>
  <authentication mode="Windows" />
```

For no authentication, you can change the last line in the Web.Config file above to

```
<authentication mode = "None" />
```

Authorization and Impersonation

After the user is authenticated, another step checks for authorization. If ASP.NET does not use impersonation, the ASP.NET user, which is created when the Framework is installed, runs without any privileges. If impersonation is turned on, ASP.NET takes on the identity from IIS. If anonymous access is

turned off, ASP.NET takes on the credentials of the authenticated user; otherwise it impersonates the account that IIS uses.

This is where the following code applies:

```
<identity impersonate = "true"/>
```

For a specific user you can use

```
<identity impersonate = "true" name = "Domain/username" password = "password"/>
```

Writing Secure Code

Programmers need to be aware of how hackers are able to gain access to a database or a network through code. Two primary areas of importance are string injections and error messages that may give away important information about a data source.

SQL Injection

Proper validation of the code is extremely important. A system vulnerability occurs when code is "injected" into a string. A text box or a combo box control allows the user to type in information. It is the responsibility of the programmer to make sure that the input does not contain any scripting code or disruptive characters. When a program is working with a database, there must be no way for the user to inject code into that database.

It is wise to validate the keystrokes to be sure that the input text contains only valid characters.

Error Messages

Another technique that hackers use to find information about a database is to input wrong data hoping that the error message will give significant information. The default error messages indicate the name of the field containing an error. Plan your error messages so that you don't allow someone to determine valid field names or values. You also can create custom error pages and denote the link in the Web.config file. This technique is covered in the authors' Advanced VB Programming text.

Code Access Security

Basically, code access security determines what code is allowed to do on a computer, specifically what resources, such as hardware or files, the code can access. The settings of the computer ultimately determine if the code can execute or if a resource can be used by the code.

Code access security is based on several Permission classes. The Permission classes are organized into three types: code access, identity, and role-based. Examples of the code access type include the PrintingPermission class and the RegistryPermission class; the SiteIdentityPermission and the UrlIdentityPermission classes fall into the identity permission type. The PrincipalPermission class is the role-based type for user credentials.

If your program has an OpenFileDialog component, it may be necessary to request permission to access the files from a given system. The following code would appear at the top of the file:

```
Imports System.Security.Permissions
<Assembly: FileDialogPermissionAttribute(SecurityAction.RequestMinimum, Unrestricted: = True)>
```

Glossary

A

About box A window that displays information about the program; usually displayed from the *Help / About* menu item.

absolute positioning Placing an element on a Web page by X and Y coordinates.

abstract class A class that cannot be instantiated but instead is used for inheritance.

abstract method An empty method declared with the `MustOverride` keyword; must be overriden in the derived class.

AcceptButton property Form property that sets the default button, which is activated with the Enter key.

access key Underlined character that allows the user to select using the keyboard rather than the mouse; also called a *hot key*.

access level Specification of the permission required to access an element. Examples: `Private`, `Public`, `Friend`, and `Protected`.

accessor method The `Get` and `Set` methods written to allow external objects to access the private properties of a class.

AJAX Asynchronous JavaScript and XML; method of speeding Web page display by updating only the part of the page that has changes.

AllowDrop property A property of a form or control used for a drag-and-drop operation.

ANSI code A coding method used to represent characters on a microcomputer (American National Standards Institute).

argument The expression to operate upon in a function or method. A value being passed to or from a procedure.

array A series of variables; each individual element can be referenced by its index position. Also called a *list*.

assignment operator An equal sign (=); assigns a value to the variable or property named on the left side of the sign.

assignment statement Assigns a value to a variable or property using an assignment operator.

attribute Supplies additional information about an XML element; must appear within single or double quotes.

authentication The policies used to determine who the user is; may be Windows-based, forms-based, Passport-based, or none (no authentication performed).

authorization Determination of the rights allowed for a particular user. For ASP.NET applications, can allow access from any user by turning on impersonation.

AutoCorrect Popup suggestions for corrections of misspelled words in the Editor.

Autos window Window that opens in IDE during execution; automatically displays all variables and control contents that are referenced in the current statement and three statements on either side of the current one.

B

base class Class that is inherited from; also called a *super class* or *parent class*.

binding source Object that establishes a link to a data source.

block-level variable A variable declared inside a block of code; only accessible within that block.

Boolean expression An expression that evaluates to True or False. May be referred to as a *condition*.

BorderStyle property Property of a control that allows the control to appear flat or three-dimensional.

bound control A control that automatically displays the contents of database fields.

breakpoint Indicated point in project code where execution should break; used for debugging.

browser An application used to render and display HTML code; used to display Web pages; in VB used to execute Web Forms.

Brush object Graphical object for drawing filled shapes.

Button Control used to activate a procedure.

`ByRef` Declares that an argument passed to a procedure should be passed as the address of the data so that both calling and called procedures have access to the same memory location.

`ByVal` Declares that an argument passed to a procedure should be passed as a copy of the data. The calling and called procedures do not have access to each other's variables.

C

`Call` (procedure call) Execute a procedure.

callback An object notifies the program that it needs to do something or that a situation exists that the program needs to handle. The object notifies the program of the situation by firing an event.

CancelButton property Form property that sets the Cancel button, which is activated with the Esc key.

cascading style sheet (CSS) A set of styles for formatting elements of Web pages.

`Case` structure Selection structure; can be used in place of an `If` statement.

casting Converting from one data type to another.

CausesValidation property Property of a control that forces validation to occur on the control that just lost focus when this control receives the focus.

CharacterCasing property Property of text boxes that specifies whether input should be left as entered or converted to uppercase or lowercase.

check box A control used to indicate a value that may be True or False. In any group of check boxes, any number may be selected.

checked A check mark next to a menu item indicates that the option is currently selected.

Checked property Determines if a check box is checked or not.

child class A class inherited from another class, called the *parent*. Also called a *derived class* or *subclass*.

child form Multiple Document Interface. A child form belongs to a parent form, is displayed inside the parent, and closes when the parent does.

class A prototype or blueprint for an object; includes specifications for the properties and methods.

class-level variable A variable that is available to all procedures in the class and exists as long as the class is loaded.

clean compile Code compiles to Common Language Runtime without errors.

click-once deployment New simplified method of deploying VB applications to another computer. Provides for installation and automatic updates via the Web.

`Close` method Closes forms or files; releases resources used by the object.

code Programming statements in the Basic language.

code separation model A style of Web Form in which the VB code is in a separate file from the HTML code.

code snippet Small sample of code that illustrates coding techniques; can be added to a program in the editor.

collection A series of objects or an object that can contain a series of objects; has properties and methods.

color constant Values assigned in the Color class. Examples: Color.Red and Color.Blue.

column A vertical section of a grid control.

ComboBox control A control that is a combination of a list box and a text box.

common dialog A set of Windows dialog boxes available to Visual Basic programmers for Open, Save, Fonts, Print, and Color.

comparison operator See *relational operator*.

component tray Area across the lower edge of a form designer window; used to store components that are not visible on the form.

compound Boolean expression Multiple conditions combined with the use of the logical operators `And` or `Or`.

concatenation Joining string (text) fields. The ampersand (&) is used to concatenate text.

condition An expression that will evaluate True or False. May be a comparison of two values (variables, properties, constants) using relational operators.

constant A value that cannot change during program execution.

constructor A procedure that runs automatically when an object is instantiated from that class. In VB, a constructor is coded with `Sub New`.

container An object that can hold other objects.

context menu A popup menu, sometimes referred to as a *shortcut menu* or a *right-mouse menu*.

context-sensitive Help Use of the F1 function key to directly access the Help topic related to the code or object containing the cursor.

ContextMenuStrip component A container control used to create context menus.

control An object used on a graphical interface, such as a radio button, text box, button, or label.

`CType` function Converts from one object type to another; used with a shared event procedure to access the Sender object.

D

data binding Connecting a control or property to one or more data elements.

data-bound controls Controls that can be set up to display the data from a database.

Data Designer A window of the VS IDE that shows a visual representation of the schema of a database; allows modification of the schema.

data file A file used to store small amounts of information such as the contents of a list box.

data source The original source of database data; may be a file, a server, or an array or other object.

data type Specifies the type of data a variable or constant can hold, such as Integer, Decimal, or String.

DataGridView control A control used to display database data in a grid format.

dataset A temporary set of data stored in the memory of the computer.

DateTime structure Used to retrieve and format the current date and time.

debug time Temporary break in program execution; used for debugging.

`Debug.WriteLine` method Statement to write a line in the Debug window; used to write a message for debugging.

debugging Finding and eliminating computer program errors.

declaration Statements to establish a project's variables and constants, give them names, and specify the type of data they will hold.

Declarations section Code outside of a procedure, used to declare module-level variables.

delimited file A file in which the data elements are separated by a predefined character or characters, such as a comma, tab, or carriage return.

deployment Distribution of a compiled application to another computer; normally done through a setup.exe file. See *click-once deployment*.

derived class A subclass inherited from a base class; also called a child class.

design time The status of the Visual Studio environment while a project is being developed, as opposed to run time or break time.

destructor A method that is called as an object goes out of scope.

DialogResult object Used to check to determine which button the user clicked on a message box.

direct reference Accessing an element of an array by a subscript when the value of the subscript is known.

disabled Enabled property set to False; user can see the control but cannot access it.

`Do` and `Loop` statements Statements to indicate the beginning and ending of a loop. A condition can appear on the `Do` or on the `Loop`.

`Do/Loop` A loop constructed with the `Do` and `Loop` statements.

Document window IDE window that displays the Form Designer, the Code Editor, and the Object Browser.

`DoDragDrop` method A method to begin a drag-drop operation for a source object.

DragDrop event The event that occurs when the user drags an object and drops it on a form or control that has its AllowDrop property set to True.

DragEnter event The event that occurs when the user drags an object over a form or control that has its AllowDrop property set to True; occurs before the DragDrop event.

`DrawLine` method Method of the Graphics object.

`DrawRectangle` method Method of the Graphics object; used to draw squares and rectangles.

`DrawString` method Method of the Graphics object; sends a line of text to the graphics page.

drop-down combo box A combo box control with a down-pointing arrow that allows the user to drop down the list. Allows efficient use of space on a form.

drop-down list A list box with a down-pointing arrow that allows the user to drop down the list. Allows efficient use of space on a form.

E

element Single item within a table, array, list, or grid.

element (XML) An item in an XML file surrounded by tags.

empty string A string that contains no characters; also called a *null string* or *zero-length string*.

Enabled property Boolean property of a control that determines whether it is available or disabled (grayed).

encapsulation OOP feature that specifies that all methods and properties of a class be coded within the class. The class can hide or expose the methods and properties, as needed.

`End If` Terminates a block `If` statement.

entry test A loop that has its test condition at the top. See *pretest*.

ErrorProvider component A component that can display an error icon and message when a validation rule is violated for the specified text box.

event An action that may be caused by the user, such as a click, drag, key press, or scroll. Events also can be triggered by an internal action, such as repainting the form or validating user input.

event procedure A procedure written to execute when an event occurs.

exception An error that occurs at run time.

exit test A loop that has its test condition at the bottom. See *posttest*.

explicit conversion Writing the code to convert from one data type to another; as opposed to *implicit conversion*.

Express Edition A "light" version of Visual Basic. Available for download at msdn.microsoft.com/express.

Extensible Application Markup Language (XAML) Extension of HTML used to create the visual elements of a Windows Presentation Foundation (WPF) window.

F

field A group of related characters used to represent one characteristic or attribute of an entity in a data file or database.

field-level validation Checking the validity of input data in each control as it is entered, rather than waiting until the user clicks a button.

file A collection of related records.

`FillEllipse` method Method of the Graphics object; used to draw circles and ovals.

focus The currently selected control on the user interface. For controls such as buttons, the focus appears as a light dotted line. For text boxes, the insertion point (also called the *cursor*) appears inside the box.

`Focus` method Sets the focus to a control, which makes it the active control.

`For` and `Next` statements A loop structure; usually used when the number of iterations is known.

`For Each` and `Next` A looping construct for stepping through an array; each element of the array is accessed without the necessity of manipulating subscripts.

`For/Next` loop A loop structure; usually used when the number of iterations is known.

ForeColor property Property that determines the color of the text.

form An object that acts as a container for the controls in a graphical interface.

Form Designer The IDE window for creating the user interface.

format A specification for the way information will be displayed, including dollar signs, percent signs, and the number of decimal positions.

format specifiers Codes used as arguments for the `ToString` method; used to make the output easier to read. Can specify dollar signs, commas, decimal positions, percents, and date formats.

FormClosing event Occurs before a form unloads. A good location to place the code to prompt the users if they wish to save any changes.

`Friend` The access level specifier that limits access to the forms in the current project.

`FromFile` method Retrieves an image from a file.

function Performs an action and returns a value.

function procedure A procedure that returns a value.

G

garbage collection Automatic deletion of objects from memory after they are out of scope.

general procedure A procedure not attached to an event; may be a sub procedure or a function procedure.

graphical user interface (GUI) Program application containing icons, buttons, and menu bars.

graphics Lines, shapes, and images. An image file assigned to a PictureBox control; methods of the Graphics class, such as `DrawString`, `DrawLine`, and `DrawEllipse`.

GroupBox control A control used as a container for other controls, such as a group of radio buttons.

H

handle A small square on a selected control at design time; used to resize a control. Also called a *resizing handle*.

Help The collection of reference pages about programming in VB and using the Visual Studio IDE.

`Hide` method Method of a form or a control that makes it invisible but does not unload it from memory.

horizontal scroll bar A Windows control that provides a scroll bar that appears horizontally on the form.

I

IDE Integrated development environment. See *Visual Studio environment*.

identifier A name for a variable, procedure, class, or named constant; supplied by the programmer.

`If/Then/Else` Statement block for testing a condition and taking alternate actions based on the outcome of the test.

Image property A graphic file with an extension of .bmp, .gif, .jpg, .png, .ico, .emf, or .wmf.

immutable The inability of a string to be modified once it is created. A new string must be created for any modifications.

implicit conversion A conversion from one data type to another that occurs automatically or by default according to specified rules.

index Position within a list or array.

information assurance Secure programming measure to provide accurate and timely transfer of information.

inheritance Ability to create a new class based on an existing class.

instance An object created from a class.

instance property See *instance variable*.

instance variable Each object created from the class has a separate occurrence of the variable.

instantiate Create an object using the `New` keyword.

integrated development environment (IDE) Tool for writing projects and solutions; includes an editor, tools, debugger, and other features for faster development.

Interval property Determines the amount of time until a Timer component fires a Tick event; measured in milliseconds.

intranet Network within a company.

intrinsic constant Constant supplied with a language or application such as Color.Blue.

IsMdiContainer property Used to create a parent form for MDI.

Items property Collection of elements for a list box or combo box control.

`Items.Add` method Adds elements to the Items collection of a list box.

`Items.Clear` method Clears all elements from a list box.

Items.Count property Property that holds the number of elements in a list box.

`Items.Insert` method Inserts an element in a list for a list box.

`Items.Remove` method Removes the currently selected item from a list.

`Items.RemoveAt` method Removes the specified item from a list.

iteration A single pass through the statements in a loop.

K

key field The field (or fields) on which a data file is organized; used to search for a record.

L

Label A control that displays text; cannot be altered by the user.

Language Integrated Query (LINQ) New .NET feature that allows SQL-like queries to be written in VB code.

LargeChange property A property of a scroll bar that determines how far to scroll for a click in the gray area of the scroll bar.

late binding Program elements cannot be determined at compile time, but must be determined at run time. Should be avoided, if possible, for performance reasons.

`LayoutMdi` method Arranges MDI child windows vertically, horizontally, or cascaded.

lifetime The period of time that a variable exists.

line-continuation character A space and underscore; used in program code to indicate that a Basic statement continues on the next line.

ListBox control A control that holds a list of values; the user cannot add new values at run time.

local The scope of a variable or constant that limits its visibility to the current procedure.

local variable A variable that is declared within a procedure and may be used only in that procedure.

Locals window Window that opens in IDE during execution; displays all objects and variables that are within scope at break time.

logic error An error in a project that does not halt execution but causes erroneous results in the output.

logical operator The operators `And`, `Or`, `Not`, `AndAlso`, and `OrElse`; used to construct compound conditions and to reverse the truth of a condition.

loop A control structure that provides for the repetition of statements.

loop index A counter variable used in a `For/Next` loop.

M

MaskedTextBox A specialized form of text box that includes a Mask property, which can indicate to the user the format of data expected and require the correct data type and format of input.

Maximum property Scroll bar property for highest possible value.

MaxLength property Property of text boxes that limits the number of characters the user can enter as input.

MdiWindowListItem property Determines whether the menu will display a list of open MDI child windows; used on the *Window* menu.

menu A list of choices; the available commands displayed in a menu bar.

Menu Designer Feature of the development environment for creating menus; accessed by adding a Main Menu component to the component tray.

MenuStrip component A control used to create menus for forms.

MessageBox A dialog box that displays a message to the user.

method Predefined actions (procedures) provided with objects.

Minimum property Scroll bar property for lowest possible value.

modal A dialog box that requires a user response before continuing program execution.

modeless A dialog box that does not require a user response before continuing program execution.

module-level variable A variable that can be used in any procedure within the current code module.

MouseDown event The event of a form or control that occurs when the user presses the mouse button.

Multiline property Boolean property of many controls, including labels and text boxes, that allows text to appear on multiple lines. WordWrap must also be set to True.

multiple document interface (MDI) Multiple form project that has parent and child forms.

multitier application A program designed in components or services, where each segment performs part of the necessary actions. Each of the functions of a multitier application can be coded in a separate component and the components may be stored and run on different machines.

`MustInherit` Modifier on a class definition. The class cannot be instantiated, but instead must be used for inheritance.

`MustOverride` Modifier on a procedure definition; requires that the procedure be overridden in an inherited class.

My.Computer.FileSystem VB-specific objects for accessing files.

N

Name property The property of an object that is used to reference the object in code.

named constant Constant created and named by the developer.

namespace Used to organize a group of classes in the language library; the hierarchy used to locate the class. No two classes may have the same name within a namespace.

namespace-level variable A variable that can be used in any procedure within the current namespace, which is generally the current project.

nested `If` An `If` statement completely contained within another `If` statement.

nested `Try/Catch` block A `Try/Catch` block completely contained within another `Try/Catch` block.

NewLine character The Visual Studio constant `Environment.NewLine` or `ControlChars.NewLine`; used to determine line endings.

`Next` method Returns the next in a series of random numbers for an object of the Random class.

node (XML) A branch of the tree. The file can have only one root node and multiple child nodes.

`Nothing` An object variable that does not have an instance of an object assigned. Formerly used to destroy an object.

Now property Current date and time from the DateTime structure.

O

object An occurrence of a class type that has properties and methods; a specific instance of a control type, form, or other class.

object-oriented programming (OOP) An approach to programming that uses classes to define the properties and methods for objects. Classes may inherit from other classes.

OpenFileDialog Common dialog component used to display the Windows ***Open File*** dialog box; allows the user to view files and select the file to open.

Option Explicit Setting this option On forces variables and objects to be declared before they can be used.

Option Strict Setting this option On enforces strong data typing.

order of precedence Hierarchy of mathematical operations; the order in which operations are performed.

overloading Allows a method to act differently for different arguments. Multiple procedures in the same class with the same name but with different argument lists.

overriding A method in a derived (inherited) class with the same name and argument list as a method in the parent (base) class. The method in the derived class overrides (supersedes) the one in the parent class for objects of the derived class.

P

parameterized constructor A constructor (`Sub New`) that contains an argument list; as opposed to an empty constructor.

parameterized query A database query that allows a value to be supplied at run time.

parent class The base class for inheritance, also called a *super class*.

parent form MDI container for child forms.

Pascal casing The naming convention that specifies mixed-case names; the first character must be uppercase and the first character of each word within the name must be uppercase; the rest of the characters must be lowercase.

`Peek` method Used to look ahead to determine if records remain in a file stream.

Pen object Graphical object for drawing lines and shapes.

PictureBox control A control used to display an image.

pixel Picture element; a single dot on the screen; a unit of measurement for displaying graphics.

Point structure Holds X and Y coordinates as a single unit.

polymorphism OOP feature that allows methods to take different actions depending on the situation. Methods may have the same name but different argument lists. Also refers to the naming convention of naming methods with similar actions the same in each class.

postback A round-trip to the Web server.

posttest A loop that has its test condition after the body of the loop; the statements within the loop will always be executed at least once; also called an *exit test*.

pretest A loop that has its test condition at the top; the statements inside the loop may never be executed; also called an *entry test*.

`Print` method A method of the PrintDocument class to begin executing code for printing.

print preview View the printer's output on the screen and then choose to print or cancel.

PrintDocument component Contains methods and events to set up output for the printer.

PrintForm A method of a form that prints the form in its current state; can be set to print on the printer or the Print Preview window.

PrintPage event procedure Contains the logic for printing.

PrintPreviewDialog component Used to allow print previews for an application.

`Private` Variable or procedure declared with the `Private` keyword; available only inside the current class.

procedure A unit of code; may be a sub procedure, function procedure, or property procedure.

Professional Edition A version of Visual Basic that includes fewer features than the Team System edition but more features than the Standard and Express editions.

Project Designer A tabbed window of the IDE used to view and set the project's properties. Displayed from *Project / ProjectName Properties*.

project file A text file that contains information about the current project. Displays in the Solution Explorer and can be viewed and edited in a text editor.

Properties window A window in the IDE used to set values for properties at design time.

property Characteristic or attribute of an object; control properties may be set at design time or run time depending on the specific property.

property procedure Procedure written with `Set` and `Get` keywords to pass values to and from private variables in a class.

`Protected` Access modifier for a variable or procedure; behaves as private but allows inheritance.

pseudocode Planning tool for code using an English expression or comment that describes the action.

`Public` The access level specifier that allows access from all classes.

R

radio button A control used to indicate a value that may be True or False (selected or not selected). In any group of radio buttons, only one button may be selected.

Random class Used to create Random numbers.

`ReadAllText` method A simple method to read an entire text file into a variable. The method opens a file, reads the data, and closes the file automatically.

`ReadLine` method Reads one record from a file; reads to the end of the line.

`ReadOnly` A property that can be retrieved but not set by external classes; indicates that only a `Get` method exists for the property.

record A group of related fields; relates to data files and database tables.

Rectangle structure Defines a rectangular region, specified by its upper-left corner and its size.

refactoring Feature of some .NET languages that can automatically change the name and class of variables and objects. VB provides only for renaming variables.

relational operator Used to compare two fields for greater than >, less than <, or equal to =.

remark A Basic statement used for documentation; not interpreted by the compiler; also called a *comment*.

resizing handle See *handle*.

return value Value returned from a function.

reusability Code modules that can be used in multiple projects.

RichTextBox A specialized form of a text box that allows formatting of the Text property. If an .rtf file is loaded into a RichTextBox, the text appears properly formatted.

row A horizontal section of a grid control.

run time During the time a project is executing.

run-time error An error that occurs as a program executes; causes execution to break.

S

scope The extent of visibility of a variable or constant. The scope may be namespace, module-level, block, or local.

Scroll event Scroll bar event that occurs as the user moves the scroll box.

`Select Case` Selection structure; can be used in place of an `If` statement.

***Select Resource* dialog box** A dialog box in which the image and sound files of a project can be added and selected.

SelectedIndex property Index of the item currently selected in a list box or combo box.

separator bar A horizontal line used to separate groups of menu commands.

`SetBounds` method Sets the location of a control; used to move a control.

`SetError` method Defines the message and turns on the error message for an ErrorProvider control; used for validating input data.

shared property A property that can be used by all objects of the class; generally used for totals and counts. Only one copy exists for all objects of the class.

shared variable One variable that can be used by all objects of the class; generally used for totals and counts.

short circuit Skipping the evaluation of parts of a compound condition that are not required to determine the result.

shortcut menu The menu that pops up when the right mouse button is clicked. Also called a *popup menu*, *context menu*, or *right-mouse menu*.

`Show` method Displays a form or message box. A form displayed with the `Show` method is modeless.

`ShowDialog` method Displays a common dialog box or a form; the form is displayed modally.

siblings (XML) Elements at the same level as each other.

signature The name and argument list of a method or procedure.

simple combo box Fixed-size combo box.

simple list box Fixed-size list box.

single document interface (SDI) Forms act independently in a multiple-form project.

single-file model A style of Web Form in which the VB code and HTML are contained in the same file.

Size structure A size specified by width and height; measured in pixels.

SizeMode property Allows the size of an image in a picture box to stretch.

SmallChange property Scroll bar property for amount of move by a click on an arrow.

snap lines Guidelines that pop up on a form during design time to help align the controls.

snippet See *code snippet*.

solution A Visual Basic application; can consist of one or more projects.

Solution Explorer window An IDE window that holds the filenames for the files included in your project and a list of the classes it references.

solution file A text file that holds information about the solution and the projects it contains.

Sorted property Property of a list box and combo box that specifies that the list items should be sorted.

SoundLocation property The path of the sound file played by the SoundPlayer component.

SoundPlayer component A component that allows the user to play a sound file.

splash screen A window that appears before the main application window; generally displays program information and gives the appearance of quicker application loading.

Standard Edition A version of Visual Basic with fewer features than the Professional and Team System versions.

StartPosition property Determines the screen location of the first form in a project when execution begins.

startup form The main form; the first form to display after the splash screen.

stateless Does not store any information about its contents from one invocation to the next.

`Static` A local variable with a lifetime that matches the module. The variable retains its value as long as the form is loaded.

status bar An area along the lower edge of a window used to display information for the user.

StatusStrip control A container control that creates a status bar across the lower edge of a form.

Step Into Debugging command; executes each statement, including those in called procedures.

Step Over Debugging command; executes each statement in the main procedure but does not show statements in called procedures.

stream An object used to transfer a series of bytes from one location to another.

StreamReader Object used to input small amounts of information stored in a disk file.

StreamWriter Object used to write small amounts of information to disk.

StretchImage Setting for the value of the SizeMode property of a PictureBox control.

string literal A constant enclosed in quotation marks.

strongly typed A feature of VB that requires the programmer to always be aware of the data type. If you assign data to a wider type, VB can implicitly (automatically) convert for you; if you are assigning data to a narrower type, where precision or accuracy might be lost, VB will generate a compiler error.

structure A grouping that combines multiple fields of related data.

sub procedure A procedure that performs actions but does not return a value.

subclass A derived class; also called a *child class*.

submenu A menu within a menu.

subscript The position of an element within an array; also called an *index*.

subscripted variable An element of an array.

superclass A base class for inheritance, also called a *parent class*.

syntax error An error caused by failure to follow the syntax rules of the language; often caused by typographical errors. The Editor informs you of syntax errors.

System.IO namespace Holds the stream objects for reading and writing data files.

T

TabIndex property Determines the order the focus moves as the Tab key is pressed.

table A two-dimensional array.

table adapter An object that handles retrieving and updating of the data in a dataset.

table lookup Logic to find an element within an array.

TabStop property Determines if a control can receive focus.

Team System Edition The version of Visual Studio with the most features.

text box A control for data entry; its value can be entered and changed by the user.

Text property The value that displays on a control such as the words in a text box or label.

TextAlign property Used to change the alignment of text within the control.

TextFieldParser Object used to read a delimited file and separate it into its individual fields.

Tick event One firing of a Timer component; each time the interval passes, another Tick event occurs.

Timer component Fires Tick events at a specified time interval.

`ToLower` method Converts text to lowercase letters.

toolbar The bar beneath the menu bar that holds buttons; used as shortcuts for menu commands.

toolbox A window that holds icons for tools; used to create controls and components on a form.

ToolStrip control A container control that creates a toolbar on a form.

ToolStripStatusLabel object Individual item on a StatusStrip control.

ToolTip Small label that pops up when the mouse pointer pauses over a toolbar button or control.

ToolTip component Placed on a form to allow the individual controls to display ToolTips. A ToolTip property is added to each control.

ToolTip on ToolTip1 property The new property added to each control when a ToolTip component is added to the form.

`ToUpper` method Converts text to all uppercase.

`Try/Catch` block Traps user errors or program errors.

U

user interface The display and commands seen by a user; how the user interacts with an application. In Windows, the graphical display of an application containing controls and menus.

`Using` block A group of statements bounded by `Using` and `End Using`; any variables declared inside the block are not available outside the block.

V

validation Checking to verify that appropriate values have been entered.

validator controls Controls that can automatically validate input data; used on Web Forms.

`value` keyword Incoming value for a `Set` clause in a property procedure.

Value property Holds the current setting of a scroll bar control.

ValueChanged event Event that occurs when a scroll bar control is scrolled.

variable Memory location that holds data that can be changed during project execution.

vertical scroll bar A Windows control that provides a scroll bar that appears vertically on the form.

Visible property Determines if a control can be seen or not.

visual inheritance Inheritance of the visual elements of a form.

Visual Studio environment The development environment including tools for designing the interface, editing program code, and running and debugging applications; also called the *IDE*.

W

Web Form Form in Visual Studio for creating pages that display in a browser.

Web page A static page consisting of HTML elements; displayed in a browser application.

WebBrowser control Displays Web pages on a Windows form.

Windows Presentation Foundation (WPF) Technology for creating rich user interfaces, such as those used in Windows Vista. Can use WPF interoperability to include WPF controls on a Windows Form, use a WPF Application template to write a WPF application, or use a WPF Browser template to create a browser application.

`With` and `End With` statements A block of code that refers to the same object. The object name appears in the `With` statement; all subsequent statements until the `End With` relate to that object.

`With` block The lines of code between a `With` and `End With` statement.

WordWrap property Boolean property that allows text to wrap to a second line. Multiline property must also be set to True.

`Write` method Writes one record to a stream object; does not include a carriage return.

`WriteAllText` method A simple method to write a text file. The method opens a file, writes the data, and closes the file automatically.

`WriteLine` method Writes one record to a stream object; includes a carriage return character at the end.

X

XAML Extensible Application Markup Language.

XAML Browser Application (XBAP) A WPF application that runs in a browser. The user interface is created using XAML. See *Extensible Application Markup Language*.

XML Extensible markup language. A format for data; popular for data storage and transfer on the Internet.

Index

SYMBOLS

(pound sign), preceding a CSS style name, 379
sign, in a Date variable, 624
& (ampersand). *See* Ampersand (&)
&=, 125
&= assignment operator, 124
^ (exponentiation), 122
* (multiplication), 122
*=, 125
*= assignment operator, 124
= (equal to) operator, 163
= assignment operator, 124
–= assignment operator, 124, 125
+= assignment operator, 124, 125
+ (addition), 122
– (subtraction), 122
< (less than) operator, 163
<= (less than or equal to) operator, 163
<> (start-tag and end-tag brackets)
    attribute name enclosed in, 588
    in an XML file, 586
<> (not equal to) operator, 163
> (greater than) operator, 163
>= (greater than or equal to) operator, 163
/= assignment operator, 124, 125
/ (separator) character, for date formatting, 624
/ (division), 122
\ (integer division), 122
"...", appending to a Text property, 222
: (colon), as a statement terminator, 162

A

About box, 220, 257
About box form, 276, 277
About Box template, 257, 258
About form, 508, 511, 513
Abs (absolute value) method, 629
Absolute positioning, 375–376
Abstract class, 492, 497
Abstract methods, 492
Academic Alliance, 6
Accept button, 82
Access keys, 81–82, 83
Access level, 268
Accessor methods, 475, 476
Accumulators, 335–337
Activated event, 264
Active control, 80
ActiveX Data Objects (ADO), 402
Activity diagrams, 162
Add Connection dialog box, 409
Add Existing Item command, 256
Add method, 622, 625
Add New Data Source option, 420
Add New Item dialog box, 254, 384, 478, 479
    choosing Splash screen, 260–261
    selecting About Box, 258
    templates in, 262
Add Project Data Source, 407, 408
Add WHERE Clause dialog box, 427–428, 429
Add Windows Form, 254
Addition (+) operator, 122
ADO.NET, 402, 404
AJAX (Asynchronous JavaScript and XML), 369, 388–389
Algebraic comparisons, 163
Alignment
    of decimal points, 310
    options for controls, 80
    of text in a text box, 69
Alignment property, changing, 39
AllowDrop property, 548, 550
Alphabetic button, 24
Alt + F4, 222
Alt + right arrow, 644
American National Standards Institute. *See* ANSI code
Ampersand (&)
    in concatenation, 93
    specifying keyboard access, 82, 215
And logical operator, 167
AndAlso logical operator, 167, 169
Animated graphic, 534, 535
Animation, 534–537
ANSI code, 164, 165
APL, 5
Apostrophes
    adding to the beginning of code lines, 203
    at the beginning of lines, 643
    beginning remarks, 31
Application tab, of Project Designer, 272
Applications. *See also* Database applications; Interactive Web applications; Web applications; WPF (Windows Presentation Foundation)
    adding sound to, 543–545
    deploying, 646
    designing for user convenience, 80–87
    multitier, 473–474
    projects in, 7
    writing, 6–8
Apply New Style option, 380
Apply Styles window, 379
Applying, styles, 382
Arcs, drawing, 531
Arguments
    constructors requiring, 477–478
    of functions, 232, 626
    functions with multiple, 234–235
    of the Parse method, 120
    passing ByVal or ByRef, 231
    passing to procedures, 230–231
    specifying multiple in procedures, 231
Arithmetic expressions, order of precedence, 123–124
Arithmetic operations, 122
ArithmeticException, 139
Array elements, 335, 337
Arrays, 330
    declaring, 331
    including in a structure, 334–335
    inside structures, 334
    list boxes with, 340–341
    multidimensional, 341–347
    reinitializing, 343
    single-dimension, 330–332
As clause, 114, 116
Ascending sort, 421, 422
ASCII characters, 164
ASP.NET, 363, 366, 386
ASP.NET application, Web.Config file for, 648
ASP.NET server controls, 370
.aspx extension, 363
aspx file, 371
.aspx.vb extension, 363
Assembly Information dialog box, 258, 259
Assembly Name entry, 238
Assignment operators, 124–125
Assignment statements, 31–32
    performing calculations in, 124
    typing, 33
Asynchronous JavaScript and XML. *See* AJAX
Atan method, 629
Attributes
    in HTML, 403
    specifying, 588
    in an XML file, 585, 586
Authentication, 648
Authorization, 648–649
Auto style application, 380
AutoCorrect box, 48
AutoHide feature, 636, 637
AutoHide pushpin icon, 17
Automatic context menus, 227
Autos window, 198, 202, 337
AutoSize property, 21, 26, 77, 133
AutoSizeMode, 411, 412
Average, calculating, 145

B

Back constant, 177
BackColor property
    of a control, 81, 90
    of a form, 81, 90–91
    of a ToolTip component, 86, 87
BackgroundImage property, 77
BackgroundImageLayout property, 77
BackStyle property, 95
Base class, 471, 472
    creating strictly for inheritance, 497
    forms inheriting from, 499
    inheriting from, 497
    using property values from, 493
Base form, 508, 510, 513
Base-class constructor, 492
Basic. *See* Visual Basic (VB)
Basic code, 6, 7

BgColor property, 368
bin\Debug folder, 535
Binding, data fields, 413–417
Binding Source object, 408
Binding sources, 405, 406
BindingSource component, 410, 411
Blanks, checking for, 180
Blinking icon, displaying, 562, 563
Block variable, 117
Block-level declarations, 120
Block-level variables, 117
Blue snap lines, 641
Bookmarks, setting, 643
books.xml sample file, 584–585
  displaying in the Output window, 586–587
  elements in, 585, 586
  reading, 589
Boolean data type, 112, 298, 632, 633
Boolean variable, 298, 459
BorderColor property, 94, 95
Borders, in an HTML table, 374, 375
BorderStyle property, 77, 95
  for a group of controls, 79
  of labels, 77, 133
  of a line, 94
BorderWidth property, 94, 95
Bound controls, 405, 413, 416–417
Bound data, sorting, 421
Break All button, 195
Break time, 302
Breakpoints
  forcing breaks, 195–196
  setting, 199, 372
Browsers, 2, 362, 363, 372, 373
Brush objects, 527, 528
Brushes, 528
Bugs, finding and fixing, 50
Business logic, 473
Business tier, 474
Button control, 21
Button tool, 21, 22
Buttons
  Accept button, 82
  adding new, 41
  Alphabetic button, 24
  Assembly Information button, 258, 259
  Break All button, 195
  Cancel button, 82, 454
  changing location and text of, 40–41
  Close button, 13, 637
  coding in WPF, 601
  default, 100, 178–179
  disabling, 89
  displaying multiple, 177–179
  Error List button, 638
  event procedures for, 41, 43
  Events button, 266, 295
  Exit button, 34–35, 36
  illustrated, 2
  Immediate Window button, 638
  Import button, 74
  naming, 27–28
  Object Browser button, 505, 638
  Open Files button, 255, 256
  ORDER BY button, 425, 426
  performing overlapping functions, 186
  placing on forms, 21
  Print button, 308
  Print Preview button, 312
  Properties button, 39, 73, 74, 266
  Properties Window button, 638
  Push Me button, 32, 35, 36
  Refresh button, 424, 443, 444
  Save All toolbar button, 36, 43
  Save button, 442
  setting access keys for, 82
  setting for a ToolStrip, 575
  setting name and text properties for, 27–28
  Show All Files button, 443, 444
  Solution Explorer button, 638
  Start Debugging button, 35, 50
  Step Into button, 201
  Stop Debugging button, 202
  Tab Order button, 84
  Toolbar button, 12, 505
  Toolbox button, 638
  View Code button, 37
  View Designer button, 37, 368, 384
ByRef keyword, 231, 232
Byte data type, 112
ByVal keyword, 231, 232

C

C currency specifier code, 130, 131
C# language, 3
C++ language, 3
Calculations, 110
  breaking into smaller units, 235–237
  performing, 120–130
Calendar controls, 578–581
Call keyword, 185
Call statement, 185–186
Callback, 306
Calling, procedures, 185, 230
Cancel button, 82, 454
CancelEventArgs argument, 566
Capitalization, of variables and constants, 51, 113
Carriage return character, 442
Cascade constant, 574
Cascading style sheets (CSS), 378
Case Else clause, 182
Case statement, 182
Case structure, 181–183
Case studies
  VB Auto Center, 64, 106, 158, 209–210, 251, 286, 327–328, 359, 400, 438, 468, 523, 560, 604
  VB Mail Order, 64, 106, 157, 208–209, 251, 286, 327, 359, 400, 438, 468, 522, 560, 604
  Very Very Boards, 65, 107, 158, 210–211, 252, 286, 328, 360, 400, 438, 468, 523, 560, 605
  Video Bonanza, 65, 107, 158, 210, 252, 286, 328, 360, 400, 438, 468, 523, 560, 605
Casting, 120, 128, 228. *See also* Explicit conversions
Catch blocks, 138, 139
Cells, merging, 374
CenterScreen, 84, 85
Char data type, 112
CharacterCasing property, 565
Characters
  comparing uppercase and lowercase, 166–167
  swapping, 644
Charting, If statements, 162
Check boxes, 73
  Checked property of, 88
  checking the state of multiple, 175
  If statements with, 172–175
  illustrated, 2
  setting access keys for, 82
  testing the value of, 174
Check marks, toggling on and off, 221–222
Checked property
  of a check box, 73
  for menu items, 221–222
  of a radio button, 73
  setting for radio buttons and check boxes, 88
CheckedChanged event, 73
CheckFileExists property, 452
CheckPathExists property, 452
Child class, 471
Child elements, 587, 588
Child form, 571–572
Child nodes, in an XML file, 585
Child windows, 573, 574
Choose Default Environment Settings dialog box, 8
Choose Toolbox Items dialog box, 94, 595
Circle, drawing, 530, 531
Class files, adding to projects, 504
Class icon, 505
Class methods, 476–477
Class name, for a form, 29, 30
Class Name list, 44, 45, 265
Class properties, 478–479
Class variables. *See* Shared members
Class-based style, for CSS, 379
Classes, 4–5, 474
  adding shared properties to, 489
  creating, 470, 478–483
  creating objects using, 484–491
  creating properties in, 475–476
  data type, 121
  derived, 472
  designing, 474
  examining, 506, 507
  exception, 138, 139
  form, 497–501
  hierarchy of, 472
  permission, 650
  reusable, 473
Class-level variables. *See* Module-level variables
Clean compile, 50
Clear All Bookmarks shortcut, 643
Clear method, 87, 294–295, 531
Click event, 5, 34–35
Click-once deployment, 646
Client/server Web applications, 362–363
Close button, 13, 637
Close method, 32
  closing forms, 263
  of StreamReader, 449
  of StreamWriter, 447, 449
Close Project, in the File menu, 37
Closing, files, 449
CLR (Common Language Runtime), 5
CLR data types, 112, 129
COBOL, 5
Code
  adding for a Web application, 368
  calculations in, 124–125
  commenting out, 203
  compared to pseudocode, 6
  dragging to the toolbox, 645
  executing one line at a time, 197
  keyboard shortcuts when editing, 643–644
  planning, 6
  printing, 45–46
  snippets and samples, 570–571
  stepping through, 196–197
  in a Web form, 363
  writing for a form, 29–30
  writing for the Print button, 308
  writing secure, 649
Code access security, 649–650
Code Editor, 162–163, 265
Code procedures, in the .vb file, 7
Code separation model, 366
Code snippets, 570–571

Code statements, 30–32
Code-behind file, 363
Coding
  buttons, 601
  click events, 32, 34–35
  combo boxes, 584
  controls, 87–95
  event procedures, 32–35
  inherited controls for events, 501
  menu items, 220–222
  methods for a class, 481
  module-level declarations, 119
  module-level variables, 119
  table lookup, 338, 340
  ToolStrip control, 575, 577
Collating sequence, of ANSI code, 164, 165
Collections, 289. *See also* DropDownItems collection; Items collection
Colon (:), as a statement terminator, 162
Color(s)
  changing for text, 90
  indicating expectations to users, 81
  listing of, 90
  using radio buttons to select, 90–92
Color constants, 90, 527, 528
Color dialog box, 224–225
Columns
  aligning decimal, 310–311
  in data tables, 402
  editing, 411–412
  in HTML tables, 374
  in tabular data, 341
Combo boxes, 288, 289, 295, 417
ComboBox controls
  compared to ListBox controls, 288
  setting up, 418, 419
  as a type of menu item, 218, 219
ComboBox Save and Read program, 456–458, 591–592
Comment out the selected lines toolbar button, 204, 643
Comment Selected Lines shortcut, 643
Commenting out code, 203–204, 643
Comments. *See also* Remark statements
  in an XML file, 586
Common Controls tab, 68
Common dialog components, 223
Common Language Runtime. *See* CLR
Compare methods, in String, 630–631
CompareValidator control, 386
Comparing, strings, 164–166
Comparison operators, 163
Compile errors, 46
Compile tab, of Project Designer, 127
Compiler, in an IDE, 8
Compiling, 50
Completion of a loop, 296–297
Component tray, 42
  examining, 410, 411
  ToolTip component in, 85, 86
Compound conditions, 167–169
Concatenation, 72, 93
Conditions, 163–169
  evaluating, 160
  satisfying before entry into the loop, 301
  viewing the contents of, 200–201
Configure the Select Statement page, 425, 426, 427
Connection objects. *See* Binding sources
Const keyword, 113, 270
Const statement, 114, 118
Constant icon, 505
Constants, 110, 113
  assigning values to, 114–115
  Back (backspace) constant, 177
  Cascade constant, 574
  Color, 90, 527, 528
  comparing to numeric variables, 163–164
  ControlChars, 177
  Cr constant, 177
  CrLf constant, 177
  declaration summary for, 270
  example, 115
  FormFeed constant, 177
  guidelines for declaring, 270–271
  intrinsic, 113, 115, 444
  Lf constant, 177
  Long data type constant, 115
  MessageBoxButtons constants, 177
  in multiform projects, 267–271
  Named, 111, 113–114, 270–271
  naming conventions, 112–113
  naming rules, 112
  as narrow as possible, 271
  NewLine constants, 72, 176–177
  Nothing constant, 535
  NullChar constant, 177
  Numeric, 114
  Quote constant, 177
  Tab constant, 177
  TileHorizontal constant, 574
  TileVertical constant, 574
  vbCrLf constant, 442
  VerticalTab constant, 177
  YesNo constant, 177, 178
Constructors, 477
  adding to subclasses, 494
  in inheritance, 491–492
  overloading, 477
  parameterized, 477–478
  writing for a class, 481
Contact page, for a Web application, 393, 394, 395
Containers
  drawing graphics in, 529
  for other controls, 72
  placing an image inside, 541
Containers tab, 68
Contents of files, viewing, 443
Context menus
  creating, 226–228
  displaying for controls, 23
ContextMenu property, 227
ContextMenuStrip component, 226
Context-sensitive Help, 55, 645
Continue command, 197, 201
Continue statement, 303
Control type, 421–423
Control loop variables, 301
ControlChar.Newline, 442
ControlChars constants, 177
Controls, 3, 4
  active control, 80
  adding to a new Web page, 384
  adding to the toolbox, 94
  aligning, 21, 80, 641–642
  ASP.NET server, 370
  available for Web Forms, 369–370
  bound, 413, 416–417
  button control, 21
  calendar, 578–581
  changing multiple properties of, 92–93
  changing the name of, 24, 25
  choosing for program output, 132–133
  coding for, 87–95
  ComboBox controls, 288, 418, 419
  CompareValidator control, 386
  creating multiple similar, 41
  currently selected, 24
  data controls for Web Forms, 369
  data-bound, 405
  DataGridView control, 405, 407, 431, 432, 433
  date, 578–581
  DateTimePicker control, 578, 579
  deselecting a group of, 79
  DetailsView control, 427, 429, 430
  disabling, 89
  downloading and installing, 93–94
  dragging using the white tab, 376, 377
  DropDownList control, 425
  ElementHost control, 593, 594, 595
  entering in an HTML table, 374
  Expander WPF control, 595, 596
  grayed-out control, 89
  group of, 79
  GroupBox controls, 72
  HScrollBar control, 539
  HTML, 370, 615
  HyperLink control, 383, 384
  Image control, 376
  images as the background of, 77
  inherited controls, 501
  introducing more, 68–78
  invisible, 387, 535
  Label control, 77
  Line and Shape controls, 94
  Line control, 78
  LineShape Control, 94
  List control, 288
  ListBox controls, 288
  Lock Controls, 23, 38, 43
  locking, 23, 43
  Login controls, 369
  MaskedTextBox control, 70
  MenuStrip control, 573–574
  MonthCalendar control, 578, 579
  moving as a group, 79
  moving with SetBounds, 537
  multiple, 78–79
  naming, 51
  navigation, 369
  nudging into place, 641
  OvalShape control, 94
  PictureBox control, 73, 526, 534, 550
  placing on forms, 19–23, 94–95
  placing using absolute positioning, 375–376
  PowerPacks, 93–94
  PrintForm control, 41, 94
  RangeValidator control, 385, 386
  RectangleShape control, 94
  RegularExpressionValidator control, 386
  RequiredFieldValidator control, 385, 386
  retaining the contents of, 386
  RichTextBox control, 71
  scroll bar, 539–542
  selecting, deleting, resizing, and moving, 21
  selecting multiple, 78–79
  setting a border or style, 77
  setting properties for multiple, 79
  setting the tab order for, 82–84
  shape, 95
  sharing an event procedure for, 183–185
  standardizing vertical spacing between, 642
  StatusStrip control, 577
  TextBox control, 69, 368, 418
  ToolStrip control, 575, 577, 581
  unlocking, 23
  UpdatePanel control, 388, 389
  validation, 369
  ValidationSummary control, 386
  Validator controls, 385–386
  VScrollBar control, 539
  Web controls, 370–371
  Web server controls, 373, 615
  WebBrowser control, 581–582
  WebParts controls, 369
  Windows Media Player control, 545–546
  working with multiple, 78–80
  WPF, 593, 597

Conversion, between data types, 120, 127–128, 632–633 *See also* casting
Convert class, 128
Cookies, 363, 387
Coordinate system, 529
Copy Web Site feature, 364, 390
CornerRadius, 95
Corrections, 49
Cos (cosine) method, 629
Count property, 292
Counter variable, 145
Counter-controlled loop, 300
Counting backward, in a For/Next loop, 301
Cr constant, 177
Create directory for solution check box, 37
CreateGraphics method, 527
Credentials, 648
CrLf constant, 177
Crosshair pointer, 19, 20, 599
Crystal Reports, 305
CSS. *See* Cascading style sheets
.css file, 380, 382
CSS Properties window, 382
Ctrl + A, 78
Ctrl + Alt + Break, 197
Ctrl + Alt + L, 638
Ctrl + Alt + T, 644
Ctrl + Alt + X, 638
Ctrl + Backspace, 644
Ctrl + Break, 302
Ctrl + Delete, 644
Ctrl + End, 644
Ctrl + Enter, 72, 85, 644
Ctrl + F5, 369, 371
Ctrl + F6, 256, 638
Ctrl + Home, 644
Ctrl + K, Ctrl + C, 643
Ctrl + K, Ctrl + L, 643
Ctrl + K, Ctrl + U, 643
Ctrl + K, N, 643
Ctrl + K, P, 643
Ctrl + K, T, 643
Ctrl + L, 644
Ctrl + Shift + Enter, 644
Ctrl + Shift + T, 644
Ctrl + Spacebar, 644
Ctrl + T, 644
Ctrl + Tab, 13, 256, 638
Ctrl + Y, 644
CType function, 184
CurDir method, 586
Currency, 130, 131, 634
Cursor. *See* Insertion point

D

d, date formatting character, 624
D specifier code, 131
Data
  appending to an existing file, 447–448
  formatting for display, 130–133
  reading from a file, 449
Data access, 405–406
Data application, running, 410
Data binding, 405, 418, 419
Data changes, tracking, 459
Data controls, for Web Forms, 369
Data Designer, 413
Data fields
  binding individual, 413–417
  selecting from a data table, 420
  setting up additional, 427–429
Data file input and output (I/O) objects, 440
Data files, 408, 440
Data hiding, 471, 475
Data source, 406, 416, 420
Data Source Configuration Wizard, 407, 408, 414, 420
  data components generated by, 411
  setting the data source, 425
Data Sources window, 405, 413–415
  adding a new data source, 413, 414
  binding features of, 413
  control type for a bound control in, 417–419
  default location for, 414
  different type of control in, 421, 422
Data tables, 402, 405
Data tier, 474
Data type classes, Parse method for, 121
Data types
  for arguments of functions, 232
  assigning strong, 586
  Boolean data type, 112, 298, 632, 633
  Byte data type, 112
  Char data type, 112
  CLR, 112, 129
  converting between numeric, 127–128
  Date data type, 112, 632, 633
  DateTime CLR data type, 112
  Decimal data type, 111, 112, 115, 632, 633
  declaring, 115
  Double data type, 112, 115, 632, 633
  Int16 CLR data type, 112
  Int32 data type, 112
  Int64 data type, 112
  Integer, 112, 115, 633
  Long data type, 112, 115, 633
  methods for conversion between, 632–633
  .NET, 112
  Numeric data types, 120–121, 127–128
  Object data type, 112
  performing calculations with unlike, 128–129
  Short data type, 112, 633
  Single data type, 112, 115, 633
  String data type, 111, 112, 633
  String literals, 115
  table of, 112
  Unsigned Integer data type, 633
  Unsigned Long data type, 633
  Unsigned Short data type, 633
  of variables and constants, 111–112
Database applications, 407–413
Database Details program, 415–417
Database files, 402, 409
Database management systems (DBMSs), 402
Database objects, 405–406
Database programs, writing for the Web, 423
Database schema file, 412–413
Database table, example, 403
Databases, terminology of, 402–403
Data-bound controls. *See* Bound controls
Data-bound Details view, 415–417
DataGridView control, 405, 407
  adding to a form, 407
  in the Data Source window, 414–415
  for displaying data, 431
  formatting, 410–412
  LINQ query filling, 432
  retrieving and displaying FileSystem data, 433
DataSet component, 410, 411
Datasets, 406
DataTips, 196
Date(s)
  finding the difference between, 625
  formatting, 623–624, 634
  functions and methods for, 622–625
  selecting a mask for, 70
  setting future, 625
Date and time, displaying, 577–578
Date codes, 132
Date controls, 578–581
Date data type, 112, 632, 633
Date format, converting values to, 625
Date formatting, user-defined, 624
Date property, 622
Date variables, assigning a literal value to, 624
DateTime CLR data type, 112
DateTime structure, 132, 577, 622–623
DateTime values, 132
DateTimePicker control, 578, 579
Day of the week, checking for, 625
Day property, 622
DayOfWeek property, 622
DayOfYear property, 622
DBMSs, 402
DDB (double-declining balance) function, 626, 628
Deactivate event, 264
Debug menu, 35, 194, 197
Debug mode, 199–200
Debug output, writing, 194–195
Debug time, 14, 196
Debugger, in an IDE, 8
Debugging, 50
  array programs, 337
  projects, 487
  step-by-step tutorial, 199–204
  VB projects, 193–198
  Web applications, 371–372
Debugging commands, executing, 197
Debugging mode, 203
Debugging Not Enabled dialog box, 372
Debugging project, 199
Debugging tools, 193–194
Decimal class, 121
Decimal columns, aligning, 310–311
Decimal data type, 112
  in a constant, 115
  conversion to, 632, 633
  examples, 111
Decimal fractions, rounding, 129
Decision symbol, in a UML activity diagram, 162
Decisions, made by computers, 160
Declaration statements, 111, 115–116
  arrays for, 331
  entering, 116–117
  two-dimensional arrays for, 342–343
Declarations, for variables and constants, 270–271
Declarations section, 43–44, 119
Declaring, variables, 115–117
Default button, 100, 178–179
Default constructor, 477
Default environment settings, 8–9
Default icon, 272
Default names, assigned by Visual Basic, 51
Default.aspx file, 365, 385
Default.aspx.vb file, 365
Defaults, setting Option Strict in, 127
Deleting, controls on a form, 21
Delimited files, writing and reading, 441–446
Delimiters, 442, 444
Deployment
  of applications, 646
  removing debugging support before, 372
Depreciation, functions calculating, 626, 628
Derived class, 471, 472, 493–494
Descendants, 588
Descending sort, 422
Design tab, 366, 367
Design time, 14
Design view, 370, 384
Designer, of a Web page, 593
Designing, classes, 474
Destructors, 477, 490
Details
  displaying data in grids or individual fields, 405
  selecting in the Data Source window, 414, 415

Details view, 415
DetailsView control, 427, 429, 430
DetectUrl property, 71
Developer (programmer), of a Web page, 593
Development environment, 8
Development machine, 362
Dialog boxes
  Add Connection dialog box, 409
  Add New Item dialog box, 254, 258, 260–261, 384, 478, 479
  Add WHERE Clause dialog box, 427–428, 429
  Assembly Information dialog box, 258, 259
  Choose Default Environment Settings dialog box, 8
  Choose Toolbox Items dialog box, 94, 595
  Color dialog box, 224–225
  common, 223–226
  Debugging Not Enabled dialog box, 372
  displaying, 223–224
  Edit Columns dialog box, 411–412
  Font dialog box, 39, 225
  information from, 224–225
  Input Mask dialog box, 70
  Insert Table dialog box, 373
  as modal, 224
  New Project dialog box, 16
  New Style dialog box, 380–381
  New Web Site dialog box, 365, 366
  Open dialog box, 74, 75
  Open File dialog box, 453–455
  Open Web Site dialog box, 364
  Options dialog box, 117, 172, 173, 376, 640
  as part of the Windows environment, 223
  Rename dialog box, 645
  SaveAs dialog box, 455
  Select Image dialog box, 376, 377
  Select Resource dialog box, 73
  Select URL dialog box, 383, 384, 385
DialogResult object, 177
Dialogs tab, 223
Diamond-shape symbol, in a UML diagram, 162
Digits specifier code, 131
Dim keyword
  declaring an array, 331
  declaring variables and constants, 270
  for local declarations, 118
Dim reserved word, 116
Dim statements, 115
  defining two-dimensional arrays or tables, 342
  location of, 118
Direct reference, 336, 345
“Dirty” data, 459
Disabled menu items, 220, 221
Disconnected datasets, 406
Disk files. *See* Data files
Dispose method, 531
Division (/) operator, 122
Do and Loop statements, 296–298
Dockable tool windows, 639
Document tabs, 638
Document window(s), 11, 12–13, 17
  in the IDE, 639
  resizing the form in, 19
  switching between forms in, 255
Documentation
  of programs, 30–31
  of projects, 43
DocumentCompleted event, 581
Documents, 638
DocumentTitle property, 582
DocumentTitleChanged event, 582
DoDragDrop method, 547
Do/Loop, 296
  with a list box, 298–299
  for a table lookup, 338, 340
Double data type, 112
  in a constant, 115
  conversion to, 632, 633
  not converting to any other type, 128
Double spacing, in a message box, 176–177
Double-declining balance. *See* DDB function
Drag-and-drop editing, 645
Drag-and-drop operation, 547
Drag-and-drop programming, 547–552
DragDrop event, 547, 549
DragDropImage program, 551–552
DragEnter event, 547, 548–549
Draw methods, 530
DrawArc method, 531
DrawEllipse method, 531
Drawing, graphics, 526–527
Drawing methods, 530
DrawLine method, 530, 531
DrawPie method, 531
DrawRectangle method, 530, 531
DrawString method, 307–308, 531
Drop-down combo boxes, 288, 289
Drop-down lists, 2, 288, 289, 425–427, 434–435
DropDownItems collection, 216, 217
DropDownList control, 425
DropDownStyle property, 288

E

e argument
  defining, 548, 549
  of the DragDrop event procedure, 549
  of an event, 566
  of the KeyPress event procedure, 569
  of the KeyUp event procedure, 584
Each/Next statements, 332–333
Edit Columns dialog box, 411–412
Edit-and-Continue feature, 50, 197
Editions, of Visual Basic, 5–6
Editor. *See also* Code Editor
  in an IDE, 8
  shortcuts in, 642–645
Editor tab, 34
Editor window
  creating sub procedures in, 229–230
  displaying, 200
  displaying a form’s code in, 37
  exploring, 44–45
  PushButton_Click event procedure in, 32
  splitting, 644–645
Element-based style, for CSS, 379
ElementHost control, 593, 594, 595
Elements
  of arrays, 330
  in HTML, 403
  specifying in an XML file by name, 587
  of structure, 334
  of an XML file, 585, 586
Else clause
  in If/Then/Else, 161
  nesting If statements in, 170–171
ElseIf keyword, 161
Empty string (" "), 87
Enable AutoPostBack, 426, 428
Enabled property
  changing based on user actions, 89
  of a control, 89
  for menu items, 220–221
  of a Timer component, 537–538
EnableViewState property, 386, 387
Encapsulation, 471, 475
End If, 161
End of file, 445, 450
End Sub statement, 229
Endless loops, 302
EndOfData method, 445
EndsWith method, 631
Enter event, 295
Enter event procedure, 304
Enter key
  checking for, 583–584
  pressing at the end of each line, 72
Entries, selecting, 304–305
Entry test loop, 296, 297
Environment constants, 177
Environment settings, default, 8–9
Equal sign (=), 163
Equal to (=) operator, 163
Equals method, 631
Error(s), 46–50. *See also* Syntax errors
Error Corrections Options box, 49
Error handling, 138
Error indication, 562
Error lines, jumping to, 48
Error List button, 638
Error List window, 47, 48, 50
Error messages, 562, 649
Error trapping, 138, 346
ErrorMessage property, 385
ErrorProvider component, 562–565
Event(s), 4, 29
  Activated event, 264
  CheckedChanged event, 73
  Click events, 5, 34–35
  compared to methods, 471
  Deactivate event, 264
  DocumentCompleted event, 581
  DocumentTitleChanged event, 582
  DragDrop event, 547, 549
  DragEnter event, 547, 548–549
  Enter event, 295
  Form events, 264
  FormClosed event, 264
  FormClosing event, 264
  Leave event, 295
  of list boxes and combo boxes, 295
  Load event, 264
  MouseDown event, 547
  Page_Load event, 371, 387
  Paint event, 264
  PrintPage event, 313
  for scroll bars, 541
  Scroll event, 541
  TextChanged event, 295
  Tick event, 537
  ToolStripButton.Click event, 577
  Validating event, 566
  ValueChanged event, 541
  of Web Forms and controls, 371
Event handling, 370–371
Event procedures, 29–30
  adding for buttons, 41, 43
  calling, 185–186
  coding for Hello World, 32–35
  DragEnter event procedure, 548
  Enter event procedure, 304
  Form_Load event procedure, 337, 338
  FormClosing event procedure, 459
  KeyUp event procedure, 584
  named by Visual Basic, 30
  Paint event procedure, 527
  planning, 58, 135, 148, 189, 241, 316–317
  PrintPage event procedure, 306, 310
  SaveButton_Click event procedure, 442
  sharing for several controls, 183–185
  TextChanged event procedure, 305
  ToolStripButton_Click event procedure, 582
  ToolStripComboBox_KeyUp event procedure, 582

Validating event procedure, 566
writing for selected events, 264–266
Event-driven programming language, 3
Event-handling methods, 30
Events button, 266, 295
Exception classes, 138, 139
Exception handling, 203
Exception messages, 143
Exceptions, 137–139. *See also* Run-time errors
Executable file, copying, 271
Execution
halting program, 202
pausing with Break All, 195
single-stepping, 487
stopping, 197
Exit button, 34–35, 36
Exit command, 222
Exit Do statement, 302–303
Exit For statement, 333
Exit statement, 302–303
Exit test loop, 296, 297
Exiting, loops, 302–303
Exp method, 629
Expander WPF control, 595, 596
Explicit conversions, 128
Exponentiation (^) operator, 122
Express Edition, 5, 6, 8, 198
Express Edition toolbox, 13, 14
Expression Blend, 593
Expression Design, 593
Expression Media, 593
Expression Web, 378, 593
Expressions, 123, 196
Extensible Application Markup Language. *See* XAML
Extensible Hypertext Markup Language. *See* XHTML
Extensible Markup Language. *See* XML
External style sheets, 378–379

F

F specifier code, 131
F# programming language, 3
F1, 55
F4, 23, 638
F5, 35, 50, 197, 201, 203
F7, 638, 644
F8, 197, 200
F9, 195
F12, 644
False, testing for, 166
Field names, 416
Field-level validation, 566–570
Fields
checking for required, 179–180
control type for, 421–423
in data tables, 402
displaying, 407
testing multiple, 143–144
File extensions, 8, 452
File handling, 447–452
File I/O, 440–446
File menu, placing, 222
File open procedure, 454
File Read program, 451
File System Web sites, 364, 389
FileName property, 452
Files, 440. *See also* Data files; Graphic files; XML files
closing, 449
database, 402
delimited, 441–442
existence of, 457–458
jumping to the top or bottom of, 644
opening and closing, 449
saving, 37, 458–459
viewing contents of, 443
in Web applications, 371
writing to, 440
FileSystem object, 432
Fill command, 421
Fill methods, 413, 530
FillEllipse method, 530, 531
Filling an Items collection, 289
FillPie method, 531
FillRectangle method, 531
Filter property, 452, 453
Filtered By entry, 13
Filtering Help topics, 52, 53, 54
Finalize procedure, 490, 491
Finally statement, 138
Financial functions, 626–628
Fix function, 630
Fixed3D, 77
Fixed-point specifier code, 131
Flags. *See* Boolean variable
Focus, 82–83, 87–88
Focus method, 87–88, 264
Folders, for each Web site, 389
Font dialog box, 39, 225
Font list, 38
Font object, 38
Font properties
assigning to other objects, 225
changing, 39
in the Properties window, 38
Font styles, 71
For Each and Next loop construct, 332
ForeColor property, 86, 87, 90–91
Form(s), 3, 4
adding and removing, 256
adding to projects, 254
changing properties of, 28
creating, 254–256, 485
creating animation on, 534
with data-bound text boxes, 413, 414
drawing lines on, 77–78
hiding or closing, 263–264
images as the background of, 77
making into a child window, 572
making into parent, 572
methods and events of, 262–267
multiple, 254–256
passing properties between, 501–504
placing buttons on, 21
placing controls on, 19–23, 94–95
printing the current, 60
removing from a project, 256
renaming, 238, 646
setting location on the screen, 84–85
setting up, 19
showing, 262–263
switching between in design time, 255
Form classes, inheriting, 497–501
Form Designer, 8, 13, 641–642
Form Designer forms, 266
Form Designer tab, 34
Form Designer Window tab, 256
Form events, 264
Form objects, 263
Form_Load procedure, 337, 338, 457
Format characters, 624
Format menu, 641
Format specifier, 623–624
Format specifier codes, 130–132
FormatCurrency function, 634
FormatDateTime function, 634
FormatException, 138, 139
FormatNumber function, 634
FormatPercent function, 634
Formatting, data for display, 130
FormClosed event, 264
FormClosing event, 264
FormClosing event procedure, 459
FormFeed constant, 177
Forms, changing the filename of, 29
For/Next loops, 299–304
compared to a Do/Loop, 301
traversing elements in an array, 332
using nested, 343
FORTRAN, 5
Friend, access level of, 268
Friend Const keyword, 270
Friend keyword, 268, 471
declaring an array, 331
declaring variables and constants, 270
From operator, in a LINQ query, 431
FromFile method, 534, 535
FTP Web sites, 365
Full screen, 638
Function(s), 130
for checking validity, 633–634
for formatting output, 634
with multiple arguments, 234–235
Function name, 232, 233
Function procedures, 229, 231–234, 238, 475
Function...End Function statements, 232
Future value (FV) function, 626
Future value, of an investment, 155

G

Garbage collection, 491
GDI+ technology, 526
General procedures, 229–237
Get accessor method, 475, 476
GetData method, 413, 549
.gif file, 534, 535
Global variables. *See* Namespace-level variables
Graphic files, 73, 74
Graphical user interface (GUI), 3
Graphics, 526
adding to a Web page, 376
coordinates for, 529
steps for drawing, 526–527
Graphics class, 531–532
Graphics Device Interface (GDI), 526
Graphics environment, 526–532
Graphics methods, 526, 530–532
Graphics page, 307
Gray, use of, 81
Gray squiggle underline, 118
Grayed-out control, 89
Grayed-out menu items, 220, 221
Greater than (>) operator, 163
Greater than or equal to (>=) operator, 163
Green, displaying remarks, 33
Grid, adding to display data, 407
Grid container, 598–599
Group boxes, 2, 72, 73
Group number, 336
Group of controls, 79
GroupBox controls, 72
GroupTextBox, 336
GUI (graphical user interface), 3
Guide diamonds, 639

H

Handled property, 569
Handles, 13, 19
Handles clause, 183–184, 228
HasMorePages property, 313
HeaderText property, 411
Hello project, 383–384
Hello World form, 15, 18, 32–35
HelloWorld application, 7–8, 599–601

HelloWorld project, 17
Help, 8, 13, 15, 51–56, 571, 645
Help Index window, 54
Help menu, 13, 15, 52
Help page, for a control, 68
Help topics, 52–55
Help Topics list, 305
Help window, 52, 53
Hide method, of a form, 263–264
Hiding, windows, 636–637
Hierarchy
  of classes, 472
  of operations, 123
Horizontal scroll bar tool, 540
Horizontal scroll bars, 539, 541
Hot keys. *See* Access keys
Hour property, 622
HScrollBar control, 539
HTML (Hypertext Markup Language), 362, 369
HTML controls, 370, 615
HTML pages, generating, 363
HTML tables, 373–375
HTTP (Hypertext Transfer Protocol), 390
HyperLink control, 383, 384

I

.ico extension, 74, 272
Icon files, on this text's Web site, 75
Icons
  in message boxes, 141
  in the Object Browser window, 505
  for programs, 272
ID property, 368
ID-based style, for CSS, 379
IDE (integrated development environment)
  customizing, 17–18, 636, 639
  initial screen, 9, 10
  layout resetting to default, 17, 640
  main window, 11
  running programs outside, 271–272
  state of, 7
  tips and shortcuts for, 636–646
  tools in, 8
  viewing a file in, 443
  for a WPF application, 598
Identifiers, 51, 111, 112, 232
Identity permission type, 650
If statements, 160–163
  charting, 162
  checking the state of check boxes, 175
  determining the selected radio button, 174–175
  logic, 160, 161
  nested, 169–172
  radio buttons and check boxes with, 172–175
  validation techniques using, 179
  WriteLine methods in, 195
If/Then/Else statements, 160, 161
IIS (Internet Information Services), 362, 364–365
IIS Authentication, 648
IIS Web sites, 364–365
Image control, 376
Image property, of a picture box, 73
Images
  as background of forms or controls, 77
  dragging and dropping, 550–552
  including on Web pages, 376–378
  switching, 535–537
ImageURL property, 376
Immediate window, 194–195
Immediate Window button, 638
Immutable strings, 630
Impersonation, authorization and, 648–649
Implicit conversions
  not allowed by Option Strict, 126
  of numeric data types, 127–128
Implied operations, 124
Import button, 74
Imports statement, System.IO for, 447
Imports System.XML, 582
In clause of LINQ, 588
In operator, in a LINQ query, 431
Indentation
  in an If statement, 172
  in a With block, 92–93
Index. *See also* Subscript
  of an array, 330
  of items in a collection, 289
Index position, for a new item, 291
Index Results window of Help, 54, 55
Index variable, 300
IndexOf method, 631
IndexOutOfRange exception, 294
Information assurance, 648
Inheritance, 471–472, 491–492, 494–496, 497
Inherited class, 493, 494, 495–496
Inherited controls, 501
Inherited Form template, 499
Inheriting, form classes, 497–501
Inherits clause, modifying, 499
Inherits statement, 491
Initial values, for common dialog boxes, 226
InitialDirectory property, 452
Initializing, two-dimensional arrays, 343
Inline styles, 378, 379
Input, from a file, 440
Input data, validating in ASP.NET, 385
Input fields, validating, 180
Input Mask dialog box, 70
Input text boxes, background of, 132
Input validation, 179–180
Insert method, in String, 631
Insert Snippet menu option, 570, 571
Insert Table dialog box, 373
Insertion point
  deleting from, 644
  in text boxes, 82
Instance, of a class, 4, 470
Instance members. *See* Shared members
Instance variables, 487–489, 503
Instantiating, an object, 470
Int (integer) function, 630
Int16 CLR data type, 112
Int32 data type, 112
Int64 data type, 112
Integer class, 121
Integer data type, 112
  in a constant, 115
  conversion to, 633
Integer division (\) operator, 122
Integer example, 111
Integrated development environment. *See* IDE
IntelliSense
  entering Private, Public, and Dim statements, 116
  list of arguments for newly written procedures, 235
  list of possible object names, 33
  turning off, 117
Interactive Web applications, 388
Interest payment. *See* IPmt function
Interest rate. *See* Rate function
Interface, for a Web page, 593
Interface design, 81
Internal rate of return. *See* IRR function
Internet Explorer, 2
Internet Information Services (IIS). *See* IIS
Interval property, of a Timer component, 537
Intranet, browsers on, 363
Intrinsic constants, 113, 115, 444
InvalidCastException, 139
Invisible control, 387, 535
Invisible label, 387
IPmt (interest payment) function, 626
IRR (internal rate of return) function, 626
Is, in a Select Case statement, 182
IsBalloon property, 86, 87
IsDate function, 634
IsMdiContainer property, 572
IsNot keyword, 454
IsNothing function, 634
IsNumeric function, 634
IsPostBack property, 387
Items, removing from a list, 293–294
Items collection, 289
  belonging to MenuStrip, 216
  defining at design time, 290
  defining in the Properties window, 289
  reading items into, 457
  referencing, 292–293
Items Collection Editor
  of MenuStrip, 216, 217
  opening, 575, 576
Items property, 290
Items.Add method, 289, 290–291
Items.Clear method, 294–295
Items.Count property, 292
Items.Insert method, 289, 291–292
Items.Remove method, 293, 294
Items.RemoveAt method, 293–294
Iteration, 296, 303–304

J

J#, 3
Java, 3, 5
Java applet, 534
Jump to Next Bookmark shortcut, 643
Jump to Previous Bookmark shortcut, 643

K

Key field, 402
Keyboard access keys. *See* Access keys
Keyboard mappings, 200
Keyboard shortcuts
  displaying on ToolTips, 202
  displaying windows using, 638
  setting for menu items, 222
  using when editing code, 643–644
KeyChar property, 569
KeyCode property, 584
KeyData property, 584
KeyEventArgs, 584
KeyPressEventArgs, 569
Keystrokes, 569–570, 649
KeyUp event procedure, 584
Keywords, 112. *See also* Reserved words

L

Label control, 77
Label tool, 19, 20
Labels
  adding new, 40
  AutoSize property, 26
  clearing, 87
  creating, 20–21
  default BackColor of, 133
  displaying output in, 133
  illustrated, 2
  name and text properties for, 23–27
  naming, 51
  selecting, 26–27

Language Integrated Query. *See* LINQ
LargeChange property, 540
LastIndexOf methods, 631
Late binding, 184
Laying out, Web Forms, 373–382
Layout
  options for windows, 574
  using HTML tables for, 373–375
Layout menu, for an HTML table, 374
Layout toolbar, 12
  resizing and aligning controls, 80
  Tab Order button, 84
  using, 641
LayoutMdi method, 574
Leave event, 295
Less than (<) operator, 163
Less than or equal to (<=) operator, 163
Lf constant, 177
Lifetime
  of a variable, 117
  of variables or constants, 268–269, 270
Line and shape controls, 94
Line breaks, 72
Line control, 78
Line numbers, on source code, 47
Line-continuation character, 93
Lines
  creating empty, 644
  cutting to the clipboard, 644
  displaying text on multiple, 71–72
  drawing, 77–78, 531
  printing multiple, 309
  swapping, 644
LINQ (Language Integrated Query), 431, 588
LINQ project, 431–433
LINQ queries, 432, 588–589
LINQ to SQL component, 431
LINQ to XML component, 431
LINQ to XML program examples, 589
List(s)
  clearing, 294–295
  determining the number of items in, 292
  filling, 289
  printing selected items from, 310
  removing items from, 293–294
  searching for a particular value, 298
  selecting records from, 417–423
List boxes
  with arrays, 340–341
  for data entry, 346
  at design time, 289
  Do/Loops with, 298–299
  events, 295
  illustrated, 2
  loading, 457
  printing contents of, 310
  saving the contents of, 456–460
  selecting an entry in, 305
  Text property, 289
  tools for creating, 288
  types of, 288, 289
List changes, saving, 460–465
List control, adding to a form, 288
List data, sorting, 421
List item, retrieving, 293
ListBox controls, 288
Literals, 31, 33
  assigning to a Text property, 69
  printing a left-aligned, 311
Load event, 264
Load method, 585
LoadFile method, 71
Loading, list boxes, 457
Local declarations, 118
Local IIS project location and name, 365
Local variables, 117
  lifetime of, 117
  locations for coding, 119
  passing to called procedures, 230
  showing values of, 198
  in a Web application, 387
Locals window, 198
Lock Controls, selecting, 23, 38, 43
Log method, 629
Logic errors, 49–50
Logical operators, 167–169
Login controls, for Web Forms, 369
Long data type, 112, 115, 633
Lookup operation, for tables, 345–347
Loop control variables, 301–302
Loop index, 299
Loop index variable, 302
LoopIndex, in a For/Next loop, 300
LoopIndexInteger, initializing, 299
Loops, 296
  endless, 302
  exiting, 302–303
  skipping to the next iteration of, 303–304
  terminating, 302
  type of, 296
Lowercase characters
  comparing, 166–167
  String instances converting to, 632

M

M, date formatting character, 624
Main Document window, in the Help window, 55
Main form, 508, 510–511, 513
Main window, 11
Manage Styles window, 379, 380, 381–382
Managed code, 5
Manual style application, 380
Margin settings, for printing, 309
Markup language, 362
Mask property, 70
Masked text boxes, 70, 570
MaskedTextBox control, 70
Mathematical functions, 628–630
Max method, 629
Maximum property, of a scroll bar, 540
MaximumInteger, for a loop index, 299
MaxLength property, of text boxes, 565
.mdb extension, 402
.mdf extension, 402
.mdf file, copying, 424, 425
MDI (multiple document interface), 571–574, 639
Me entry, 198
Me keyword, 32, 478
MeasureString method, 310–311
Me.Close, 263
Members list, of the Object Browser, 507
Memory locations, variables and constants as, 110
Menu bar, 2, 214
Menu Designer, 214
  activating, 215
  adding a ContextMenuStrip component, 226
  creating a submenu in, 218
  rearranging or deleting menu items, 217
Menu items, 214, 218
  coding, 220–222
  creating, 219
  entering, 214–215
  keyboard shortcuts for, 222
Menus, 214
  creating step-by-step, 219–220
  defining, 214–219
  displaying and modifying properties of, 216, 217
  standards for Windows, 222
Menus & Toolbars tab, 214, 227
MenuStrip component, 214–215, 219, 220
MenuStrip control, 573–574
Message(s)
  changing the size and alignment of, 38–39
  displaying, 140–144
Message boxes
  displaying for About boxes, 220
  displaying messages in, 140–144
  enhancing, 175–179
Message lines, creating, 176–177
Message property, 139
Message string, 175–177
MessageBox class, 140, 506
MessageBox object, 140
MessageBoxButtons, 506
  argument, 140
  constants, 177
MessageBoxIcon argument, 140, 141
Method icon, 505
Method Name list, 265
  in the Editor window, 44, 45
  selecting a new event from, 44
Methods, 4
  Abs (absolute value) method, 629
  abstract, 492
  Accessor methods, 475, 476
  Add method, 622, 625
  Atan method, 629
  Class methods, 476–477
  Clear method, 87, 294–295, 531
  Close method, 32, 263, 447, 449
  coding for a class, 481
  Compare method, 630–631
  Cos (cosine) method, 629
  CreateGraphics method, 527
  CurDir method, 586
  determining the return type of, 178
  Dispose method, 531
  DoDragDrop method, 547
  Draw methods, 530
  DrawArc method, 531
  DrawEllipse method, 531
  drawing methods, 530
  DrawLine method, 530, 531
  DrawPie method, 531
  DrawRectangle method, 530, 531
  DrawString method, 307–308, 531
  EndOfData method, 445
  EndsWith method, 631
  Equals method, 631
  Event-handling methods, 30
  executing, 32
  Exp method, 629
  Fill methods, 413, 530
  FillEllipse method, 530, 531
  FillPie method, 531
  FillRectangle method, 531
  Focus method, 87–88, 264
  FromFile method, 534, 535
  Get accessor method, 475, 476
  GetData method, 413, 549
  Graphics methods, 526, 530–532
  Hide method, 263–264
  IndexOf method, 631
  inheriting, 491
  Insert method, 631
  Items.Add method, 289, 290–291
  Items.Clear method, 294–295
  Items.Insert method, 289, 291–292
  Items.Remove method, 293, 294

Methods—*Cont.*
Items.RemoveAt method, 293–294
LastIndexOf method, 631
LayoutMdi method, 574
Load method, 585
LoadFile method, 71
Log method, 629
Max method, 629
MeasureString method, 310–311
Method icon, 505
Method Name list, 44, 45, 265
Min method, 629
Navigate method, 581
New constructor method, 477
Next method, 532
Nonshared methods, 630
of an object, 471
of object-oriented programming, 229
overloaded methods, 140, 141–142
overloading, 472–473
overriding, 472–473, 492, 495
PadLeft method, 631–632
PadRight method, 632
Parse methods, 120–121, 137–138, 143, 625
Peek method, 450
Pow method, 629
Print method, 43, 306
Property accessor methods, 493
ReadAllText method, 441
ReadFields method, 445
ReadLine method, 449, 450
Refresh method, 527
Remove method, 293, 294, 632
RemoveAt method, 293–294
Replace method, 632
Round method, 129, 629
Select method, 472
SelectAll method, 143, 304
Set accessor method, 475, 476
SetBounds method, 537
SetError method, 562
Shared methods, 630
Show method, 140, 141, 142, 178, 224, 262
ShowDialog method, 223–224, 262–263, 311, 503
showing, hiding, and closing forms, 262–264
Sign methods, 629
Sin method, 629
Sleep method, 267
Sqrt method, 629
StartsWith method, 632
Substring method, 632
Subtract method, 623, 625
Tan method, 629
ToDateTime method, 625
ToInt16 method, 128
ToInt32 method, 128
ToInt64 method, 128
ToList method, 431
ToLongDateString method, 577, 623
ToLongTimeString method, 577, 623
ToLower method, 166–167, 632
ToShortDateString method, 577, 623
ToShortTimeString method, 577, 623
ToString method, 121, 130, 132, 623–624
ToUpper method, 166–167, 632
Trim method, 632
TrimEnd method, 632
TrimStart method, 632
Write method, 448
WriteAllText method, 441
WriteLine method, 194, 195, 447, 448–449, 458
Microsoft Academic Alliance, 6
Microsoft Developer Network library. *See* MSDN
Microsoft Expression Studio, 593
Microsoft Intermediate Language (MSIL), 5, 50
Microsoft Knowledge Base, 13, 51
Microsoft.NET Framework. *See* .NET Framework
Microsoft Passport, 648
Microsoft Silverlight, 593
Microsoft SQL Server, 408
Microsoft Visual Basic. *See* Visual Basic (VB)
Microsoft Windows, 2, 3
Microsoft's Visual Studio. *See* Visual Studio
Millisecond property, 534
Min method, 629
Minimum property, 540
Minute property, 622
MIRR (rate of return) function, 626
Mixed-level access, 483
Mod (modulus), 122
Modal forms, 262, 263
Modal windows, 224
Modeless form, 262, 263
Modeless windows, 224
Modes, 14
Modifying, projects, 38–45
Module-level declarations, 118–119
Module-level variables, 117
for class properties, 479
compared to static local variables, 268
declaring as a Color data type, 184
declaring as Friend or Public, 267
declaring for the total, 145
lifetime of, 117
locations for coding, 119
setting the access level of, 268
in Web applications, 387
Modulus (Mod) operator, 122
Monitors, resolution of, 527
Month property, 622
MonthCalendar control, 578, 579
Mouse pointer, 374
MouseDown event, 547
Moving
controls on a form, 21
pictures, 537
Mozilla FireFox, 2, 362
MSDN Help, 13, 51, 52, 488
MSIL (Microsoft Intermediate Language), 5, 50
Multiclass projects, 504
Multidimensional arrays, 341–347
Multiline property, 71
Multiline ToolTips, 85
Multiple controls, selecting, 78–79
Multiple document interface. *See* MDI
Multiplication (*) operator, 122
Multitier applications, 473–474
MustInherit modifier, 497
MustOverride keyword, 492
MustOverride modifier, 497
Mutable strings, 630
My.Computer, 237
My keyword, 75
My.FileSystem object, 432

N

N format specifier code, 130, 131
Name property
changing, 27–28
compared to the Text property, 27
of controls in WPF, 600
of a menu item, 216
of OpenFileDialog, 452
setting for controls, 28
Named constants, 113–114
declaring, 111
using, 270–271
Namespace(s), 23, 269
Namespace icon, 505
Namespace-level declarations, 120
Namespace-level variables, 117, 120
Naming conventions, 51, 112–113
Naming rules, 51, 112
Navigate method, 581
NavigateUrl property, 383, 385
Navigation bar, deleting, 417
Navigation controls, for Web Forms, 369
Negative increment, in a For/Next loop, 301
Nested For/Next loops, 343
Nested If statements, 169–172, 181
Nested parentheses, 123
Nested Try/Catch blocks, 143
.NET 3.5 platform, 591
.NET Common Language Runtime, garbage collection, 491
.NET Framework, 5
downloading, 271
file handling, 447–452
New Connection, selecting, 408, 409
New constructor method, 477
New Inline Style option, 380
New keyword
creating a TextFieldParser object, 444
creating instances of a class, 470
creating objects, 484
instantiating objects, 474
New Project dialog box, 9–11, 16
New Style dialog box, 380–381
New Web Site dialog box, 365, 366
NewLine character, 72, 176
NewLine constants, 176–177
Next method, 532
Next statements, 300–301, 333
Nodes, in an XML file, 586
Nonnumeric data, 180
Nonshared methods, 630
Not equal operator (<>), 163, 454
Not logical operator, 167
Not operator, 222
Nothing keyword, 454, 535
Now property, 577, 622, 623
NPer (number of periods) function, 626
NPV function, 626
N-tier applications, 473
Nudging, controls into place, 641
Null string. *See* Empty string
NullChar constant, 177
Number of periods function, 626
Number format specifier code, 131
Numbers
calculating the sum of, 144
format specifier code for, 130
formatting, 634
random, 532–534
rounding, 129–130
summing, 145
Numeric constants, 114
Numeric data
allowing to be entered, 569
displaying in a Text property, 130
Numeric data types, 120–121, 127–128
Numeric digits, inside a string literal, 114
Numeric variables, comparing to constants, 163–164

O

Object(s), 4, 470–471
Binding Source object, 408
Brush objects, 527, 528
characteristics and behavior of, 474
creating using classes, 484–491
Data file input and output (I/O) objects, 440
Database objects, 405–406

declaring and instantiating, 484
defining and using new, 485–487
DialogResult object, 177
FileSystem object, 432
Font object, 38
Form objects, 263
instantiating, 474
MessageBox object, 140
My.FileSystem object, 432
naming, 51
passing as properties, 503–504
Pen object, 527, 528
planning, 134–135, 146–148, 187–189, 239–240, 273, 274–276, 315–316
PrintDocument objects, 306, 307
Random object, 532
renaming, 645
rules and conventions for, 50–51
Source object, 547–548
StreamReader object, 447, 449–452, 617
StreamWriter object, 447–449
Target object, 547, 548
TextFieldParser object, 443–444, 445
ToolStripButton object, 575
ToolStripStatusLabel objects, 577
XDocument objects, 585–587
XElement objects, 587
XmlWriter object, 591
Object box, 23, 27
Object Browser
in an IDE, 8
opening, 505
using, 504–507
Object Browser button, 638
Object data type, 112
Object model, 4–5
Object names, sample, 51, 52
Object type, converting, 184
Object variable, declaring, 178, 486
Object-oriented languages, 471
Object-oriented programming (OOP), 3–4, 279, 470
Objects list, 505
Odbc, 402
OleDb, 402
OOP. *See* Object-oriented programming
Opacity property, in WPF, 601
Open and Write File program, 455–456
Open dialog box, 74, 75
Open file, checking for, 454–455
Open File dialog box, 453–455
Open Files button, 255, 256
Open menu item, selecting, 454
Open Project, on the Visual Studio File menu, 37
Open Web Site dialog box, 364
OpenFileDialog component, 452, 453, 650
Opening, projects, 37
Operating system data, 431
Operations, order of, 123–124
Option Explicit, 125, 126
Option Strict
On, 115, 125, 126–127
turning off for Windows XP, 601
turning on, 127
Options, changing in the IDE, 640–641
Options dialog box
displaying, 640
state of radio buttons and check boxes, 172, 173
turning off IntelliSense, 117
turning on absolute positioning, 376
Or logical operator, 167
Oracle, 402
ORDER BY button, 425, 426
ORDER BY clause, 421, 422, 426, 427
Order By, in LINQ, 588–589
Order of evaluation, for logical operators, 168
Order of precedence, in arithmetic expressions, 123–124
OrElse operator, 167, 168, 169
OutOfMemoryException, 139
Output
creating multiple lines of, 176–177
to a file, 440
functions for formatting, 634
multiple-page, 313
setting up for the printer, 306
text, gray background of, 132–133
Oval shape, drawing, 531
Overloaded methods, 140, 141–142
Overloading, 141, 472–473, 477
Overridable keyword, 492
Overrides keyword, 492, 495
Overriding, 472–473, 492

P

P format specifier code, 131
PadLeft method, 631–632
PadRight method, 632
Page(s)
printing multiple, 313–314
setting up to print, 308
Page counter, 314
Page styles, 378
Page_Load event, 371, 387
Paint event, 264
Paint event procedure, 527
Parameterized constructors, 477
Parameterized query, 428
Parent class, 471
Parent form, 571–572, 573–574
Parentheses
after a method name, 32, 46
nested, 123
Parse methods
of Date, 625
failing, 137–138
testing individually, 143
using, 120–121
Pascal, 5
Pascal casing, for naming controls, 51
Payment. *See* Pmt function
Payment function, 626
PDAs (personal digital assistants), 362
Peek method, 450
Pen class, 528
Pen object, drawing lines or outlined shapes, 527, 528
Percent format specifier code, 131
Percents, 634
PERL, 5
Permission, required, 268
Permission classes, 650
Personal digital assistants (PDAs), 362
Phone icons, 535–537
Picture boxes, 2, 73–76
Picture elements. *See* Pixels
PictureBox control, 73
AllowDrop property of, 550
displaying an animated .gif, 534
placing a graphic image in, 526
Pictures, 534–537
Pie chart, 552–557
Pixels, 307, 311, 527
Playing
sounds, 543–545
videos, 545–546
Pmt (payment) function, 626–627
Point structure, X and Y coordinates as a single unit, 529
Polymorphism, 472–473
Postback, 423
checking for, 387–388
server response to, 386
Posttest loop, 296, 297
Pound sign (#), preceding a CSS style name, 379
Pow method, 629
PowerPack, downloading, 93
PPmt (principal payment) function, 626
Predefined masks, 570
Present value functions, 626
Presentation tier, 473
Pretest loop, 296, 297
Principal payment. *See* PPmt function
Print button, 308
Print element, on the graphics page, 307
Print method, 43, 306
Print operation, 306
Print output, setting up, 306–307
Print preview, displaying, 311–312
Print Preview button, 312
PrintAction property, 43
PrintDocument component, 306, 311
PrintDocument objects, 306, 307
Printer, sending information to, 305–314
Printer reports, 305
PrintForm component, 41–42
Printing
code, 45–46
contents of a list box, 310
multiple lines, 309
multiple pages, 313–314
selected items from a list, 310
step-by-step, 308–309
summary of steps, 310
two-dimensional tables, 343
PrintPage event, 313
PrintPage event handler, 308
PrintPage event procedure, 306, 310
PrintPageEventArgs argument, 307, 309
PrintPreviewDialog component, 311, 312
Private keyword, 268, 471
declaring an array, 331
declaring variables and constants, 270
for methods, 481
methods declared with, 476–477
for module-level variables, 118
Private variables, 475, 478–479
Procedural languages, 3
Procedure header, 233
Procedures, 29. *See also* General procedures
converting to function procedures, 234
jumping to, 644
passing arguments to, 230–231
planning, 273–274
referring to as methods, 30
sharing, 228
types of, 230
Professional Edition
of Visual Basic, 5, 6
of Visual Studio, 8
Program execution, 196, 197
Program lines, continuing long, 93
Program output, controls for, 132–133
Programming
approaches to, 3–4
good habits, 100
Programming errors. *See* Error(s)
Programming languages
.NET versions of, 5
types of, 3–4

Programs
ending, 32
running outside the IDE, 271–272
Project(s)
adding existing class files to, 504
adding form files to, 256
adding forms to, 254
basing new on existing, 237–238
closing, 37
copying and moving, 646
debugging, 50, 193–198
form files in, 7
managing multiclass, 504
modifying, 38–45
naming, 16
opening, 9, 16–17, 37
planning, 18–19
removing forms from, 256
renaming, 646
running, 35–36
sample in Visual Studio, 571
saving and running, 43
variables and constants in multiform, 267–271
writing, 14–45
Project Designer
changing a project's root namespace in, 269
changing the Assembly Name entry, 238
opening, 76, 257–258, 259
Resources tab, 76, 543
selecting a different icon for a project, 272
Project files, opening, 37
Project menu, 254, 256
Project user option file, 8
Properties, 4
AcceptButton property, 82
accessing, 493
adding to any form, 501
Alignment property, 39
AllowDrop property, 548, 550
assigning values to, 31
AutoSize property, 21, 26, 77, 133
BackColor property, 81, 86, 87, 90–91
BackgroundImage property, 77
BackgroundImageLayout property, 77
BackStyle property, 95
BgColor property, 368
BorderColor property, 94, 95
BorderStyle property, 77, 79, 94, 95, 133
BorderWidth property, 94, 95
CancelButton property, 82
changing for forms, 28
changing from default, 39
changing multiple for a control, 92–93
CharacterCasing property, 565
Checked property, 73, 88, 221–222
CheckFileExists property, 452
CheckPathExists property, 452
class, 478–479
Color property, 224
ContextMenu property, 227
ContextMenuStrip property, 226
for controls, 68
Count property, 292
creating in classes, 475–476
Date property, 622
Day property, 622
DayOfWeek property, 622
DayOfYear property, 622
deleting, 27
DetectUrl property, 71
DocumentTitle property, 582
DropDownStyle property, 288
Enabled property, 89, 220–221, 537–538
EnableViewState property, 386, 387
ErrorMessage property, 385
FileName property, 452
Filter property, 452, 453
Font property, 38, 225
ForeColor property, 86, 87, 90–91
Handled property, 569
HasMorePages property, 313
HeaderText property, 411
Hour property, 622
ID property, 368
Image property, 73
ImageUrl property, 376
inheriting, 491
InitialDirectory property, 452
Instance properties, 503
Interval property, 537
IsBalloon property, 86, 87
IsMdiContainer property, 572
IsPostBack property, 387
Items property, 290
Items.Count property, 292
KeyChar property, 569
KeyCode property, 584
KeyData property, 584
LargeChange property, 540
Mask property, 70
Maximum property, 540
MaxLength property, 565
MdiWindowListItem property, 573, 574
Message property, 139
Millisecond property, 534
Minimum property, 540
Minute property, 622
Month property, 622
Multiline property, 71
Name property, 27–28, 216, 452, 600
NavigateUrl property, 383, 385
Now property, 577, 622, 623
of an object, 470
Opacity property, 601
passing between forms, 501–504
passing objects as, 503–504
planning, 134–135, 187–189, 273, 274–276, 315–316
planning during form design, 6
planning for a project, 146–148, 239–240
PrintAction property, 43
read-only properties, 476
ReadOnly property, 133, 503
for scroll bars, 539–540
Second property, 622
SelectedIndex property, 292, 305, 340, 341
setting, 7, 23–29, 79, 89–90
Shared properties, 488, 489
ShortcutKeys property, 222
ShowShortcutKeys property, 222
Size property, 529
SizeMode property, 75
SmallChange property, 540
Sorted property, 291, 421
sorting in alphabetic order, 23
Source property, 139
StackTrace property, 139
StartPosition property, 28, 84
TabIndex property, 83, 84
TabStop property, 83, 133
Text property, 25–26, 27, 28, 33, 40, 69, 72, 73, 77, 87, 124, 215–216, 289, 310, 577
TextAlign property, 39, 69
TextFieldType property, 444
Title property, 368, 452
Today property, 623
ToolTipIcon property, 86, 87
Url property, 545–546, 581
Value property, 540, 578
viewing the contents of, 200–201
Visible property, 75, 89, 263, 499, 535
WordWrap property, 71
write-only properties, 476
Year property, 623
Properties button
in the Properties window, 73, 74, 266
in the TextAlign property, 39
Properties window, 13, 17
changing the Text property, 216
displaying, 23
Items property, 290
setting the Checked property, 221
showing a file's properties, 29
viewing, 366, 367
Properties Window button, 638
Properties window in Designer, 266
Property accessor methods, 493
Property icon, 505
Property procedures, 475–476
adding for a class, 479–480
of a class, 474
with mixed access levels, 483
Property settings, planning, 57–58
Proportional fonts, 310
Protected keyword, 471, 481, 491
Protected variables, 475
Pseudocode, 6
Public keyword, 268, 471
declaring an array, 331
declaring variables, 475
declaring variables and constants, 270
for methods, 481
methods declared with, 477
for module-level variables, 118
Publish Wizard, 646
Pushpin AutoHide icon, 17, 18, 636, 637
PV (present value) function, 626

Q

Query Builder window, 421, 422
Querying, users to save, 459
Quotation marks, 31, 114
Quote constant, 177

R

Radio button group, 174–175
Radio buttons, 2, 73
Checked property of, 88
disabling, 89
groups of, 73
If statements with, 172–175
selecting colors using, 90–92
setting access keys for, 82
in the tab sequence, 83
testing the state of, 174
Random class, 532
Random numbers, 532–534
Random object, seeding, 532
Range of values, 179
RangeValidator control, 385, 386
Rate function, 626, 627–628
ReadAllText method, 441
ReadFields method, 445
Reading
delimited files, 443–444
from a file, 440
ReadLine method, 449, 450
Read-only properties, 476

ReadOnly modifier, 476
ReadOnly property, 133, 503
Recent Projects menu item, 37
Records
in data tables, 402
selecting from a list, 417–423
selecting using Web forms, 423–430
Rectangle, 530, 531
Red line, 642
ReDim statement, 334
Refactoring, 645
Referencing, the Items collection, 292–293
Refresh button, 424, 443, 444
Refresh method, 527
Regional setting, default format, 130
Regular Expression Editor, 386
Reinitializing, arrays, 343
Relational database files. *See* Database files
Relational databases, 402
Relational operators, 163
Relationships, between data tables, 402
Remainder, of a division operation, 122
Remark statements, 30–31
Remarks
adding, 43–44, 482
displaying in green, 33
Remote sites, 365
Remove method, 293, 294, 632
RemoveAt method, 293–294
Removing, forms, 256
Rename command, 238
Rename dialog box, 645
Rename feature, 116
Renaming, variables and objects, 645
Replace method, 632
Required field, checking for, 179–180
RequiredFieldValidator control, 385, 386
Reserved words, 112. *See also* Keywords
Resetting, the focus, 87–88
Resizing
controls, 21
handles, 21, 78, 79
Resource file, for a form, 8
Resources, adding and removing, 76
Resources tab, 76, 543
Responding, to form events, 264
.resx file, 8
Return functions, 626
Return statement, 232, 233
Return value, 229, 232
Reusability, 472
Reusable classes, 473
RichTextBox control, 71
Rnd (random number) function, 630
RnrBooks.mdf file, 407, 424, 425, 434–435
Role-based permission type, 650
Root namespace, 269
Round method, 129, 629
Rounding, numbers, 128, 129–130
Rows, 341, 374, 402
RPG, 5
.rtf file, 71
Run time, 14
controlling pictures at, 534–537
determining the type at, 184
setting visibility at, 88–89
Run-time errors, 49, 203–204

S

Sample projects, in Visual Studio, 571
Sans serif font, 81
Save All menu command, 43
Save All option, 37
Save All toolbar button, 36, 43
Save As command, 238
Save button, 442
SaveAs dialog box, 455
SaveButton_Click event procedure, 442
Saved projects, 37
SaveFileDialog component, 455
Saving
files, 458–459
work, 36–37
Schema file
for a database, 412–413
in XML, 404
Scope, 117, 267–268
Screen
setting a form's location on, 84–85
splitting vertically, 640
Screen layout, modifying, 639
Script, in Web pages, 363
ScriptManager component, for AJAX, 388, 389
Scroll bar controls, 539–542
Scroll bars
automatically added, 288
events, 541
properties of, 539–540
Scroll box, 540
Scroll event, 541
SDI (single document interface), 571
Second property, 622
Secure code, writing, 649
Security, 424, 648–650
Seeding, 532
Select All option, 78
Select Case statement, 181–182
SELECT command, modifying, 421
Select Image dialog box, 376, 377
Select method, 472
Select operator, in LINQ, 431
Select Resource dialog box, 73
Select Url dialog box, 383, 384, 385
SelectAll method, 143, 304
SelectColor, 234
SelectedIndex property
determining an array subscript, 340, 341
of a list box, 292
setting, 305
Selection box, 78
Selection parameter, 428, 429
Selection program, Web version of, 424
Sender argument, 184
Separator bars, in menus, 218, 219
Sequential logic, not followed in OOP, 4
Session variables, 387
Set accessor method, 475, 476
SetBounds method, 537
SetError method, 562
Settings box, 25
Setup.exe application, 646
Shape controls, 95
Shapes, interiors of, 95
Shared keyword, 488, 489
Shared members, 487–488
creating, 488–489
of the DateTime structure, 622
Shared methods, 630
Shared modifier, 490
Shared properties, 488, 489
Shared variables, 487–489
Sharing, procedures, 228
Shift + Alt + Enter, 638
Shift + Alt + F10, 48
Shift + F1, 55, 645
Shift + F7, 368
Shift + F8, 197
Shipping rate table, 345
Short data type, 112, 633
Short-circuit operations, 169
Shortcut menus, 226
ShortcutKeys property, 222
Show All Files button, 443, 444
Show Data Sources, 413
Show method
calling, 140
displaying a modeless window, 224
displaying modeless forms, 262
of the MessageBox object, 140
overloading, 141
returning an object, 178
signatures for, 142
ShowDialog method
displaying a dialog box, 223–224
displaying a form, 503
displaying modal forms, 262–263
executing, 311
ShowShortcutKeys property, 222
Siblings, in an XML file, 585, 586
Sign methods, 629
Signatures, 141, 142
Simple combo boxes, 288, 289
Simple Delimited File Read program, 445–446
Simple Delimited File Write program, 443
Simple list boxes, 288, 289
Simple Object Access Protocol (SOAP), 390
Sin method, 629
Single data type, 112, 115, 633
Single document interface (SDI), 571
Single-dimension arrays, 330–332
Single-file model, 366
Single-stepping, 487
Size property, 529
Size structure, 529
SizeF structure, 310–311
SizeMode property, 75
Sizing handle. *See* Handles
Sleep method, 267
SLN (straight line) function, 626, 628
.sln file(s), 37, 365, 389
SmallChange property, 540
Smart tags, 76–77, 407, 412
Snap lines, 21, 641–642
SOAP (Simple Object Access Protocol), 390
Solution (.sln) file, 7, 37
Solution Explorer, 238, 646
Solution Explorer button, 638
Solution Explorer window, 13, 17, 255, 256
Solutions. *See also* Applications
naming, 13
primary file for, 7
renaming, 646
Sorted list, 292
Sorted property, 291, 421
Sorting, list data, 421
Sounds, playing, 543–545
Source object, 547–548
Source property, 139
Source tab, 369
Spacing, between controls, 80
Splash screen, 260, 261
display, 267
drop-down list, 261
form, 276, 277
template, 260–261
Split bar, in the Editor window, 644–645
Split tab, on a Web Form, 369
SQL, 425, 649
SQL Server Express (SSE), 402, 405, 408
SQLClient, 402
Sqrt method, 629
StackTrace property, 139

Standard (ASP.NET server controls), for Web Forms, 369
Standard Edition, of Visual Basic, 5
Standard section, of the toolbox, 370
Standard toolbar, 12, 194, 638
Standards, followed by programmers, 51
Start Debugging button, 35, 50
Start Page, 9, 10
  contents of, 9
  displaying, 16
Start without Debugging option, 369, 371
StartPosition property, 28, 84
StartsWith method, 632
Startup form, 254
State(s)
  of a Boolean variable, 298
  maintaining for Web pages, 386–389
Stateless, Web pages as, 363
Statement terminator, 162
Statements
  Assignment statements, 31–32, 33, 124
  Call statement, 185–186
  Case statement, 182
  Code statements, 30–32
  Const statement, 114, 118
  Continue statement, 303
  Declaration statements, 111, 115–117, 331, 342–343
  Dim statements, 115, 118, 342
  Do and Loop statements, 296–298
  Each/Next statements, 332–333
  End Sub statement, 229
  Exit Do statement, 302–303
  Exit For statement, 333
  Exit statement, 302–303
  Finally statement, 138
  For/Next loop, 299–300
  Function...End Function statements, 232
  If statements, 160–163, 169–172, 174–175, 179, 195
  If/Then/Else statements, 160, 161
  If statements, nested, 169–172, 181
  Imports statement, 447
  Inherits statement, 491
  Next statements, 300–301, 333
  ReDim statement, 334
  Remark statements, 30–31
  Return statement, 232, 233
  Select Case statement, 181–182
  Static statement, 268–269
  Structure and End Structure statements, 333–334
  Sub...End Sub statements, 229–230
  With and End With statements, 92–93
  With statement, 294
StateTextBox, 565
Static data, 386
Static keyword, 270
Static local variable, 314
Static statement, 268–269
Static variables, 268–269. *See also* Shared members
Status bars, 575, 577–578
StatusStrip control, 577
Step increment, 301
Step Into (F8), 201
Step Into button, 201
Step Into command, 197
Step Over command, 197
Step word, in a For/Next loop, 300
Stepping, through code, 196–197
Stop Debugging button, 202
Stop Debugging option, 197
Straight line function. *See* SLN function
StreamReader object, 447
  declaration for, 617
  declaring and instantiating, 449–450
  reading data from a file using, 449–452
Streams, 447
StreamWriter object, 447–449
String(s)
  comparing, 164–166
  converting to a numeric data type, 120–121
  injecting code into, 649
  methods for working with, 630–632
  reading or writing single, 441
String characters, 164
String class, 630
String Collection Editor, 290
String constants. *See* String literals
String data type, 111, 112, 633
String literals, 114
String value, 121, 182
String variables, 164
StringBuilder class, 630
Strongly typed languages, 126
Structured Query Language. *See* SQL
Structures, 333–335, 337
Style Application toolbar, 380
Style code, 380
Style rules, 379
Style tools, 379
Styles
  applying, 382
  defining, 378, 380–381
  managing, 381–382
  modifying, 382
  types of, 379–380
  using, 378–379
Sub procedures, 29, 229–230, 231
Sub...End Sub statements, 229–230
Subclass, 471
Submenus, of menu items, 218
Subprograms. *See* Sub procedures
Subroutines. *See* Sub procedures
Subscript, 330–331, 338
Subscripted variables. *See* Arrays
Substring methods, 632
Subtract method, 623, 625
Subtraction (-) operator, 122
Summary form
  completed, 513
  passing values to, 501–503
  planning, 508, 512
Summing
  numbers, 145
  two-dimensional tables, 344
Sum-of-the-years' digits function. *See* SYD function
Sums, 144–145
.suo files, 365, 389
Superclass, 471
Swapping, characters, 644
Switches. *See* Boolean variable
Switching, images, 535–537
SYD (sum-of-the-years' digits) function, 626, 628
Symbol Rename, 645
Syntax errors, 46–49
System date and time, 623–624
SystemException class, 138
System.IO namespace, 447
System.IO.EndOfStreamException, 139
System.Math class, 628

T

Tab constant, 177
Tab order, 82–84, 100
TabIndex property, 83, 84
Table(s). *See also* Arrays; Data tables
  lookup in large, 340
  summing two-dimensional, 344
Table adapters, 405, 406
Table lookup
  of array elements, 337–340
  coding, 338, 340
  in two-dimensional tables, 345–347
  UML action, diagram of, 339
TableAdapter
  in the component tray, 410, 411
  for a table, 413
TabStop property
  of controls, 83
  of a text box, 133
Tabular data, subscripts identifying, 341
Tags, in XML, 403–404, 585
Tan method, 629
Target object, 547, 548
Team System Edition, 5, 6
Templates, selecting, 254
Terminating, loops, 302
Text
  changing the color of, 90
  concatenating, 93
  copying or moving, 645
  displaying on multiple lines, 71–72
  drawing a string of, 531
  entering in an HTML table, 374
  flowing to multiple lines in a label, 26
  in an XML file, 586
TextBox control, 69
Text boxes, 69–71
  adding contents of, 291
  automatic context menu of, 227
  changing widths of, 416
  CharacterCasing property, 565
  clearing, 87
  creating access keys for, 83
  for data entry, 346–347
  default background color of, 133
  form with data-bound, 413, 414
  illustrated, 2
  MaxLength property, 565
  for output, 133
  product of, 110
  returning the focus to, 566
  selecting the entry in, 304
  user inputting data into, 447
Text Editor, 641
Text Editor toolbar, 12, 638, 643
Text files, 441
Text property
  assigning a literal to, 33
  assigning the result of a calculation to, 124
  changing a label's, 40
  of a check box, 73
  of combo boxes and list boxes, 289
  of a control, 25–26, 27
  deleting the value for, 26
  of a form, 28
  of a group box, 72
  of labels, 77, 577
  for a menu item, 215–216
  of a multiline text box, 72
  printing selected items, 310
  of a radio button, 73
  setting to String.Empty, 87
  of a text box, 69
Text Web site, icon files, 103
TextAlign property, 39, 69
TextBox control
  adding to a Web application, 368
  deleting, 418
  as a type of menu item, 218, 219
TextChanged event, 295
TextChanged event procedure, 305

TextFieldParser object, 443–444, 445
TextFieldType property, 444
TextMessage string, 140, 141
Then clause in If/Then/Else, 161
"There were build errors. Continue?" message, 50
Threading, 267
Threads, 267
Three-axis model, 587, 588
Three-step process, 6, 7
Three-tier applications, 473
Throwing, exceptions, 138
Thumb, 540
Tick event, 537
TileHorizontal constant, 574
TileVertical constant, 574
Time(s), 577–578, 623–624, 634
Timer component, 537–539
TimeSpan class, 625
Title bar, 28
Title property
  of OpenFileDialog, 452
  for a Web Form, 368
Titlebar text, 140, 141
ToDateTime method, 625
Today property, 623
Toggle Bookmark on Current Line shortcut, 643
ToInt16 method, 128
ToInt32 method, 128
ToInt64 method, 128
ToList method, 431
ToLongDateString method, 577, 623
ToLongTimeString method, 577, 623
ToLower method, 166–167, 632
Tool windows, 11, 639
Toolbar buttons, 12, 505
Toolbars, 12, 575–578
Toolbox, 13, 14
  adding controls to, 94
  Common Controls tab, 68
  Containers tab, 68
  dragging code to, 645
  Printing tab, 305
  scroll bar tools, 540
  tool for the Timer component, 538
  ToolStrip and StatusStrip controls, 575
  Web Browser control, 581
  for WPF applications, 599
Toolbox button, 638
Toolbox icon, 17
Toolbox tools, 288
Toolbox window, 17, 18
ToolStrip control, 575, 577, 581
ToolStripButton object, 575
ToolStripButton_Click event procedure, 582
ToolStripButton.Click event, 577
ToolStripComboBox_KeyUp event procedure, 582
ToolStripMenuItem, 215
ToolStripStatusLabel objects, 577
ToolTip component, 85
ToolTip on ToolTip1 property, 85, 86
ToolTip tool, 85
ToolTipIcon property, 86, 87
ToolTips
  adding in WPF, 601
  creating, 85–87
  defining, 85, 86
  modifying the appearance of, 86
ToShortDateString method, 577, 623
ToShortTimeString method, 577, 623
ToString method, 121, 130
  formatted value returned by, 132
  formatting codes, 131
  formatting dates and times with, 623–624
Total accumulators, using array elements as, 335
TotalInteger array element, 336
Totals
  adding to correct, 335–336
  modifying code to calculate, 489–490
ToUpper method, 166–167, 632
Tree structure, of an XML file, 585
Trim method, 632
TrimEnd method, 632
TrimStart method, 632
True, testing for, 166
Try/Catch blocks, 138–139
  inside procedures, 484
  nested, 143–144
  StreamWriter declaration in, 617
Two-dimensional arrays, 342–343, 344, 345–347
Type inference, 431
Type-declaration characters, 114

U

UML action diagrams, 160, 162
  of For/Next loop logic, 300
  of Inherited class, 493, 494
  of lookup logic, 338, 339
  of pretest and posttest loops, 297
UML specification, 162
Uncomment Selected Lines, 204, 643
Unformatted string, 130
Unicode, 164
Uniform Modeling Language (UML) activity diagram. *See* UML action diagrams
Uniform Resource Identifier (URI), 582
Uniform resource locator. *See* URL
Unlocking, controls, 23
Unsigned Integer data type, 633
Unsigned Long data type, 633
Unsigned Short data type, 633
UpdatePanel control, for AJAX, 388, 389
Uppercase characters
  comparing, 166–167
  converting String instances to, 632
  converting user-entered characters into, 565
URI (Uniform Resource Identifier), 582
URL (Uniform Resource Locator), 363
URL addresses, 71
Url property, of the WebBrowser control, 581
URL property, of Windows Media Player control, 545–546
User actions
  causing events, 29
  setting properties based on, 89–90
User interface
  creating for a Web application, 368
  defining, 7, 19–23
  designing, 2, 6, 18–19, 80–81
  designing a form for, 485
  planning, 6
Users
  capturing keystrokes from, 569–570
  querying to save, 459
  signing off on planned forms, 56
Using block, 313
Utility programs, 305

V

Validating event, 566
Validating event procedure, 566
Validation(s), 179
  advanced techniques, 562–571
  field-level, 566–570
  performing multiple, 180
  during table lookup, 340
  using a masked text box for, 570
Validation controls, for Web Forms, 369
Validation example program, 567–569
ValidationSummary control, 386
Validator controls, 385–386
Validity, checking, 179, 633–634
Value keyword, 475
Value property
  of DateTimePicker, 578
  of a scroll bar, 540
ValueChanged event, 541
Values
  assigning to constants, 114–115
  checking current in an expression, 196
  checking the reasonableness of, 179
Variable icon, 505
Variables, 110
  assigning values to, 31
  in a class, 474
  declaration summary for, 270
  declaring, 115–117, 334, 475
  declaring the scope of, 117
  guidelines for declaring, 270–271
  keeping a series of, 330
  keeping scope as narrow as possible, 271
  in multiform projects, 267–271
  naming conventions, 112–113
  naming rules, 112
  renaming, 645
  retaining the values of, 387–388
  scope and lifetime of, 117–120
  testing a single for multiple values, 181
  viewing the contents of, 196, 200–201
VB code. *See* Code
.vb file, 7
VB intrinsic constants. *See* Intrinsic constants
VB projects. *See* Project(s)
vbCrLf intrinsic constant, 442
.vbproj.user file, 8
Vertical scroll bar tool, 540
Vertical scroll bars, 539, 541
Vertical spacing, standardizing, 642
VerticalTab constant, 177
Videos, playing, 545–546
View Code button, 37
View Designer button, 37, 368, 384
View menu, 11
Visibility, 88–89, 117
Visible property
  changing based on user actions, 89
  changing to True at run time, 535
  of a form, 499
  of a PictureBox control, 75
  setting to False for a form, 263
Visual Basic (VB), 3
  ASP.NET and, 363
  data types, 112
  designed with graphical user interfaces, 2
  editions of, 5–6
  modes of, 14
  modified to accommodate OOP, 470
  in Visual Studio 2008, 5–6
Visual Basic Development Settings, 16
Visual Basic PowerPacks, 42, 93–94
Visual inheritance, 497, 498
Visual separation, for input and output fields, 100
Visual Studio, 5–6
  data access in, 405–406
  Data Sources window, 405
  environment, 8–14
  Help facility, 51
  programming languages as object oriented, 3
  running, 15–16
  smart editor helping the entering of arguments, 142

Visual Studio IDE, *See also* IDE
Start Page, 9, 10
Web Forms in, 366–367
Visual Studio Menu Designer. *See* Menu Designer
Visual Studio Web server, 362
Visual Web Developer (VWD), 2, 3
VisualBasicPowerPacks3Setup.exe file, 93
VScrollBar control, 539

W

Wave files (.wav), 543, 544
Web
acronyms, 390
writing database programs for, 423
Web applications. *See also* Web site(s)
creating, 365–372
database security in, 424
debugging, 371–372
files in, 371
making portable, 429–430
requiring a server and a client, 362
running, 2, 369, 371–372, 429
testing in browsers, 372
Web clients, 362–363
Web controls, event handling for, 370–371
Web documents. *See* Web Forms
Web Forms, 362
adding to Web sites, 384
controls available for, 369–370
creating, 367–369
creating programs, 2, 3
displaying graphics files on, 526
Help topics for, 54
laying out, 373–382
pieces of, 363
selecting records using, 423–430
in the Visual Studio IDE, 366–367
Web pages, 363
adding a second, 383–385
adding an HTML table to, 373
in a client/server environment, 423
creating, 593
creating animation on, 534
displaying, 581–584
elements inserted into table cells, 378
files, 365–366
including images on, 376–378
navigating, 383–385
placing controls, 375–376
Web projects, managing, 389–390
Web Selection application, 424–430
Web server controls, 377, 615
Web servers, 362
Web Service, 390
Web Services Description Language (WSDL), 390
Web site(s). *See also* Web applications
beginning new, 424–425
copying from one location to another, 390
creating, 365–372
file system, 364
IIS, 364–365
for this book, 75
types of, 364–365
Web version, of a list selection program, 423
Web-based database applications, 423
WebBrowser control, 581–582
WebBrowser program, 582–583
Web.config file
debugging line in, 371–372
modifying, 430
settings determining authentication, 648
WebParts controls, 369
Week, checking for the day of, 625
Where, used in LINQ, 588–589
White tab, dragging controls with, 376
White-space characters, 632
Window menu, adding, 573–574
Windows
closing, 55, 637
closing or hiding extra, 636–638
creating, 2
cycling through, 638
displaying, 638
hiding and displaying, 636–637
managing, 55–56
modal versus modeless, 224
opening temporarily, 637
standards for menus, 222
switching to another, 55
Windows applications, 81
Windows database application. *See* Database applications
Windows Explorer, copying project folders, 646
Windows Form template, 254
Windows Forms
designed with graphical user interfaces, 2
displaying a graphics file on, 526
displaying Web pages on, 581
Help topics for, 54
Windows Forms Application template, 9–11
Windows Installer, 646
Windows Media Player control, 545–546
Windows Presentation Foundation. *See* WPF
Windows project folders, copying, 237
Windows Vista
default date or time value, 132
displaying file extensions, 8
setting to show underlined shortcuts, 82
using WPF technology, 593
Windows XP
displaying file extensions, 8
turning off Option Strict, 601
WindowToolStripMenuItem, 574
With and End With statements, 92–93
With block, 92–93
With statement, 294
Words, swapping, 644
WordWrap property, 71
Work, saving, 36–37
Workspace, customizing, 14–17
World Wide Web Consortium (W3C) site, 362
WPF (Windows Presentation Foundation), 2, 593–596
application template, 593, 594
applications, writing, 597–599
WPF Browser Applications template, 593, 594
WPF Components tab, 595
WPF controls, 593, 597
WPF Expander control, 597
WPF Hello World application, 599–601
WPF Interoperability section, 593, 594
WPF window, 598
Write method, 448
WriteAllText method, 441
WriteLine method(s)
placing in If statements, 195
planning in code, 194
saving a file with, 458
of StreamWriter, 447, 448–449
Write-only properties, 476
WSDL (Web Services Description Language), 390

X

X and Y coordinates, 529
setting, 309, 343
specifying for print elements, 307
XAML (Extensible Application Markup Language), 593
XAML code, 601
XAML screen, 597, 598
XDocument objects, 585–587
XElement objects, 587
XHTML, 362
XML (Extensible Markup Language), 390, 403–404
XML data files, 584–592
XML elements, 587–588
XML files
loading into XElement objects, 587
reading, 585–587
terminology and structure of, 584–585
VB tools for reading, 585–592
writing and reading, 591
XML literals, 587
XML standard, 403
XmlWriter object, 591
Xor logical operator, 167, 168
.xsd file, 404, 405, 412–413

Y

y, date formatting character, 624
Y coordinate, 307, 309
Year property, 623
YesNo constant, 177, 178

Z

Zero-based index, 289
Zero-based subscripts, for arrays, 331
Zero-length string. *See* Empty string
ZIP code, mask for, 70