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Sams Teach Yourself Microsoft® Visual C#™ .NET in 24 Hours

By [James Foxall](#)

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Publisher: Sams Publishing
Pub Date: August 20, 2003
ISBN: 0-672-32538-1
Pages: 600

In just 24 lessons of one hour or less, you will be creating your own Windows applications using the power and functionality of Visual C# .NET. Using a straightforward, step-by-step approach, each lesson builds on the previous ones, enabling you to learn the essentials of Visual C# .NET from the ground up.

Step-by-step instructions walk you through the most common Visual C# .NET tasks while questions and answers, quizzes, and exercises at the end of each hour help you test your knowledge. Notes and tips point out shortcuts and solutions and help steer you clear of potential problems.

You will learn...

- The basics of Visual C# and then quickly begin applying your knowledge to real-world Windows programming tasks.
- Important features such as building forms, working with controls, looping, debugging, and working with data in the world of .NET.
- Tips that ease migration from Visual C++ and Visual Basic 6 to Visual c# .NET 2003.

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James Foxall:

To me, cause I wrote the darn thing.

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About the Author

James Foxall is vice president of development and support for Tigerpaw Software, Inc. (www.tigerpawsoftware.com)—a Microsoft Certified Partner in Omaha, Nebraska, specializing in commercial database applications. James manages the Tigerpaw Business Suite, an award-winning CRM product designed to automate contact management, marketing, service and repair, proposal generation, inventory control, and purchasing. James's experience in creating certified Office-compatible software has made him an authority on application interface and behavior standards of applications for the Microsoft Windows and Microsoft Office environments.

James has personally written more than 200,000 lines of commercial production code in both single-programmer and multiple-programmer environments. He is the author of numerous books, including *Sams Teach Yourself C# in 24 Hours* and *Practical Standards for Microsoft Visual Basic .NET*, and he has written articles for *Access-Office-VBA Advisor* and *Visual Basic Programmer's Journal*. James has a bachelor's degree in management of information systems (MIS), is a Microsoft Certified Solution Developer, and is an international speaker on Microsoft Visual Basic. When not programming or writing about programming, he enjoys spending time with his family, playing guitar, doing battle over the chess board, listening to Pink Floyd, playing computer games (Raven Shield multiplayer), and (believe it or not) programming! You can reach James at www.jamesfoxall.com/forums.

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We Want to Hear from You!

As the reader of this book, *you* are our most important critic and commentator. We value your opinion and want to know what we're doing right, what we could do better, what areas you'd like to see us publish in, and any other words of wisdom you're willing to pass our way.

As an associate publisher for Sams Publishing, I welcome your comments. You can email or write me directly to let me know what you did or didn't like about this book—as well as what we can do to make our books better.

Please note that I cannot help you with technical problems related to the topic of this book. We do have a User Services group, however, where I will forward specific technical questions related to the book.

When you write, please be sure to include this book's title and author as well as your name, email address, and phone number. I will carefully review your comments and share them with the author and editors who worked on the book.

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Introduction

With Microsoft's introduction of the .NET platform, a new, exciting programming language was born. Visual C# .NET is the language of choice for developing on the .NET platform, and Microsoft has even written a majority of the .NET Framework using Visual C# .NET. Visual C# .NET is a modern object-oriented language designed and developed from the ground up with a best-of-breed mentality, implementing and expanding on the best features and functions found in other languages. Visual C# .NET combines the power and flexibility of C++ with the simplicity of Visual Basic.

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Who Should Read This Book

This book is targeted toward those who have little or no programming experience. The book has been structured and written with a purpose, and that is to get you productive as quickly and as smoothly as possible. I've used my experience in writing large commercial applications to create a book that, hopefully, cuts through the fluff and teaches you *what* you need to know. All too often, authors fall into the trap of focusing on the technology rather than on the practical application of the technology. I've worked hard to keep this book focused on teaching you practical skills that you can apply immediately toward a development project. Please feel free to post your suggestions at www.jamesfoxall.com/forums.

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How This Book Is Organized

This book is divided into five parts, each of which focuses on a different aspect of developing applications with Visual C# .NET. These parts generally follow the flow of tasks you'll perform as you begin creating your own programs using Visual C# .NET. I recommend that you read them in the order in which they appear.

- **Part I** *The Visual Studio .NET Environment* teaches you about the Visual Studio .NET development environment, including how to navigate and access numerous tools. In addition, you'll learn some key development concepts such as objects, collections, and events.
- **Part II** *Building a User Interface* shows you how to build attractive and functional user interfaces. In this part, you'll learn about forms and controls—the user-interface elements such as text boxes and list boxes.
- **Part III** *Making Things Happen—Programming* teaches you the nuts and bolts of Visual C# .NET programming—and there's a lot to learn. You'll discover how to create methods, as well as how to store data, perform loops, and make decisions in code. After you've learned the core programming skills, you'll move into object-oriented programming and debugging applications.
- **Part IV** *Working with Data* introduces you to working with a database and shows you how to automate external applications such as Word and Excel. In addition, this part teaches you how to manipulate a user's file system.
- **Part V** *Deploying Solutions and Beyond* shows you how to distribute an application that you've created to an end-user's computer. Then, the focus is brought back a bit to take a look at Web programming. [Chapter 24](#) concludes the book with step-by-step instructions to build a complete Visual C# .NET application.
- **Part VI** *Appendixes*. In [Appendix A](#), you'll learn about Microsoft's .NET initiative from a higher, less technical level. [Appendix B](#) contains the answers to quizzes and exercises that are presented at the end of each hour.

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Conventions Used in This Book

This book uses several conventions to help you prioritize and reference the information it contains.

Various typefaces are used to help you distinguish code from regular text. Code sequences are presented in a **monospace font**. Placeholders—words or characters used temporarily to represent the real words or characters you would type in code—are typeset in *italic monospace*.

In addition, the following special elements provide information beyond the basic instructions:

By the Way provide useful information that you can read immediately or circle back to without losing the flow of the topic at hand.

Did you Know? highlight information that can make your Visual C# .NET programming more effective.

Watch Out! focus your attention on problems or side effects that can occur in specific situations.

New Terms signal places where new terminology is first used and defined. Such terminology appears in an italic typeface for emphasis.

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Onward and Upward!

This is an exciting time to be learning how to program, and it's my sincerest wish that when you finish this book, you'll feel capable of creating, debugging, and deploying modest Visual C# .NET programs using many Visual C# .NET and Visual Studio tools. Although you won't be an expert, you'll be surprised at how much you've learned. And hopefully, this book will help you determine your future direction as you proceed down the road to Visual C# .NET mastery.

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Hour 1. Jumping in with Both Feet: A Visual C# .NET Programming Tour

Learning a new programming language can be intimidating. If you've never programmed before, the act of typing seemingly cryptic text to produce sleek and powerful applications probably seems like a black art, and you may wonder how you'll ever learn everything you need to know. The answer is, of course, one step at a time. The first step to learning a language is the same as that of any other activity—building confidence. Programming is part art and part science. Although it may seem like magic, it's more akin to illusion; after you know how things work, a lot of the mysticism goes away, freeing you to focus on the mechanics necessary to produce the desired result.

In this hour, you'll complete a quick tour that takes you step-by-step through creating a complete, albeit small, Visual C# .NET program. I've yet to see a "Hello World" program that's the least bit helpful (they usually do nothing more than print "hello world" to the screen—oh, fun). So instead, you'll create a picture-viewer application that lets you view Windows bitmaps and icons on your computer. You'll learn how to let a user browse for a file and how to display a selected picture file on the screen. Both of these skills will come in handy in the real-world applications that you'll create. Producing large, commercial solutions is accomplished by way of a series of small steps. After you've finished creating the project in this hour, you'll have an overall feel for the development process and will have taken the first step toward becoming an accomplished programmer.

The highlights of this hour include the following:

- Learning about the Visual Studio .NET IDE
- Getting familiar with some programming lingo
- Building a simple (yet functional) Visual C# .NET application
- Using a standard dialog box in your application to let the user browse a hard drive
- Adding a control to your application that enables the user to display a picture from a file on disk

I hope that by the end of this hour, you'll realize just how much fun it is to program using Visual C# .NET.

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Getting Started with Visual C# .NET

Before you begin creating programs in Visual C# .NET, you should be familiar with the following terms:

- **Distributable Component** The final, compiled version of a project. Components can be distributed to other people and other computers and they do not require Visual C# to run (although they do require the .NET runtime, which I'll discuss in [Hour 22](#), "Deploying a Visual C# .NET Solution"). Distributable components are often called programs. In [Hour 22](#), you'll learn how to distribute the Picture Viewer program that you're about to build to other computers.
- **Project** A collection of files that can be compiled to create a distributable component (program). There are many types of projects, and complex applications can consist of many projects, such as a Windows Application project and supporting dynamic link library (DLL) projects.
- **Solution** A collection of projects and files that make up an application or component.

**By the
Way**

Visual C# .NET is part of a larger entity known as the .NET Framework. The .NET Framework encompasses all of the .NET technology, including Visual Studio .NET (the suite of development tools) and the common language runtime, which is the set of files that make up the core of all .NET applications. You'll learn about these items in more detail as you progress through the book. For now, realize that Visual C# .NET is one of many languages that exist within the .NET family. Many other languages, such as Visual Basic .NET, are also .NET languages and make use of the common language runtime.

Visual C# .NET is part of the Visual Studio family. Visual Studio is a complete development environment, and it's called the **IDE** (short for **Integrated Development Environment**). The IDE is the design framework in which you build applications; every tool you'll need to create your Visual C# .NET projects is accessed from within the Visual Studio IDE. It's important to note that Visual Studio .NET supports development using many different languages, such as C# and Visual Basic .NET. The development environment itself is not Visual C# .NET—the language you will be using within Visual Studio .NET is C#. To work with Visual C# .NET projects, you first start the Visual Studio IDE.

Start Visual Studio .NET now by choosing Microsoft Visual Studio .NET 2003 from within the Microsoft Visual Studio .NET 2003 folder on your Start|All Programs menu.

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Creating a New Project

When you first start Visual Studio .NET, you see the Visual Studio Start Page tab in the IDE. You can open projects created previously or create new projects from this Start page (see [Figure 1.1](#)). For this quick tour, you're going to create a new Windows application, so click the New Project button in the lower left to display the New Project dialog box shown in [Figure 1.2](#).

Figure 1.1. You can open existing projects or create new projects from the Visual Studio Start page.

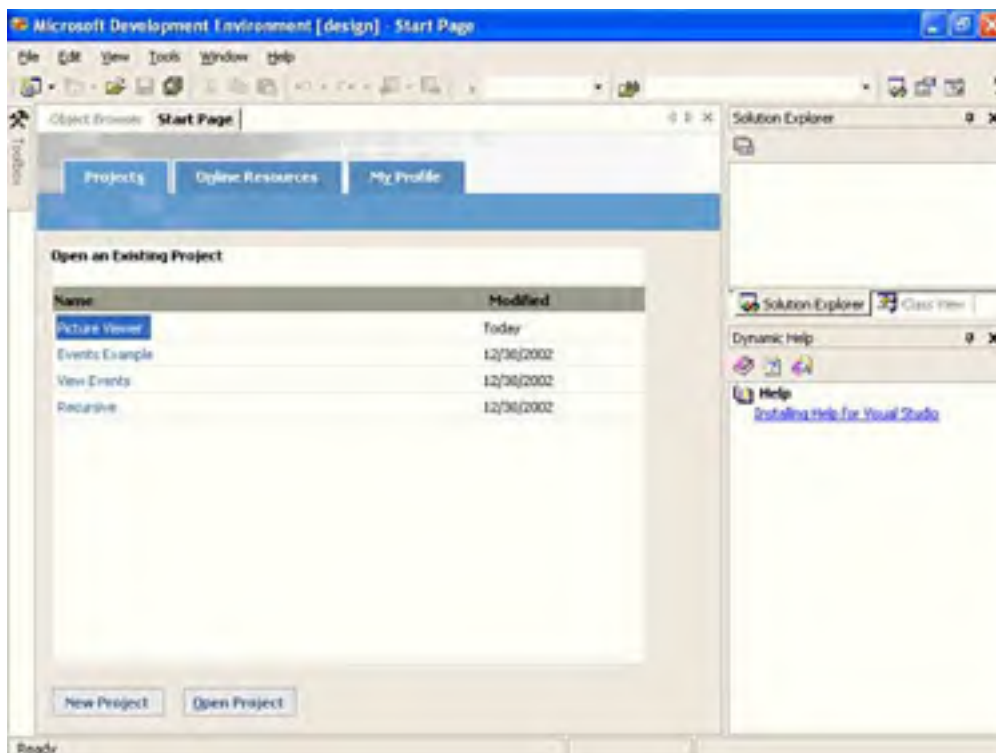
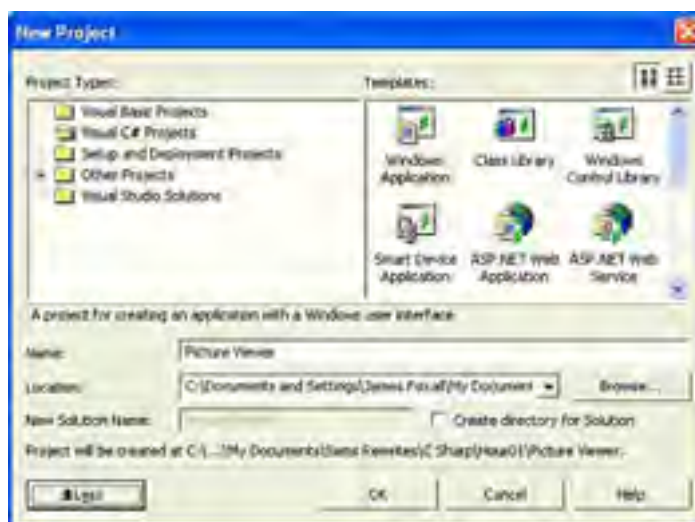


Figure 1.2. The New Project dialog box enables you to create many types of .NET projects.



By the Way

If you don't see the Visual Studio Start page, chances are that you've changed the default settings. In [Hour 2](#), "Navigating Visual Studio .NET," I'll show you how to change them back. For now, you can create a new project by choosing File, New and then clicking Project.

The New Project dialog box is used to specify the type of Visual C# project to create. (You can create many types of projects with Visual C#, as well as with other supported languages of the .NET platform.) If the Visual C# Projects folder isn't selected, click it to display the Visual C# project types, and then make sure the Windows Application icon is selected (if it's not, click it once to select it). At the bottom of the New Project dialog box is a Name text box. This is where, oddly enough, you specify the name of the project you're creating. The Location text box is used to specify the folder in which to create the project.

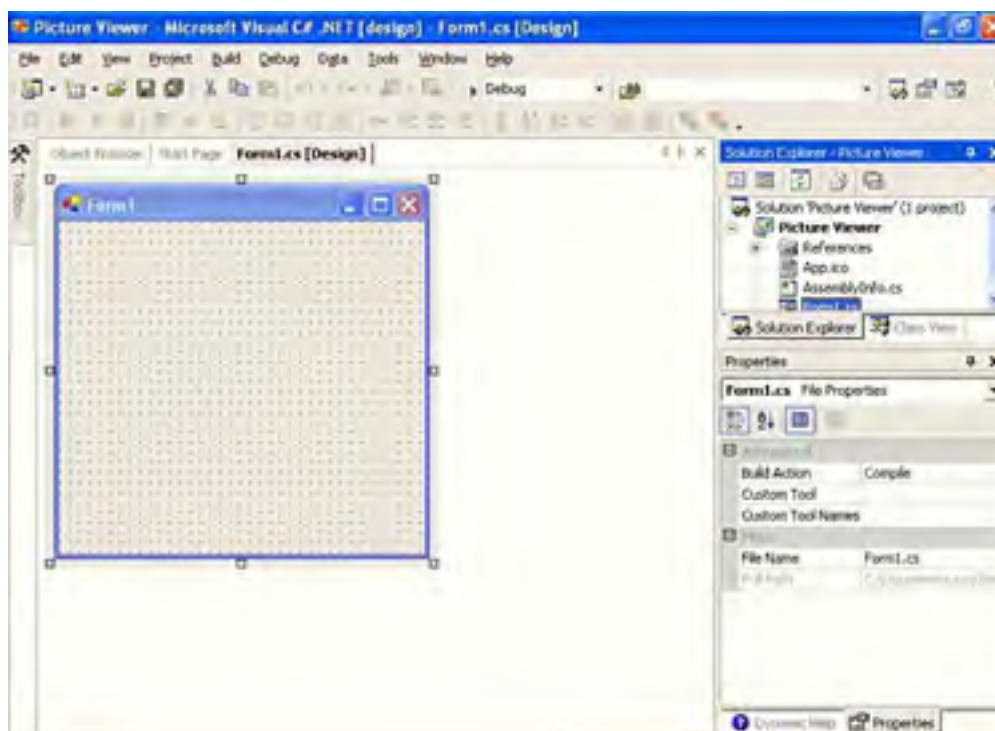
When you create the new project, Visual C# creates a new folder with the same name as the one you specify in the Name text box under the folder specified in the Location text box. For example, if you created a project named Music Cataloger and specified the location as `c:\temp`, the project would be created in a new folder with the path `c:\temp\Music Cataloger`. If you select the Create Directory for Solution check box (made visible by clicking the More button), Visual C# will create a subfolder under Location that contains the solution files (collection of files referencing multiple projects), and yet another subfolder for your actual project files. This is useful when you build solutions that consist of multiple projects.

Did you Know?

You should always set the Name and Location values to something meaningful before creating a project, or you'll have more work to do later if you want to move or rename the project. In most cases, the default Location is probably fine.

Name your project Picture Viewer by typing **Picture Viewer** into the Name text box. There's no need to change the location of where the project files will be saved at this time. Also, there's no need to worry about a separate folder for solution files because your solution will consist of a single project, so go ahead and deselect the Create Directory for Solution check box and click OK to create the new Windows Application project. Visual C# .NET creates the new project, complete with one form (the gray window with the dots on) for you to begin building the interface for your application (see [Figure 1.3](#)). Within Visual Studio .NET, *form* is the term given to the design-time view of windows that can be displayed to a user.

Figure 1.3. New Windows applications start with a blank form; the fun is just beginning!



Ready

Your Visual Studio .NET environment might look different from that shown in the figures of this hour, depending on the edition of Visual Studio .NET you're using, whether you've already "played" with Visual Studio .NET, and other factors such as the resolution of your monitor. All the elements discussed in this hour, however, exist in all editions of Visual Studio .NET. (If a window shown in a figure isn't displayed in your IDE, use the View menu to display it.)

By the Way

To create a program that can be run on another computer, you start by creating a project and then you compile the project into a component such as an executable (a program a user can run) or a DLL (a component that can be used by other programs and components). The compilation process is discussed in detail in [Hour 22](#). The important thing to note at this time is that when you hear someone refer to creating or writing a program, just as you're creating the Picture Viewer program now, they're referring to the completion of all steps up to and including compiling the project to a distributable file.

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Understanding the Visual Studio Environment

The first time you run Visual Studio .NET, you'll notice that the IDE contains a lot of windows, such as the Properties window on the right, which is used to view and set properties of objects. In addition to these windows, the IDE contains a lot of tabs, such as the vertical Toolbox tab on the left edge of the IDE (refer to [Figure 1.3](#)). Try this now: click the Toolbox tab to display the Toolbox window; clicking a tab displays an associated window. You can hover the mouse over a tab for a few seconds to display the window as well. To hide the window, simply move the mouse off the window. To close the window completely, click the Close (X) button in the window's title bar.

You can adjust the size and position of any of these windows, and you can even hide and show them as needed. You'll learn how to customize your design environment in [Hour 2](#).

Watch Out!

Unless specifically instructed to do so, do not double-click *anything* in the Visual Studio .NET design environment. Double-clicking most objects produces an entirely different result than single-clicking does. If you mistakenly double-click an object on a form (discussed shortly), a code window is displayed. At the top of the code window is a set of tabs: one for the form design and one for the code. Click the tab for the form design to hide the code window and return to the form.

The Properties window at the right side of the design environment is perhaps the most important window in the IDE, and it's the one you'll use most often. If your computer's display resolution is set to 640x480, you can probably see only a few properties at this time. This makes it difficult to view and set properties as you create projects. I highly recommend that you don't attempt development with Visual Studio .NET at a resolution below 800x600. Personally, I prefer 1024x768 or higher because it offers plenty of work space. To change your display settings, right-click your desktop and select Properties.

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Changing the Characteristics of Objects

Almost everything you work with in Visual C# .NET is an **object**. Forms, for instance, are objects, as are all the items you can put on a form to build an interface—such as list boxes and buttons. There are *many* types of objects, and objects are classified by type. For example, a form is a Form object, whereas items you can place on a form are called Control objects, or controls. ([Hour 3](#), "Understanding Objects and Collections," discusses objects in detail.) Some objects don't have a physical appearance, but exist only in code, and you'll learn about these kinds of objects in later hours.

Every object has a distinct set of attributes known as **properties** (regardless of whether or not the object has a physical appearance). You have certain properties about yourself, such as your height and hair color. Visual C# objects have properties as well, such as Height and BackColor. Properties define the characteristics of an object. When you create a new object, the first thing you need to do is set its properties so that the object appears and behaves in the way you want. To display the properties of an object, click the object in its designer (the main work area in the IDE).

Click anywhere in the default form now and check to see that its properties are displayed in the Properties window. You'll know because the drop-down list box at the top of the properties window will contain the form's name: Form1.

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Naming Objects

The property you should always set first for any new object is the Name property. Press F4 to display the Properties window (if it's not already visible), and scroll down to the Design section to see the "(Name)" property. The default name is Form1. When you first create an object, Visual C# .NET gives the object a unique, generic name based on the object's type. Although these names are functional, they simply aren't descriptive enough for practical use. For instance, Visual C# .NET named your form Form1, but it's common to have dozens of forms in a project, and it would be extremely difficult to manage such a project if all forms were distinguishable only by a number (Form2, Form3, and so forth).

**By the
Way**

In actuality, what you're working with is a form *class*, or template, that will be used to create and show forms at runtime. For the purpose of this quick tour, I simply refer to it as a form. See [Hour 5](#), "Building Forms—The Basics," for more information.

To better manage your forms, you should give each one a descriptive name. Visual Studio .NET gives you the chance to name new forms as they're created. Because Visual Studio .NET created this default form for you, you didn't get a chance to name it, so you must change both the name and the filename of the form. Change the name of the form now by clicking the Name property and changing the text from Form1 to **fclsViewer**. Notice that this did not change the filename of the form as it's displayed in the Solution Explorer window. Change the filename now by right-clicking Form1.cs in the Solution Explorer window, choosing Rename from the context menu, and changing the text from Form1.cs to **fclsViewer.cs**. In future examples, I won't have you change the filename each time because you'll have enough steps to accomplish as it is. I do recommend, however, that you always change your filenames to something meaningful in your "real" projects.

**By the
Way**

I use the fcls prefix here to denote that the file is a form class.

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Setting the Text Property of the Form

Notice that the text that appears in the form's title bar says Form1. This is because Visual Studio .NET sets the form's title bar text to the name of the form when it is first created, but doesn't change it when you change the name of the form. The text in the title bar is determined by the value of the Text property of the form. Click the form once more so that its properties appear in the Properties window. Use the scrollbar in the Properties window to locate the Text property (you'll find it in the Appearance category), and then change the text to **Picture Viewer**. Press Enter or click on a different property. You'll see the text in the title bar of the form change.

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Giving the Form an Icon

Everyone who has used Windows is familiar with icons—the little pictures used to represent programs. Icons most commonly appear in the Start menu next to the name of their respective programs. In Visual C# .NET, you not only have control over the icon of your program file, but you can also give every form in your program a unique icon if you want to.

**By the
Way**

The instructions that follow assume you have access to the source files for the examples in this book. They are available at www.sampublishing.com/detail_sams.cfm?item=0672325381. You can also get these files, and discuss this book, at my Web site, www.jamesfoxall.com. You don't have to use the icon I've provided for this example; you can use any icon of your choice. If you don't have an icon available (or you want to be a rebel), you can skip this section without affecting the outcome of the example.

To give the form an icon, follow these steps:

1. In the Properties window, click the Icon property to select it. (It's in the Windows Style category.)
2. When you click the Icon property, a small button with three dots appears to the right of the property. Click this button.
3. Use the Open dialog box that appears to locate the `Hour1.icon` file or another icon file of your choice. When you've found the icon, double-click it, or click it once to select it and then click Open.

After you've selected the icon, it appears in the Icon property along with the word (Icon). A small version of the icon appears in the upper-left corner of the form as well. Whenever this form is minimized, this is the icon that's displayed on the Windows taskbar. (Note: This doesn't change the icon for the project as a whole. In [Hour 22](#), you'll learn how to assign an icon to your distributable file.)

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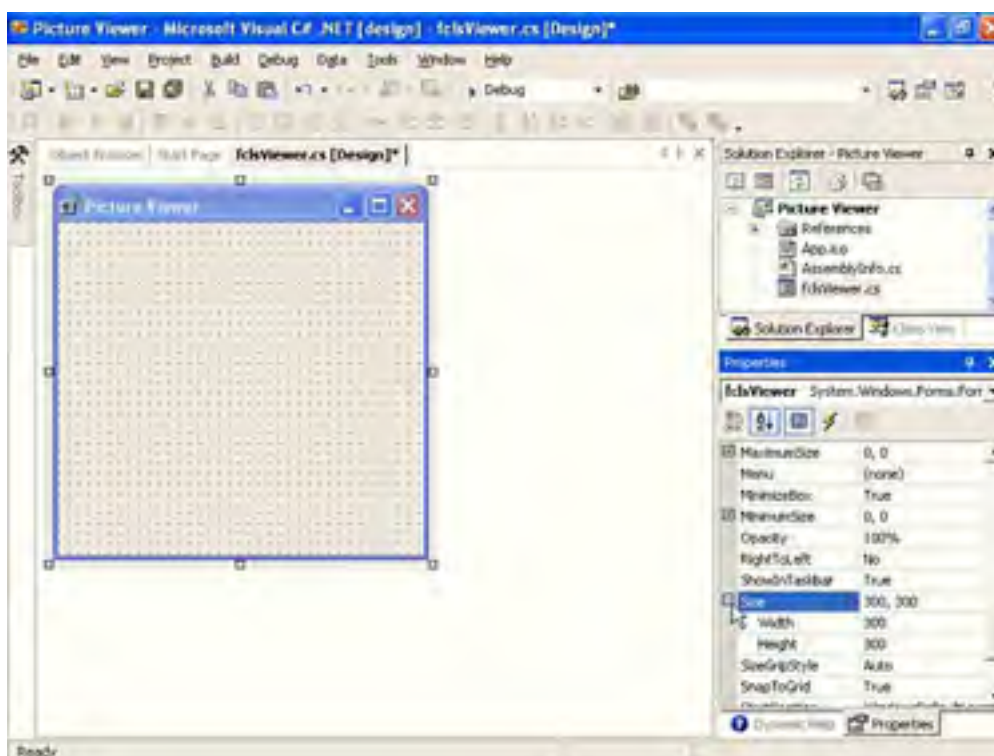
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Changing the Size of the Form

The Properties window currently shows all properties for the form by category (unless you've changed this setting since you installed Visual C# .NET). This is very useful when first learning Visual C# .NET, but as your skills progress and you begin to commit property names to memory, you might prefer to see the properties listed in alphabetical order (my personal preference). Just above the list of properties in the Properties window (below the drop-down list with the form name) is a group of tool buttons. The first button on the left changes the property display to categorical, and should be depressed already (a box appears around it). If not, click it to see the properties listed in categorical order. The button next to this changes the display to alphabetical. Go ahead and click it now to view the properties in alphabetical order. I recommend that you keep the Properties window set to show properties in alphabetical order; it will make it easier to find properties that I refer to in the text.

Next, you're going to change the Width and Height properties of the form. The Width and Height values are shown collectively under the Size property; Width appears to the left of the comma, Height to the right. You can change the Width or Height by changing the corresponding number in the Size property. Both values are represented in pixels (that is, a form that has a Size property of 200,350 is 200 pixels wide by 350 pixels tall). To display and adjust the Width and Height properties separately, click the small plus sign (+) next to the Size property. When you click the plus sign, the subproperties are displayed and a minus sign replaces the plus sign (see [Figure 1.4](#)). Clicking the minus sign would once again hide the subproperties.

Figure 1.4. Some properties can be expanded to show more specific properties.

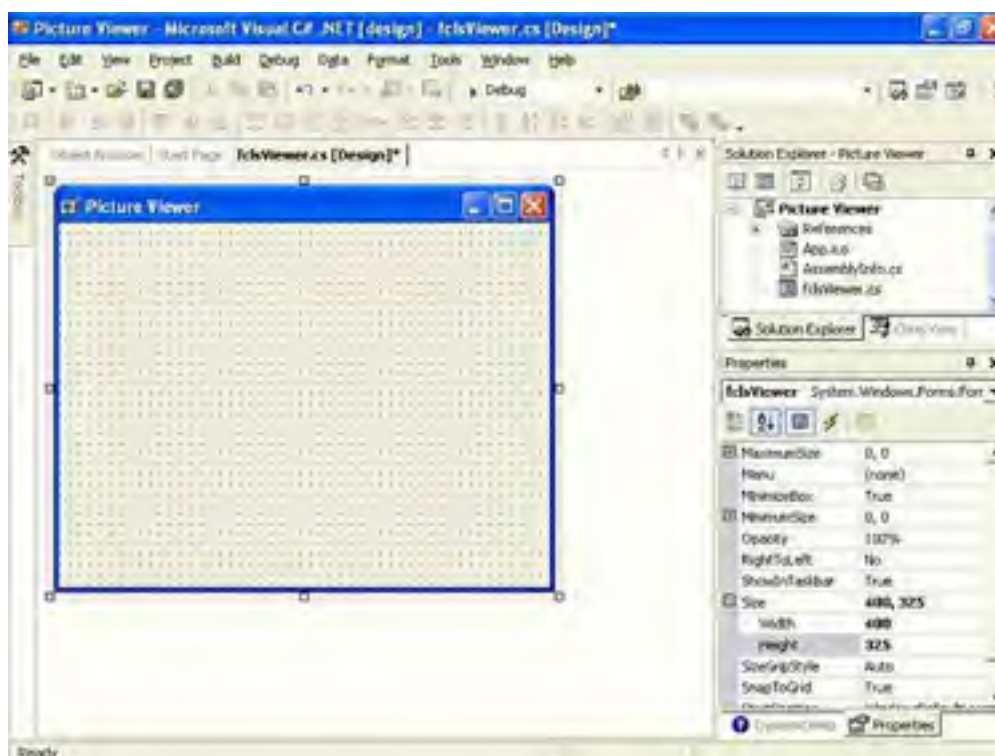


By the way

A pixel is a unit of measurement for computer displays; it's the smallest visible "dot" on the screen. The resolution of a display is always given in pixels, such as 800x600 or 1024x768. When you increase or decrease a property by one pixel, you are making the smallest possible change to the property.

Change the Width property to **400** and the Height to **325** by typing in the corresponding box next to the property name. To commit a property change, press Tab, press Enter, or click a different property or window. Your screen should now look like the one in [Figure 1.5](#).

Figure 1.5. Changes made in the Properties window are reflected as soon as they are committed.



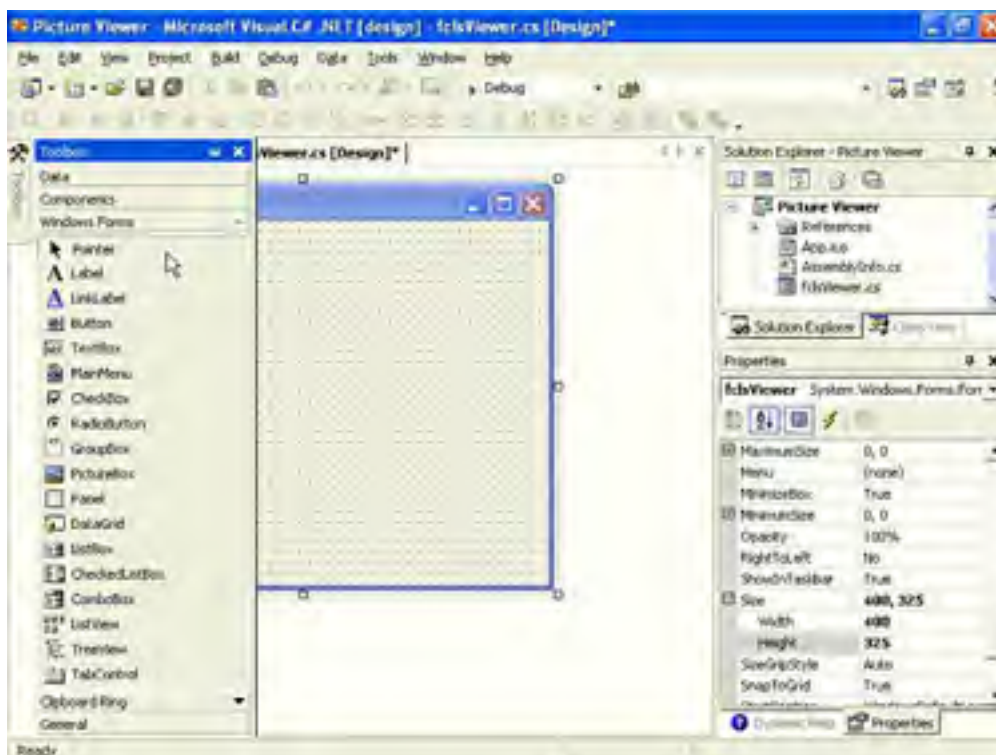
When you first created this project, Visual Studio .NET saved a copy of the source files in their initial state. The changes you've made so far exist only in memory; if you were to turn your computer off at this time (don't do this), you would lose all work up to this point. You should get into the habit of frequently saving your work (committing the changes to disk). Save the project now by choosing File, Save All or by clicking the Save All button on the toolbar—it has a picture of stacked diskettes on it.

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Adding Controls to a Form

Now that you've set the initial properties of your form, it's time to create a user interface by adding objects to the form. Objects that can be placed on a form are called *controls*. Some controls have a visible interface with which a user can interact, whereas others are always invisible to the user. You'll use controls of both types in this example. On the left side of the screen is a vertical tab titled Toolbox. Click the Toolbox tab now to display the Toolbox window (see [Figure 1.6](#)). The toolbox contains all the controls available in the project, such as labels and text boxes.

Figure 1.6. The toolbox is used to select controls to build a user interface.



Did you Know?

There are three ways to add a control to a form, and [Hour 5](#) explains them in detail. In this hour, you'll use the technique of double-clicking a tool in the toolbox.

The toolbox closes as soon as you've added a control to a form and when the pointer is no longer over the toolbox. To make the toolbox stay visible, click the little picture of a pushpin located in the toolbox's title bar.

By the Way

Refer to [Hour 2](#) for more information on customizing the design environment.

Your Picture Viewer interface will consist of the following controls:

- Two Button controls (the standard buttons that you're used to clicking in pretty much every Windows program you've ever run)
- A PictureBox control (a control used to display bitmaps to a user)
- An OpenFileDialog control (a hidden control that exposes the Windows Open File dialog box functionality)

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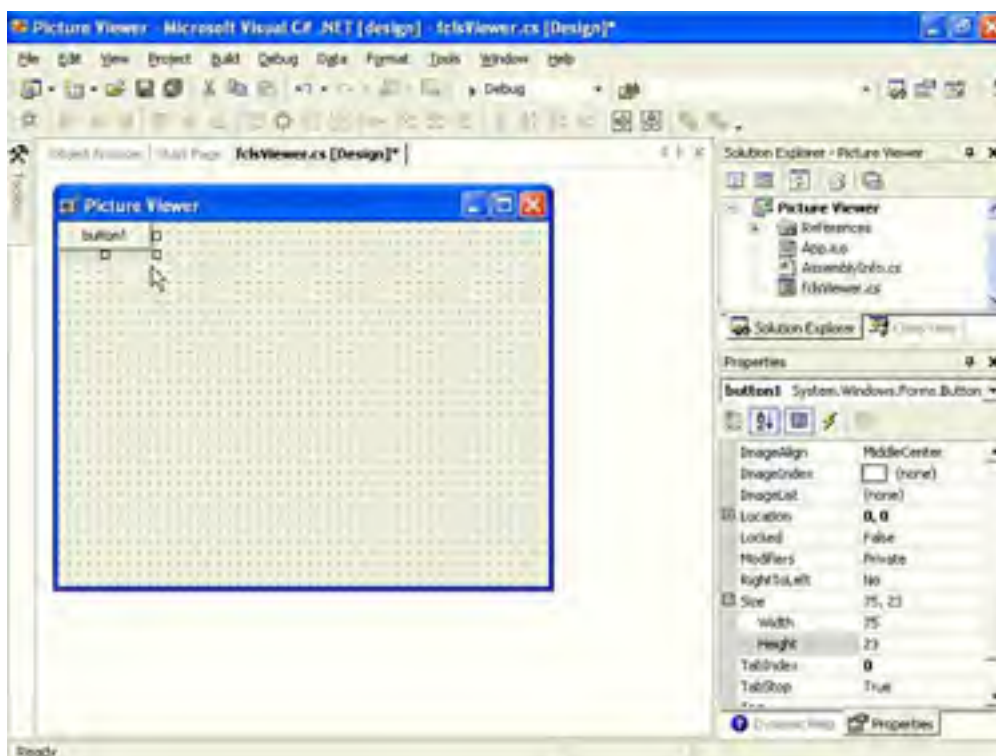
Designing an Interface

It's generally best to design the user interface of a form and then add the code behind the interface to make the form functional. You'll build your interface in the following sections.

Adding a Visible Control to a Form

Start by adding a Button control to the form. Do this by double-clicking the Button item in the toolbox. Visual C# then creates a new button and places it in the upper-left corner of the form (see [Figure 1.7](#)).

Figure 1.7. When you double-click a control in the toolbox, the control is added to the upper-left corner of the form.



Using the Properties window, set the button's properties as follows. Again, you may want to change the Properties list to alphabetical (if it is not already), to make it easier to find these properties by name. When you view the properties alphabetically, the Name property is listed first, so don't go looking for it down in the list or you'll be looking for a while.

Property	Value
Name	btnSelectPicture
Text	Select Picture
Location	301,10 (Note: 301 is the x coordinate, 10 is the y coordinate.)
Size	85,23

You're now going to create a button that the user can click to close the Picture Viewer program. Rather than adding a new button to the form, you're going to create a copy of the button you've already defined. To do this, right-click the button on the form and choose Copy from its shortcut menu. Next, right-click anywhere on the form and choose Paste from the form's shortcut menu. The new button appears centered on the form, and it's selected by default. Change the properties of the new button as follows:

Property	Value
----------	-------

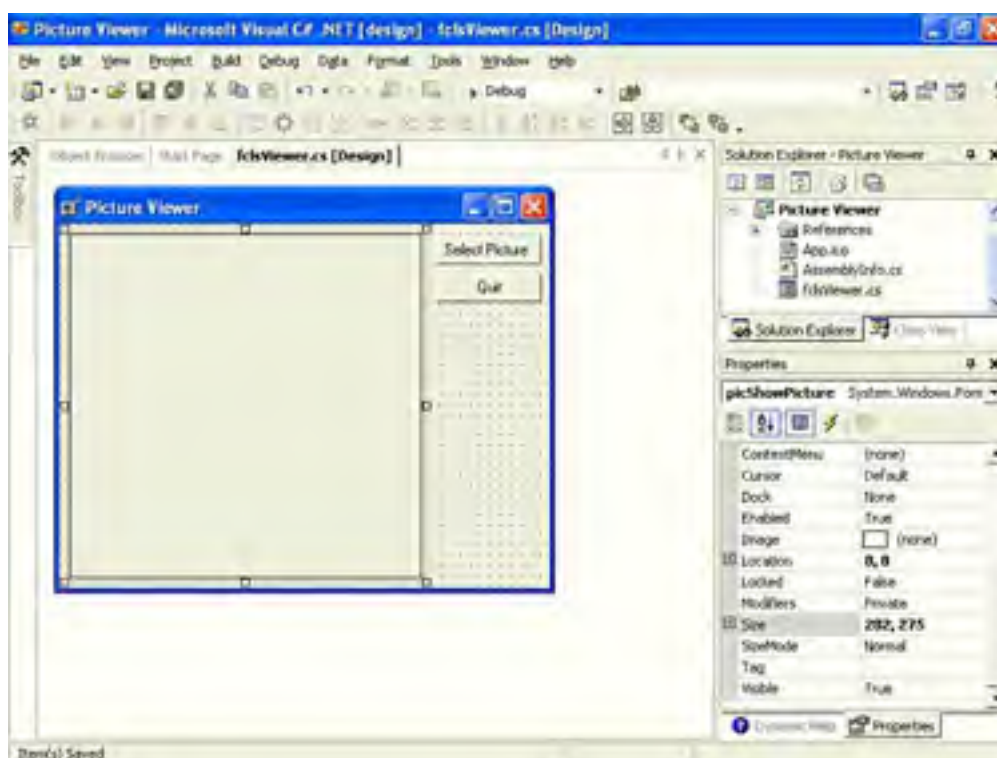
Name	btnQuit
Text	Quit
Location	301,40

The last visible control you need to add to the form is a PictureBox control. A PictureBox has many capabilities, but its primary purpose is to show pictures—which is precisely what you'll use it for in this example. Add a new PictureBox control to the form by double-clicking the PictureBox item in the toolbox, and set its properties as follows:

Property	Value
Name	picShowPicture
BorderStyle	FixedSingle
Location	8,8
Size	282, 275

After you've made these property changes, your form will look like the one in [Figure 1.8](#). Click the Save All button on the toolbar to save your work.

Figure 1.8. An application's interface doesn't have to be complex to be useful.



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Adding an Invisible Control to a Form

All of the controls that you've used so far sit on a form and have a physical appearance when the application is run. Not all controls have a physical appearance, however. Such controls, referred to as nonvisual controls (or *invisible-at-runtime controls*), aren't designed for direct user interactivity. Instead, they're designed to give you, the programmer, functionality beyond the standard features of Visual C# .NET.

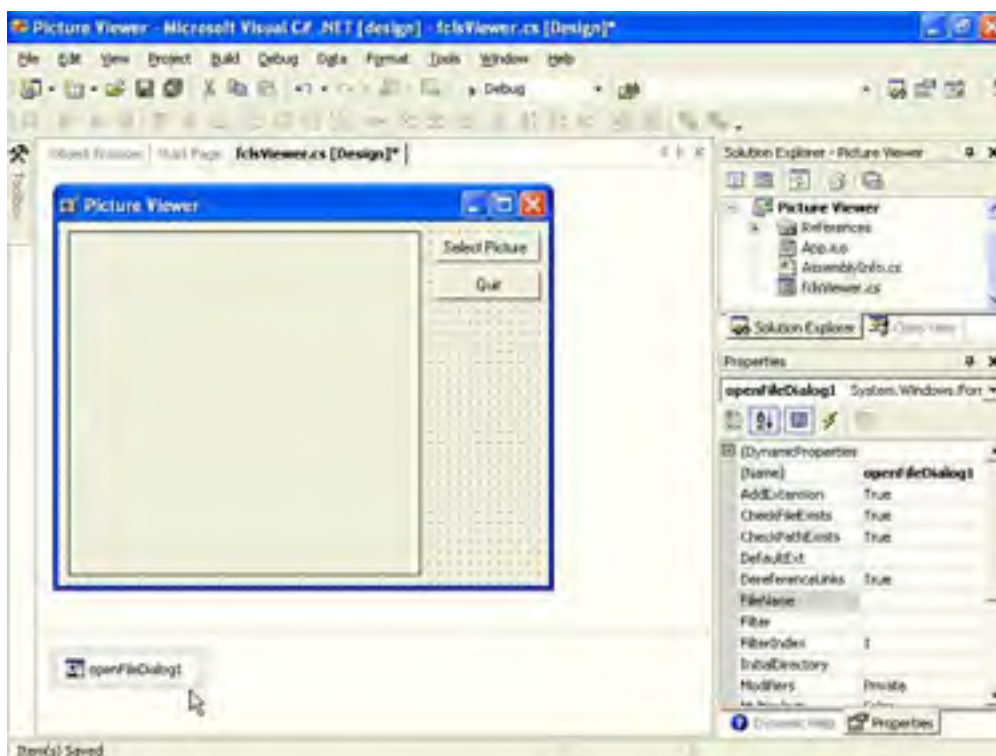
To allow the user to select a picture to display, you need to give her the capability to locate a file on her hard drive. You might have noticed in the past that whenever you choose to open a file from within any Windows application, the dialog box displayed almost always looks the same. It doesn't make sense to force each and every developer to write the code necessary to perform standard file operations. So, Microsoft has exposed the functionality via a control that you can use in your projects. This control is called the OpenFileDialog control, and it will save you dozens and dozens of hours that would otherwise be necessary to duplicate this common functionality.



Other controls besides the OpenFileDialog control give you file functionality. For example, the SaveFileDialog control provides features for enabling the user to specify a filename and path for saving a file.

Display the toolbox and scroll down using the down arrow in the lower part of the toolbox until you can see the OpenFileDialog control, and then double-click it to add it to your form. Note that the control isn't placed on the form; instead, it appears in a special area below the form (see [Figure 1.9](#)). This happens because the OpenFileDialog control has no form interface to display to a user. It does have an interface (a dialog box), that you can display as necessary, but it has nothing to display directly on a form.

Figure 1.9. Controls that have no interface appear below the form designer.



Select the OpenFileDialog control and change its properties as follows:

Property	Value
Name	ofdSelectPicture
Filter	Windows Bitmaps *.BMP JPEG Files *.JPG

Title

Select Picture

The Filter property determines the filtering of files displayed in the Open File dialog box. The text that appears before the pipe symbol (|) is the descriptive text of the file type, whereas the text after the pipe symbol is the pattern to use to filter files; you can specify more than one filter type, separated by a pipe. Text entered into the Title property appears in the title bar of the Open File dialog box.

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Writing the Code Behind an Interface

The graphical interface for your Picture Viewer program is now finished, so click the pushpin in the title bar of the toolbox to close it (if you pinned it to begin with). Now, you have to write code so that the program will be capable of performing actions and responding to user interaction. Visual C# .NET is an event-driven language, which means that code is executed in response to events. These events may come from users (for example, a user clicking a button), or from Windows itself (see [Hour 4](#), "Understanding Events," for a complete explanation of events). Currently, your application looks nice but it won't do a darn thing (sort of like me on Saturday mornings—before kids). The user can click the Select Picture button, for example, until they get carpal tunnel syndrome, but nothing will happen because you haven't told the program what to do when the user clicks the button. You can see this for yourself now by pressing F5 to run the project. Feel free to click the buttons—but they don't do anything. When you're done, close the window you created to return to design mode.

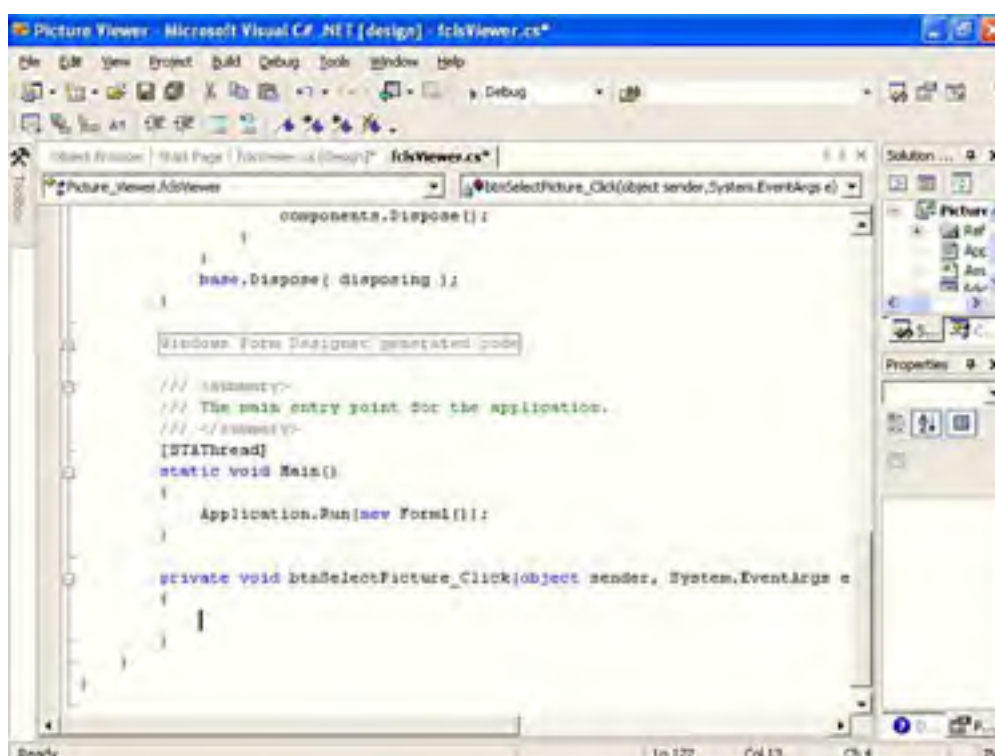
You're going to write code to accomplish two tasks. First, you're going to write code that lets the user browse his or her hard drives to locate and select a picture file and then display the file in the picture box (this sounds a lot harder than it is). Second, you're going to add code to the Quit button that shuts down the program when the user clicks the button.

Letting a User Browse for a File

The first bit of code you're going to write will enable the user to browse his or her hard drives and select a picture file, and then show the selected picture in the PictureBox control. This code will execute when the user clicks the Select Picture button; therefore, it's added to the Click event of that button (you'll learn all about events in later hours).

When you double-click a control on a form in Design view, the default event for that control is created and displayed in a code window. The default event for a Button control is its Click event, which makes sense because clicking is the most common action a user performs with a button. Double-click the Select Picture button now to access its Click event in the code window (see [Figure 1.10](#)).

Figure 1.10. You write all code in a window such as this.



When you access an event, Visual C# .NET builds an **event handler**, which is essentially a template procedure in which you add the code that executes when the event occurs. The cursor is already placed within the code procedure, so all you have to do is add code. You will also notice that the opening and closing braces are preset for your new event procedure. The braces, in this case, define the beginning and end of your procedure. You will soon see that Visual C# .NET requires many opening and closing braces({}). By the time you're done with this book, you'll be madly clicking away as you write your own code to make your applications do exactly what you want them to do—well, most of the time. For now, just enter the code as I present it here.

It's very important that you get in the habit of commenting your code, so the first line you're going to enter is a comment. Beginning a statement with the characters `//` designates the statement as a comment; the compiler won't do anything with the statement, so you can enter whatever text you want after the double slashes. Type the following statement exactly as it appears and press the Enter key at the end of the line:

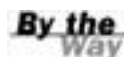
```
// Show the open file dialog box.
```



For more information on creating good comments, see [Hour 15](#), "Debugging Your Code."

The next statement you'll enter triggers a method of the `OpenFileDialog` control that you added to the form. You'll learn all about methods in [Hour 3](#). For now, think of a method as a mechanism to make a control do something. The `ShowDialog` method tells the control to show its Open dialog box and let the user select a file. The `ShowDialog` method returns a value that indicates its success or failure, which we will then compare to a predefined result (`DialogResult.OK`). Don't worry too much about what is happening here, because you'll be learning the details of this in later hours and the sole purpose of this hour is to get your feet wet. In a nutshell, the `ShowDialog` method is invoked to let a user browse for a file, and if the user selects a file, more code gets executed. Of course, there is a lot more to using the `OpenFileDialog` control than I present in this basic example, but this simple statement gets the job done. Enter the following `if` statement followed by an open brace (be sure to press Enter after each line):

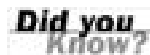
```
if (ofdSelectPicture.ShowDialog() == DialogResult.OK)
{
```



Opening and closing braces are necessary for this `if` statement because they denote that this `if` construct will be made up of multiple lines.

Time for another comment. Type this statement and remember to press Enter at the end of each code line.

```
// Load the picture into the picture box.
```



Don't worry about indenting the code by pressing the Tab key or using spaces. Visual C# .NET automatically indents code for you.

You're now going to enter the next line of code. This statement, which appears within the `if` construct braces, is the line of code that actually displays the picture in the picture box. (If you're itching to know more about graphics, take a look at [Hour 18](#), "Working with Graphics.")

Enter the following statement:

```
picShowPicture.Image = Image.FromFile(ofdSelectPicture.FileName);
```

In addition to displaying the selected picture, your program is going to display the path and filename of the picture in the title bar. When you first created the form, you changed the `Text` property of the form using the Properties window. To create dynamic applications, properties need to be constantly adjusted at runtime, and this is done using code. Insert the following three statements (again, press Enter at the end of each line):

```
// Show the name of the file in the form's caption.
this.Text = String.Concat("Picture Viewer (" + ofdSelectPicture.FileName + ")");
}
```



Visual C# .NET is case sensitive! You must enter all code using the same case as shown in the text.

Checking Your Program Entry Point

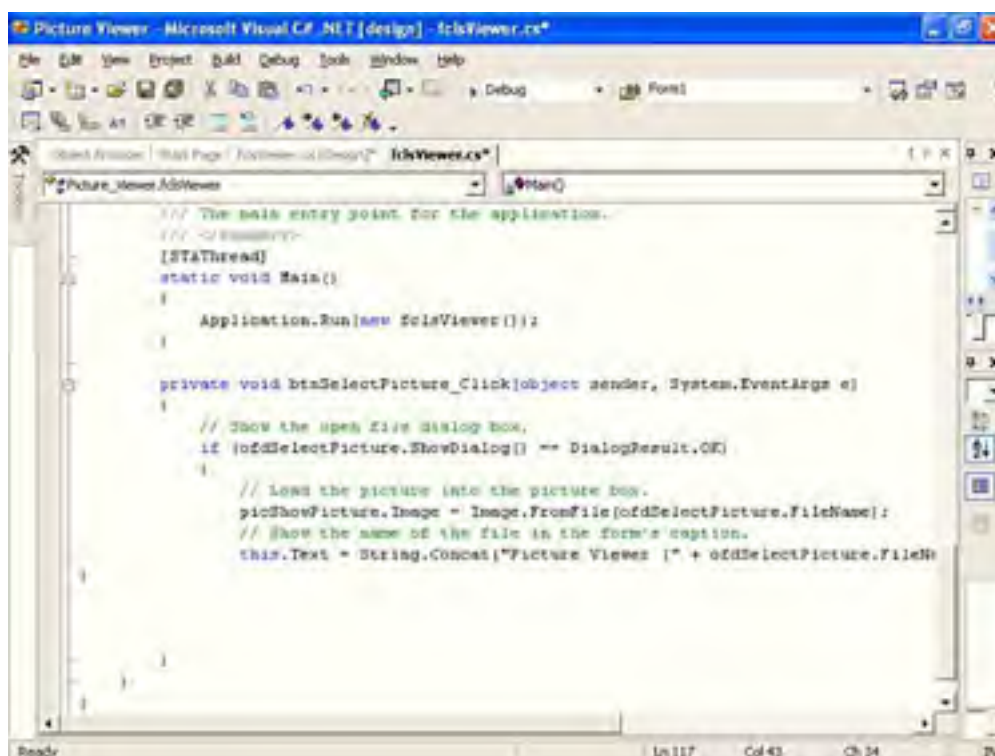
All C# programs must contain an entry point. The `Main()` method is the entry point. In this sample you need to change the reference from `Form1` to **`fcIsViewer`** (this is necessary because earlier we renamed the form). C++ programmers will be familiar with the `Main()` entry point method, but they should take notice of the capitalization of `Main`. (I'll explain this in more detail a bit later in this book.)

To update the entry point in this example, press `Ctrl+F` to open the Find window, enter **`Form1`**, and click Find Next twice. Close the Find window and replace the text `Form1` with **`fcIsViewer`**. The updated statement should now read

```
Application.Run(new fcIsViewer());
```

This change will cause Visual C# .NET to load your form when the program first runs. If you didn't make this change, you'd get an error when you tried to compile the project. After you've entered all the code, your editor should look like that shown in [Figure 1.11](#).

Figure 1.11. Make sure your code exactly matches the code shown here.



Terminating a Program Using Code

The last bit of code you'll write will terminate the application when the user clicks the Quit button. To do this, you'll need to access the Click event handler of the `btnQuit` button. At the top of the code window are two tabs. The current tab has the text `fcIsViewer.cs`. Next to this is a tab that contains the text `fcIsViewer.cs [Design]`. Click this tab now to switch from Code view to the form designer. If you receive an error when you click the tab, the code you entered is incorrect, and you need to edit it to make it the same as I've presented it. After the form designer is displayed, double-click the Quit button to access its Click event.

Enter the following code in the Quit button's Click event handler:

```
this.Close();
```

By the
Way

The `this.Close` statement closes the current form. When the last loaded form in a program is closed, the application shuts itself down—completely. As you build more robust applications, you'll probably want to execute all kinds of clean-up routines before terminating an application, but for this example, closing the form is all you need to do.

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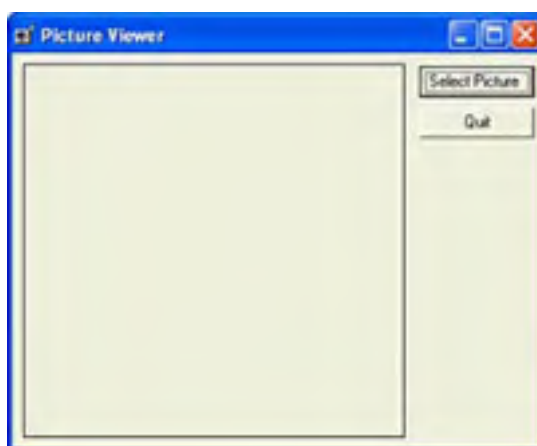
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Running a Project

Your application is now complete. Click the Save All button on the toolbar (it looks like a stack of diskettes), and then run your program by pressing F5. You can also run the program by clicking the button on the toolbar that looks like a right-facing triangle and resembles the Play button on a VCR (this button is called Start, and it can also be found on the Debug menu). Learning the keyboard shortcuts will make your development process move along faster, so I recommend you use them when at all possible.

When you run the program, the Visual Studio .NET interface changes, and the form you've designed appears floating over the design environment (see [Figure 1.12](#)).

Figure 1.12. When in Run mode, your program executes the same as it would for an end user.



You're now running your program as though it were a standalone application running on another user's machine; what you see is exactly what someone else would see if they ran the program (without the Visual Studio .NET design environment in the background, of course). Click the Select Picture button to display the Select Picture dialog box (see [Figure 1.13](#)). Use the dialog box to locate a picture file. When you've found a file, double-click it, or click once to select it and then click Open. The selected picture is then displayed in the PictureBox control, as shown in [Figure 1.14](#).

Figure 1.13. The OpenFileDialog control handles all the details of browsing for files. Cool, huh?

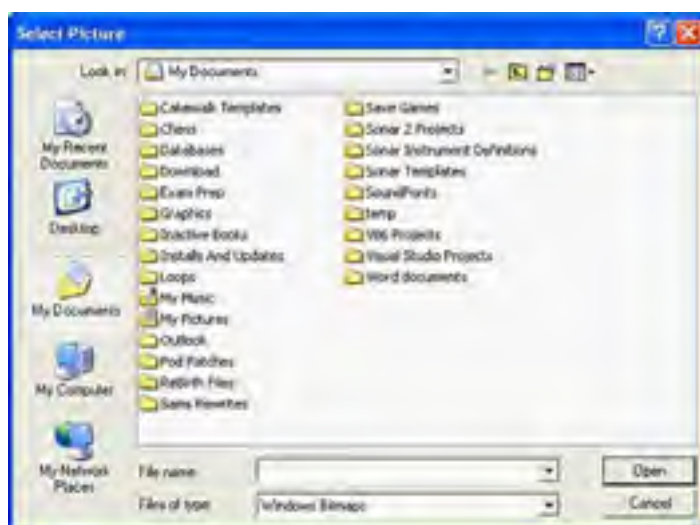


Figure 1.14. Visual Studio .NET makes it easy to display pictures with very little work.



By the
Way

If you want to select and display a picture from your digital camera, chances are the format is JPEG, so you'll need to select this from the filter drop-down. Also, if your image is very large, you'll only see the upper-left corner of the image (what fits in the picture box).

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Summary

When you're done playing with the program, click the Quit button to return to design view.

That's it! You've just created a bona fide Visual C# .NET program. You've used the toolbox to build an interface with which users can interact with your program, and you've written code in strategic event handlers to empower your program to do things. These are the basics of application development in Visual C# .NET. Even the most complicated programs are built using this fundamental approach; you build the interface and add code to make the application do things. Of course, writing code to do things *exactly* the way you want things done is where the process can get complicated, but you're on your way.

If you take a close look at the organization of the hours in this book, you'll see that I start out by teaching you to use the Visual Studio .NET environment, in which you will write your Visual C# .NET programs. I then move on to building an interface, and later I teach you all about writing code. This organization is deliberate. You might be a little anxious to jump in and start writing serious code, but writing code is only part of the equation—don't forget the word *Visual* in Visual C# .NET. As you progress through the hours, you'll be building a solid foundation of development skills.

Soon, you'll pay no attention to the man behind the curtain—you'll be that man (or woman)!

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Q&A

Q1: *Can I show bitmaps of file types other than BMP and JPG?*

A1: Yes. The PictureBox supports the display of images with the extensions BMP, JPG, ICO, EMF, WMF, and GIF. The PictureBox can even save images to a file.

Q2: *Is it possible to show pictures in other controls?*

A2: The PictureBox is the control to use when you are just displaying images. However, many other controls allow you to display pictures as part of the control. For instance, you can display an image on a Button control by setting the button's Image property to a valid picture.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** What type of Visual C# project creates a standard Windows program?
- 2:** What window is used to change the attributes (location, size, and so on) of a form or control in the IDE?
- 3:** How do you access the default event (code) of a control?
- 4:** What property of a PictureBox do you set to display an image?
- 5:** What is the default event for a Button control?

Exercise

- 1:** Change your Picture Viewer program so that the user can also locate and select GIF files. (Hint: Change the Filter property of the OpenFileDialog control.)
- 2:** Alter the form in your Picture Viewer project so that the buttons are side by side in the lower-right corner of the form, rather than vertically aligned in the upper-right corner.

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Hour 2. Navigating Visual Studio .NET

The key to expanding your knowledge of Visual C# .NET is to become as comfortable as possible—as quickly as possible—with the Visual Studio .NET design environment. Just as a carpenter doesn't think much about hammering a nail into a piece of wood, you can become so familiar with performing actions such as saving projects, creating new forms, and setting object properties that they'll be second nature to you. The more comfortable you are with the tools of Visual Studio .NET, the more you can focus your energies on what you're creating with the tools.

In this hour, you'll learn how to customize your design environment by moving, docking, floating, hiding, and showing design windows, as well as how to customize menus and toolbars. You'll even create a new toolbar from scratch. After you've gotten acquainted with the environment, I'll teach you about projects and the files that they're made of (taking you beyond what was briefly discussed in [Hour 1](#), "Jumping in with Both Feet: A Visual C# .NET Programming Tour"), and I'll introduce you to the design windows with which you'll work most frequently. Finally, I'll show you how to get help when you're stuck.

The highlights of this hour include the following:

- Navigating Visual Studio .NET
- Using the Visual Studio .NET Start Page to open and create projects
- Showing, hiding, docking, and floating design windows
- Customizing menus and toolbars
- Adding controls to a form using the toolbox
- Viewing and changing object attributes using the Properties window
- Working with the many files that make up a project
- How to get help

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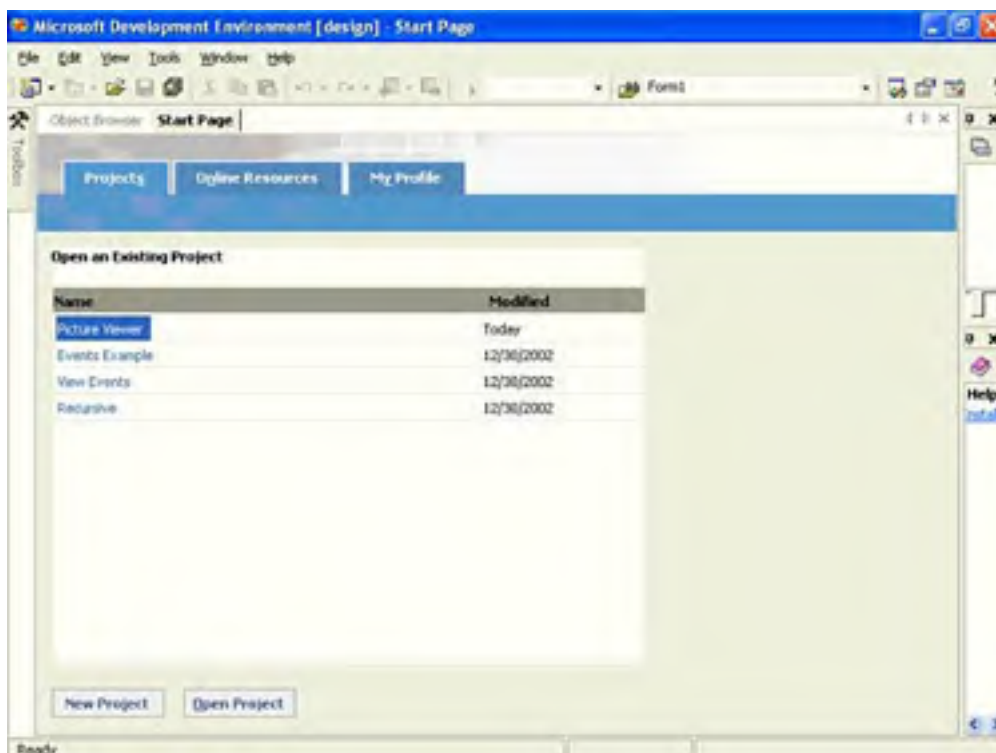
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Using the Visual Studio .NET Start Page

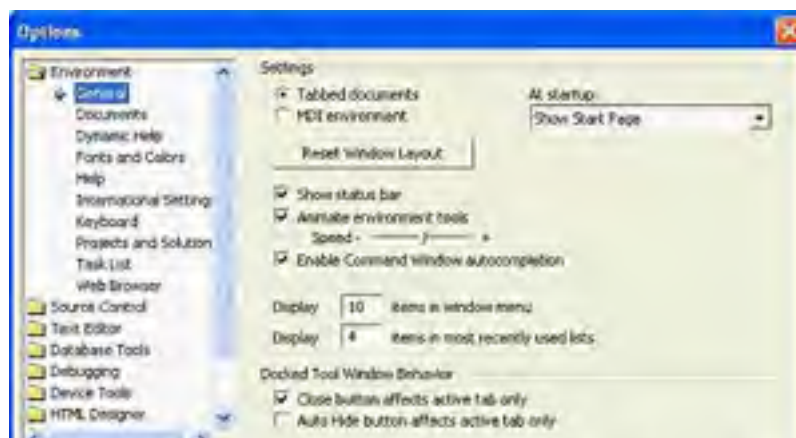
By default, the Visual Studio Start Page shown in [Figure 2.1](#) is the first thing you see when you start Visual C# .NET (if Visual C# isn't running, start it now). The Visual Studio Start Page is a gateway for performing tasks with Visual C# .NET. From this page, you can open previously edited projects, create new projects, and edit your user profile.

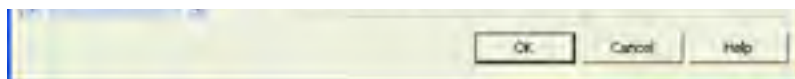
Figure 2.1. The Visual Studio Start Page is the default entry point for all .NET languages.



From this page, you can have Visual Studio .NET load the last solution you edited, show the Open Project dialog box, show the New Project dialog box, or show an empty design environment. To view or edit the startup options, choose Tools, Options to display the Options dialog box shown in [Figure 2.2](#). By default, the General section of the Environment folder is selected when the Options dialog box first appears. This section happens to contain the At Startup option. If the Visual Studio Start Page doesn't appear when you start Visual Studio .NET, verify the settings on the Options dialog box; you might need to change At Startup to Show Start Page.

Figure 2.2. Use the At Startup setting to control the first thing you see when Visual Studio .NET starts.

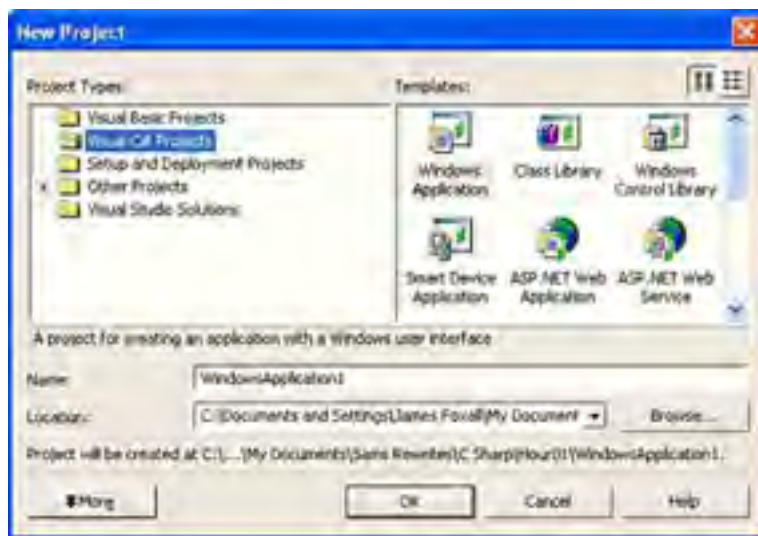




Creating New Projects

To create new projects, click the New Project button in the lower left of the Visual Studio .NET Start Page. This displays the New Project dialog box shown in [Figure 2.3](#). The Project Types list varies from machine to machine, depending on which products of the Visual Studio .NET family are installed. Of course, we're interested only in the Visual C# .NET project types in this book.

Figure 2.3. Use the New Project dialog box to create Visual C# .NET projects from scratch.



By the Way

You can create many types of projects with Visual C# .NET, but this book focuses mostly on creating Windows Applications, perhaps the most common of the project types. You will learn about some of the other project types as well, but when you're told to create a new project, make sure the Windows Application icon is selected unless you're told otherwise.

When you create a new project, be sure to enter a name for it in the Name text box before clicking OK or double-clicking a project type icon. This ensures that the project is created with the proper path and filenames, eliminating work you would otherwise have to do to change these values later. After you specify a name, you can create the new project either by double-clicking the project type template icon or by clicking an icon once to select it and then clicking OK. After you've performed either of these actions, the New Project dialog box closes and a new project of the selected type is created.

By default, Visual Studio saves all your projects in subfolders of your My Documents folder. The hierarchy used by Visual C# is

`\My Documents\Visual Studio Projects\<Project Name>`

Notice how the name you give your project is used as its folder name. This makes it easy to find the folders and files for any given project and is one reason that you should always give your projects descriptive names. You can use a path other than the default by specifying the path in the New Project dialog box, but you probably won't often need to do this if you develop alone. If you're on a team of developers, however, you might choose to locate your projects on a shared drive so that others can access the source files.

By the Way

You can create a new project at any time (not just when starting Visual Studio .NET) by choosing File, New, Project. You can't have multiple projects open at once, however, so if you choose to open a project, Visual Studio .NET will ask whether or not you want to save changes for the current project and it will then close it.

After you enter a project name and choose a location, you click OK to create the project. Visual Studio .NET will then create the necessary folders and source files, as well as display the project in the IDE for you to begin working with it.

Opening an Existing Project

Over time, you'll open more projects than you create. There are essentially two ways to open projects from the Visual Studio Start Page.

- If it's a project you've recently opened, the project name will appear in a list within a rectangle in the middle of the Start Page (as Picture Viewer does in [Figure 2.1](#)). The name displayed for the project is the one given when it was created, which is yet another reason to give your projects descriptive names. Clicking a project name opens the project. I'd venture to guess that you'll use this technique 95% of the time.
- To open a project for the first time (such as when opening sample projects), click the Open Project button on the Visual Studio Start Page. This displays a standard dialog box that you can use to locate and select a project file.

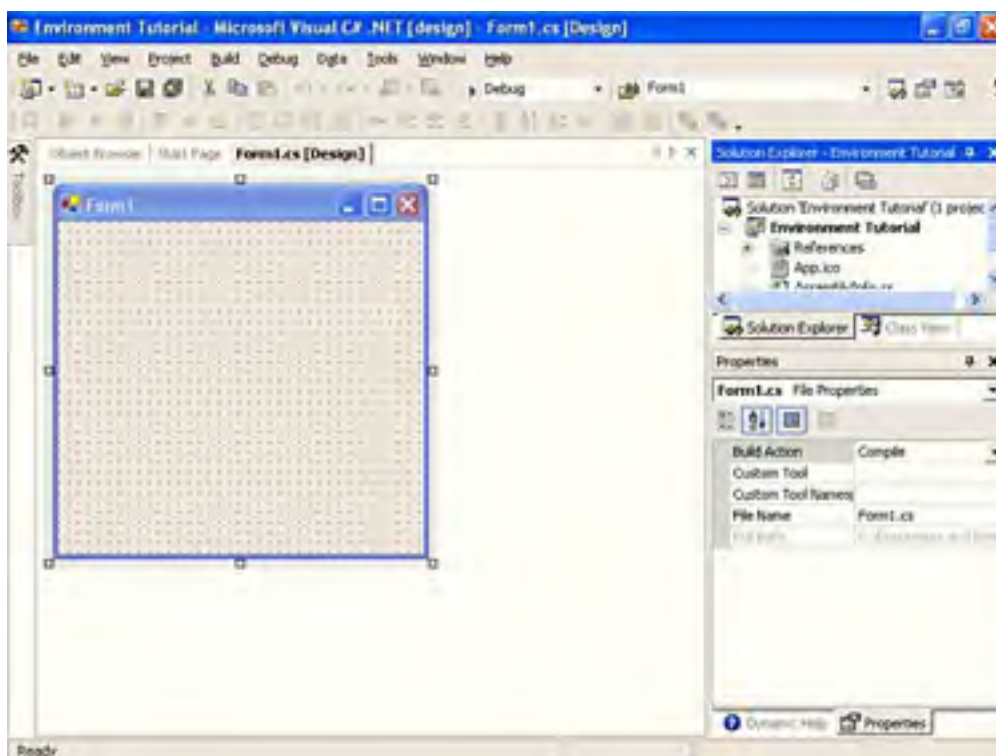
By the Way

As with creating new projects, you can open an existing project at any time, not just when starting Visual Studio .NET, by choosing File, Open. Remember, you can only have one project open at a time, so opening a project will cause the current project to be closed. Again, if you've made changes to the current project, you'll get a chance to save them before it is closed.

Navigating and Customizing the Visual Studio .NET Environment

Visual Studio .NET lets you customize many of its interface elements, such as windows and toolbars, enabling you to be more efficient in the work that you do. Create a new Windows Application now by opening the File menu, clicking New, and then choosing Project. This project will be used to illustrate manipulating the design environment. Name this project **Environment Tutorial**. (This exercise won't create anything reusable, but it will help you learn how to navigate the design environment.) Your screen should look like the one shown in [Figure 2.4](#).

Figure 2.4. This is the default appearance of the IDE when you first install Visual Studio .NET.



By the way

Your screen may not look exactly like that shown in [Figure 2.4](#), but it'll be close. By the time you've finished this hour, you'll be able to change the appearance of the design environment to match this figure—or to any configuration you prefer.

Working with Design Windows

Design windows, such as the Properties window and Solution Explorer shown in [Figure 2.4](#), provide functionality for building complex applications. Just as your desk isn't organized exactly like that of your co-workers, your design environment doesn't have to be the same as anyone else's, either.

A design window can be placed into one of four primary states:

- Closed— The window is not visible.
- Floating— The window appears floating over the IDE.
- Docked— The window appears docked to an edge of the IDE.

- Automatically hidden— The window is docked, but it hides itself when not in use.

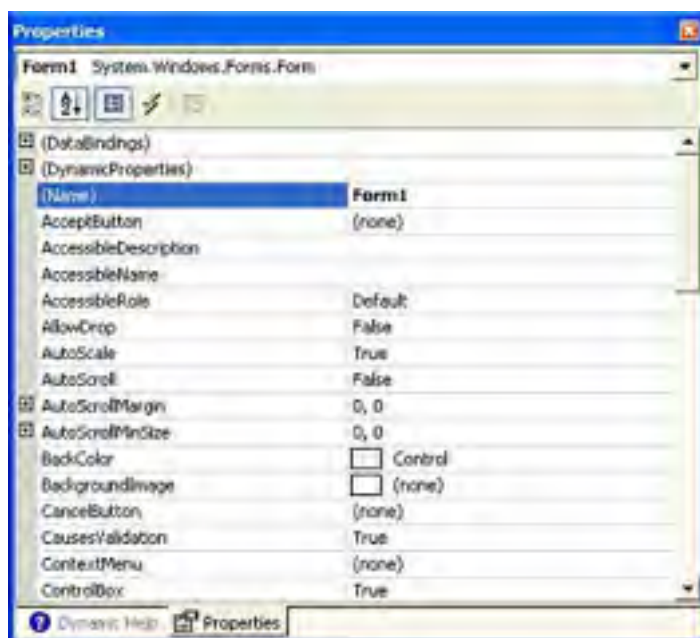
Showing and Hiding Design Windows

When a design window is closed, it doesn't appear anywhere. There is a difference between being closed and being automatically hidden, as you'll learn shortly. To display a closed or hidden window, choose the corresponding menu item from the View menu. For example, if the Properties window isn't displayed in your design environment, you can display it by choosing View, Properties Window (or press its keyboard shortcut—F4). Whenever you need a design window and can't find it, use the View menu to display it. To close a design window, click its Close button (the button on the right side of the title bar with the X on it), just as you would to close an ordinary window.

Floating Design Windows

Floating design windows are visible windows that float over the workspace, as shown in [Figure 2.5](#). Floating windows are like typical application windows in that you can drag them around and place them anywhere you please, even on other monitors when you're using a multiple-display setup. In addition to moving a floating window, you can also change its size by dragging a border.

Figure 2.5. Floating windows appear over the top of the design environment.



Docking Design Windows

Visible windows appear docked by default. A docked window is a window that appears attached to the side, top, or bottom of the work area or to some other window. The Properties window in [Figure 2.4](#), for example, is docked to the right side of the design environment. To make a floating window a docked window, drag the title bar of the window toward the edge of the design environment to which you want to dock the window. As you drag the window, you'll see a rectangle that represents the outline of the window. When you approach an edge of the design environment, the rectangle will change shape and "stick" in a docked position. If you release the mouse while the rectangle appears this way, the window will be docked. Although this is hard to explain, it's very easy to do.

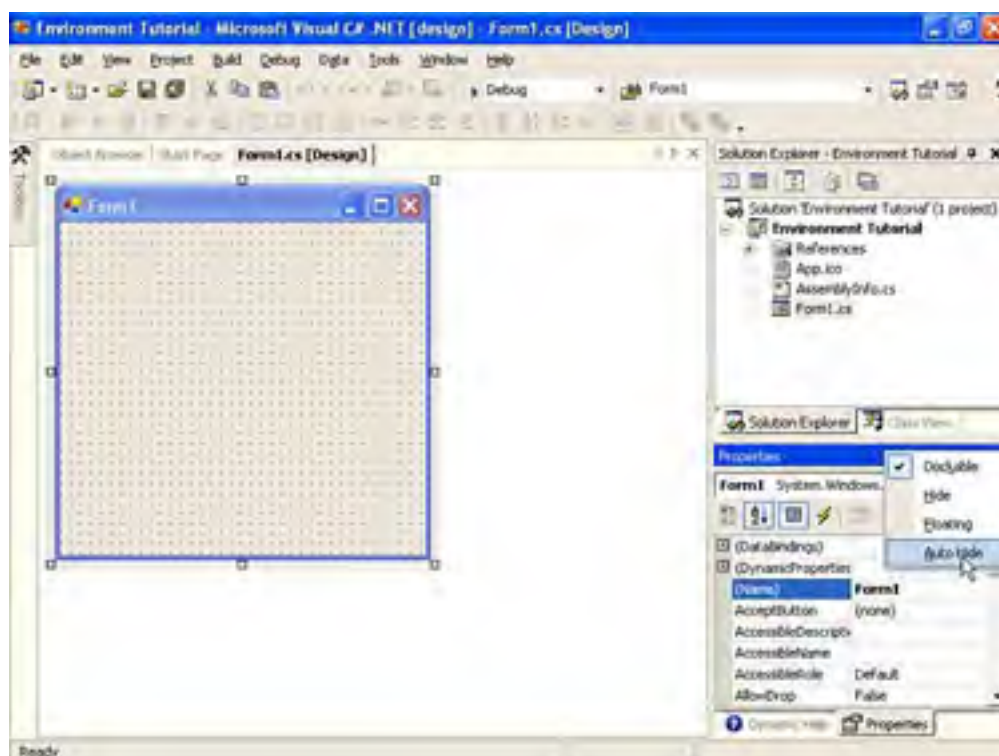


You can size a docked window by dragging its edge opposite the side that's docked. If two windows are docked to the same edge, dragging the border between them enlarges one while shrinking the other.

To try this, you'll need to float a window that's already docked. To float a window, you "tear" the window away from the docked edge by dragging the title bar of the docked window away from the edge to which it's docked. Note that this technique won't work if a window is set to Auto Hide (which is explained next). Try docking and floating windows now by following these steps:

1. Ensure that the Properties window is currently displayed (if it's not, show it by pressing F4). Make sure the Properties window isn't set to Auto Hide by right-clicking its title bar and deselecting Auto Hide from the shortcut menu (if it's selected), as shown in [Figure 2.6](#).

Figure 2.6. You can't float a window that's set to Auto Hide.



2. Drag the title bar of the Properties window away from the docked edge. When the rectangle representing the border of the window changes shape, release the mouse button. The Properties window should now float.
3. Dock the window once more by dragging the title bar toward the right edge of the design environment. Again, release the mouse button when the rectangle changes shape. If you dropped the window directly on top of an existing window, you'll create a tabbed window. This is discussed shortly.

Did you Know?

If you don't want a floating window to dock, regardless of where you drag it, right-click the title bar of the window and choose Floating from the context menu. To allow the window to be docked again, right-click the title bar and choose Dockable.

Auto Hiding Design Windows

A relatively new feature of the Visual Studio .NET design environment is the ability to auto hide windows. Although you might find this a bit disconcerting at first, after you get the hang of things, this is a very productive way to work because your workspace is freed up, yet design windows are available by simply moving the mouse. Windows that are set to Auto Hide are always docked; you can't set a floating window to Auto Hide. When a window auto hides, it appears as a vertical tab on the edge to which it's docked—in much the same way that minimized applications are placed in the Windows taskbar.

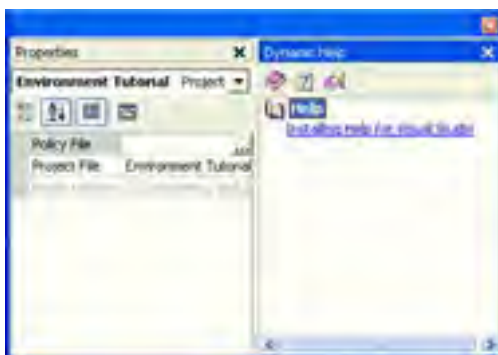
Look at the left edge of the design environment in [Figure 2.6](#). Notice the vertical tab titled Toolbox. This tab represents an auto-hidden window. To display an auto-hidden window, move the pointer over the tab representing the window. When you move the pointer over a tab, Visual Studio .NET displays the design window so that you can use its features. When you move the pointer away from the window, the window automatically hides itself—hence the name. To make any window hide itself automatically, right-click its title bar and select Auto Hide from its shortcut menu. You can also click the little picture of a pushpin appearing in the title bar next to the Close button to toggle the window's Auto Hide state.

Performing Advanced Window Placement

The techniques discussed so far in this section have been basic methods for customizing your design environment. Things can get a bit more complicated if you want them to. Such complication presents itself primarily as the ability to create tabbed floating windows like the one shown in [Figure 2.5](#). Notice that at the bottom of the floating window is a set of tabs. Clicking a tab shows its corresponding design window, replacing the window currently displayed. These tabs are created in much the same way in which you dock and undock windows—by dragging and dropping. For instance, to make the Solution Explorer window a floating window of its own, you would drag the Solution Explorer window tab away from the floating window. As you do so, a rectangle appears, showing you the outline of the new window. Where you release the rectangle determines whether you dock the design window being dragged or whether you make the window floating. To make a design window a new tab of an already floating window, drag its title bar and drop it in the title bar of a window that's already floating.

In addition to creating tabbed floating windows, you can dock two floating windows together. To do this, drag the title bar of one window over another window (other than over the title bar) until the shape changes, and then release the mouse. [Figure 2.7](#) shows two floating windows that are docked to one another and a third window that is floating by itself.

Figure 2.7. Floating, docked, floating and docked—there are a lot of possibilities!



Using all the techniques discussed so far, you can tailor the appearance of your design environment in all sorts of ways. There is no one best configuration. You'll find that different configurations work better for different projects and in different stages of development. For instance, when I'm designing the interface of a form, I want the toolbox to stay visible but out of my way, so I tend to make it float, or I turn off its Auto Hide property and leave it docked to the left edge of the design environment. However, after I've added the majority of the interface elements to a form, I want to focus on code. Then I dock the toolbox and make it Auto Hide itself; it's there when I need it, but it's out of the way when I don't. Don't be afraid to experiment with your design windows, and don't hesitate to modify them to suit your changing needs.

Working with Toolbars

Toolbars are the mainstay for performing functions quickly in almost every Windows program (you'll probably want to add them to your own programs at some point, and in [Hour 9](#), "Adding Menus and Toolbars to Forms," you'll learn how). Every toolbar has a corresponding menu item, and buttons on toolbars are essentially shortcuts to their corresponding menu items. To maximize your efficiency when developing with Visual Studio .NET, you should become familiar with the available toolbars. As your Visual C# .NET skills progress, you can customize existing toolbars and even create your own toolbars to more closely fit the way you work.

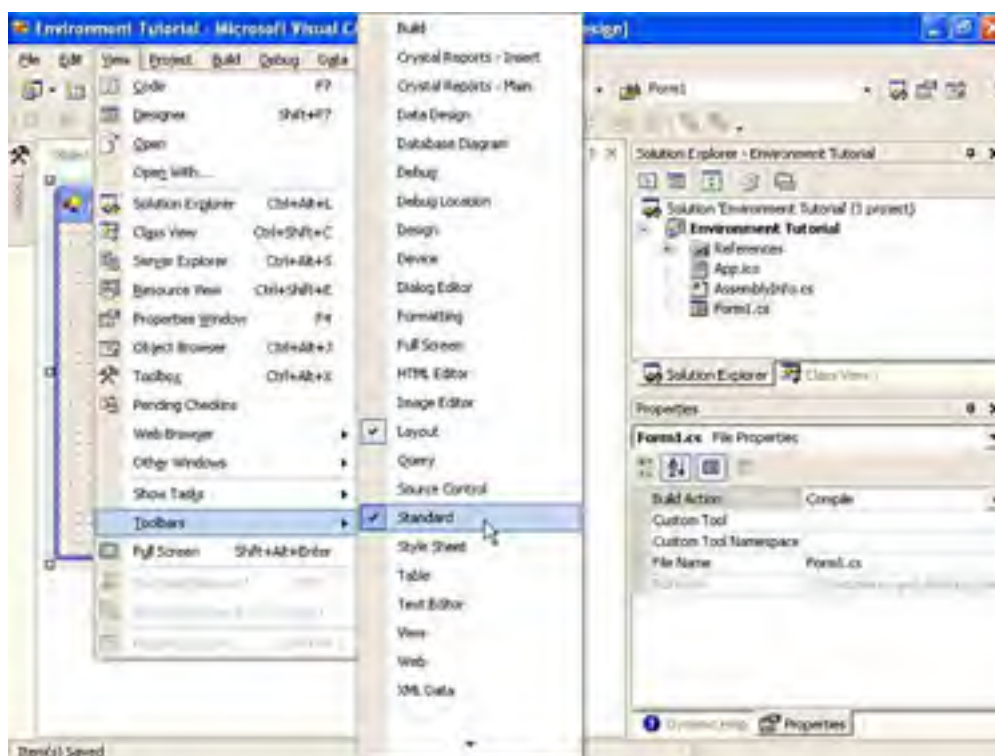
Showing and Hiding Toolbars

Visual Studio .NET includes a number of built-in toolbars you can use when creating projects. Two toolbars are visible in most of the figures shown so far in this hour. The one on the top is the Standard toolbar, which you'll probably want displayed all the time. The second toolbar is the Layout toolbar, which provides useful tools for building forms.

The previous edition of Visual Studio had about 5 toolbars; Visual Studio .NET, on the other hand, has more than 20! The toolbars you'll use most often as a Visual C# .NET developer are the Standard, Text Editor, and Debug toolbars. Therefore, this hour discusses each of these. In addition to these predefined toolbars, you can create your own custom toolbars to contain any functions you think necessary. You'll learn how to do this later in this hour.

To show or hide a toolbar, choose View, Toolbars to display a list of available toolbars. Toolbars currently displayed appear selected (see [Figure 2.8](#)). Click a toolbar name to toggle its visible state.

Figure 2.8. Hide or show toolbars to make your work more efficient.



Did you Know? Right-click any visible toolbar to quickly access the list of available toolbars.

Docking and Resizing Toolbars

Just as you can dock and undock Visual Studio .NET's design windows, you can dock and undock the toolbars. Unlike the design windows, however, Visual Studio .NET's toolbars don't have a title bar that you can click and drag when they're in a docked state. Instead, each docked toolbar has a drag handle (a set of horizontal lines along its left edge). To float (undock) a toolbar, click and drag the grab handle away from the docked edge. When a toolbar is floating, it has a title bar. To dock a floating toolbar, click and drag its title bar to the edge of the design environment to which you want it docked. This is the same technique you use to dock design windows.

Did you Know? A shortcut for docking a floating toolbar is to double-click its title bar.

Although you can't change the size of a docked toolbar, you can resize a floating toolbar (a floating toolbar behaves like any other normal window). To resize a floating toolbar, move the pointer over the edge you want to stretch and then click and drag the border to change the size of the toolbar.

Customizing Toolbars

As your experience with Visual Studio .NET grows, you'll find that you use certain functions repeatedly. To increase your productivity, you can customize any of Visual Studio .NET's toolbars, and you can create your own from scratch. You can even customize the Visual Studio .NET menu and create your own menus. To customize toolbars and menus, you use the Customize dialog box shown in [Figure 2.9](#), which is accessed by choosing View, Toolbars, Customize.

Figure 2.9. Create new toolbars or customize existing ones to fit the way you work.



By the way

I strongly suggest that you don't modify the existing Visual Studio .NET toolbars. Instead, create new toolbars of your own. If you modify the predefined toolbars, you may find that you've removed tools that I refer to in later examples. If you do happen to change a built-in toolbar, you can reset it to its original state by selecting it in the Customize dialog box and clicking Reset.

The Toolbars tab in the Customize dialog box shows you a list of all the existing toolbars and menus. The toolbars and menus currently visible have a check mark next to them. To toggle a toolbar or menu between visible and hidden, click its check box.

Creating a New Toolbar

You're now going to create a new toolbar to get a feel for how toolbar customization works. Your toolbar will contain a single button, which will be used to call Visual Studio's Help.

To create your new toolbar, follow these steps:

1. From the Toolbars tab of the Customize dialog box, click New.
2. Enter **My Help** as the name for your new toolbar when prompted.
3. Click OK to create the new toolbar.

After you've entered a name for your toolbar and clicked OK, your new toolbar appears, floating on the screen—most likely somewhere outside the Customize dialog box (see [Figure 2.10](#)). Dock your toolbar now by double-clicking the blank area on the toolbar (the area where a button would ordinarily appear). Your screen should look like the one in [Figure 2.11](#).

Figure 2.10. New toolbars are pretty tiny; they have no buttons on them.

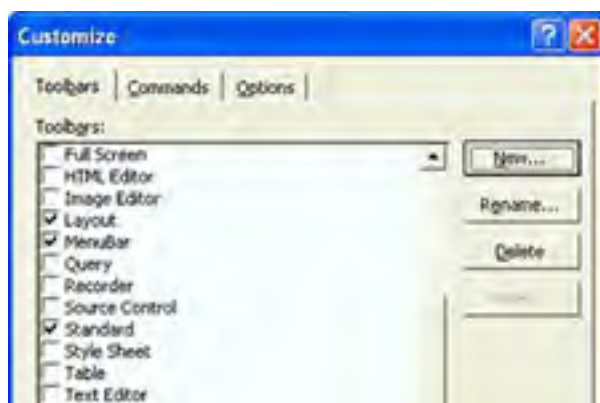
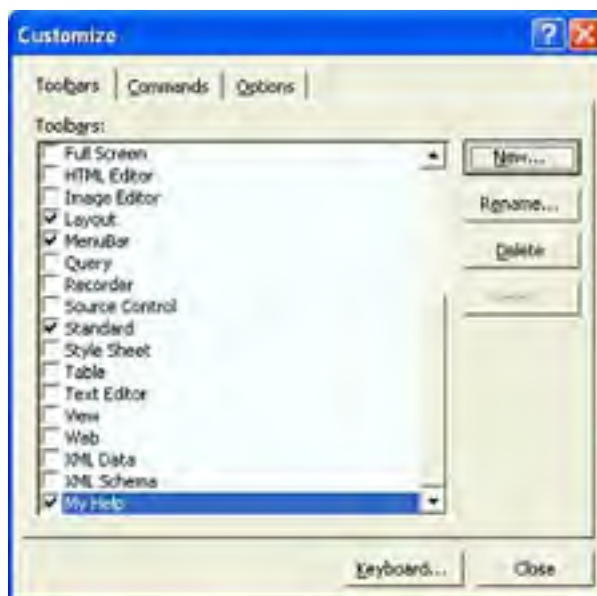




Figure 2.11. It's easier to customize toolbars when they're docked.



Adding Buttons to a Toolbar

Now that you have an empty toolbar, the next step is to add the desired command buttons to it. Click the Commands tab of the Customize dialog box to display all the available commands.

The Commands tab contains the following:

- A list of command categories
- A list of the commands for the selected command category

The Categories list shows all available command categories, such as File and Edit functions. When you select a category, all the available commands for that category are shown in the list on the right.

You're going to add a toolbar button that appears as a Help icon and that actually displays Help when clicked.

To add the command button to your toolbar, follow these steps:

1. Locate and select the category Help. All the available commands for the Help category will appear in the list on the right.
2. From the Commands list, click and drag the Contents command to your custom toolbar. As you drag, the pointer changes to an arrow pointing to a small gray box. At the lower-right corner of the pointer is a little hollow box with an x in it. This indicates that the location over which the pointer is positioned is not a valid location to drop the command.
3. As you drag the command over your toolbar (or any other toolbar for that matter), the x in the little box will change to a plus sign (+), indicating that the command can be placed in the current location. In addition, an insertion point (often called an I-beam because that's what it looks like) appears on the toolbar to indicate where the button would be placed if the command were dropped at that spot. When an I-beam appears on your toolbar and the pointer box contains a plus sign (see [Figure 2.12](#)), release the mouse button. Your toolbar will now look like the one in [Figure 2.13](#).

Figure 2.12. The cursor turns into an I-beam when you can drop the button.

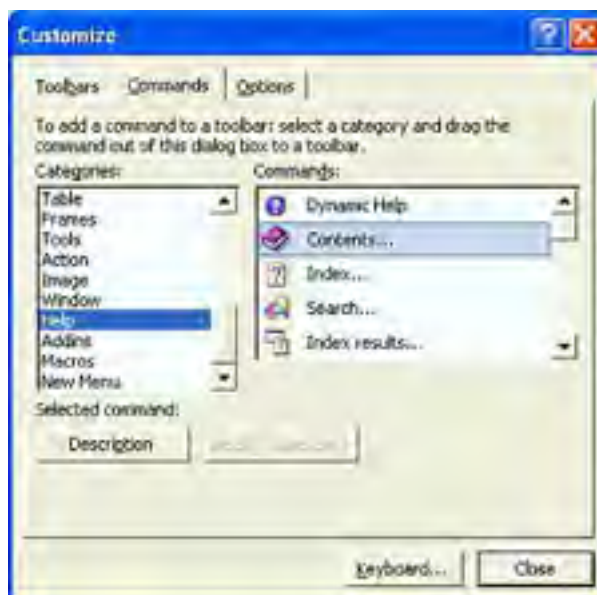
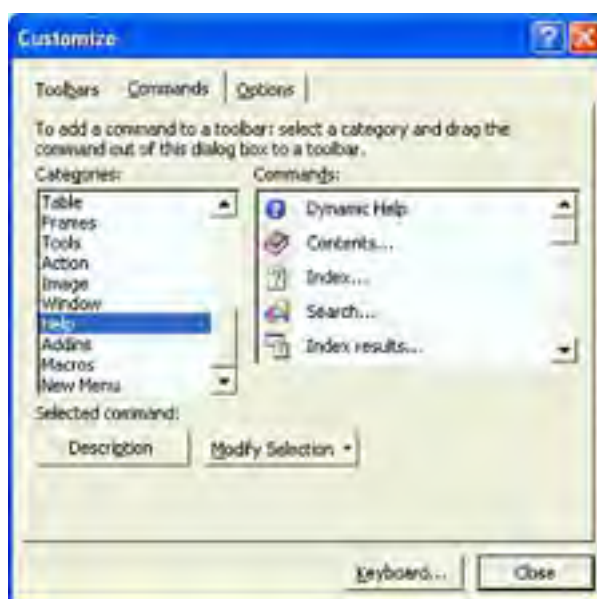


Figure 2.13. Building toolbars is a simple matter of dragging and dropping commands.



While the Customize dialog is being displayed, you can alter any button on a toolbar by right-clicking the button to access its shortcut menu and then choosing Change Button Image. Feel free to experiment with changing the image of the button on your custom toolbar, but be sure to leave the buttons on the built-in toolbars as they are.

To remove a button from a toolbar, drag the button to remove it from the toolbar and drop it somewhere other than on the same toolbar. If you drop the button onto another toolbar, the button is removed from the original toolbar and placed on the toolbar on which you dropped it. If you drop the button in a location where no toolbar exists, the button is simply removed from the toolbar.

By the Way You can drag command buttons only in Customize mode (while the Customize dialog is open). If you attempt to drag an item during normal operation, you'll simply click the button.

Did you Know? Although these techniques are illustrated using toolbars, they apply to menus as well.

Moving Buttons on a Menu or Toolbar

You should always attempt to group command buttons logically. For example, the Edit functions are all grouped together on the Standard toolbar, as are the File operations. A separator (space) is used to separate groups. To create a separator space, right-click the button that starts a new group and choose Begin a Group from the button's shortcut menu.

You probably won't get the exact groupings you want when you first add commands to a toolbar, but that's not a problem because you can change the position of a button at any time. To move a button on a toolbar, drag the button and drop it in the desired location (remember, you have to be in Customize mode to do this). To move a button from one toolbar to another, drag the button from its toolbar and drop it at the preferred location on the desired toolbar.

Now that your toolbar is complete (hey, I never said it'd be fancy), click Close on the Customize dialog box to exit Customize mode. All toolbars, including the one you just created, are no longer in Customize mode and they can't be modified. Click the button you placed on your new toolbar and Visual Studio .NET's Help will appear.

Because your custom toolbar really doesn't do much, hide it now to save screen real estate by right-clicking any toolbar to display the Toolbar shortcut menu and then deselecting My Help.



As you work your way through this book, you should always have the Standard toolbar and menu bar displayed on your screen.

Typically, you should customize toolbars only after you're very familiar with the available functions and only after you know which functions you use most often. I recommend that you refrain from modifying any of the predefined toolbars until you're quite familiar with Visual Studio .NET. As you become more comfortable with Visual Studio .NET, you can customize the toolbars to make your project work area as efficient as possible.

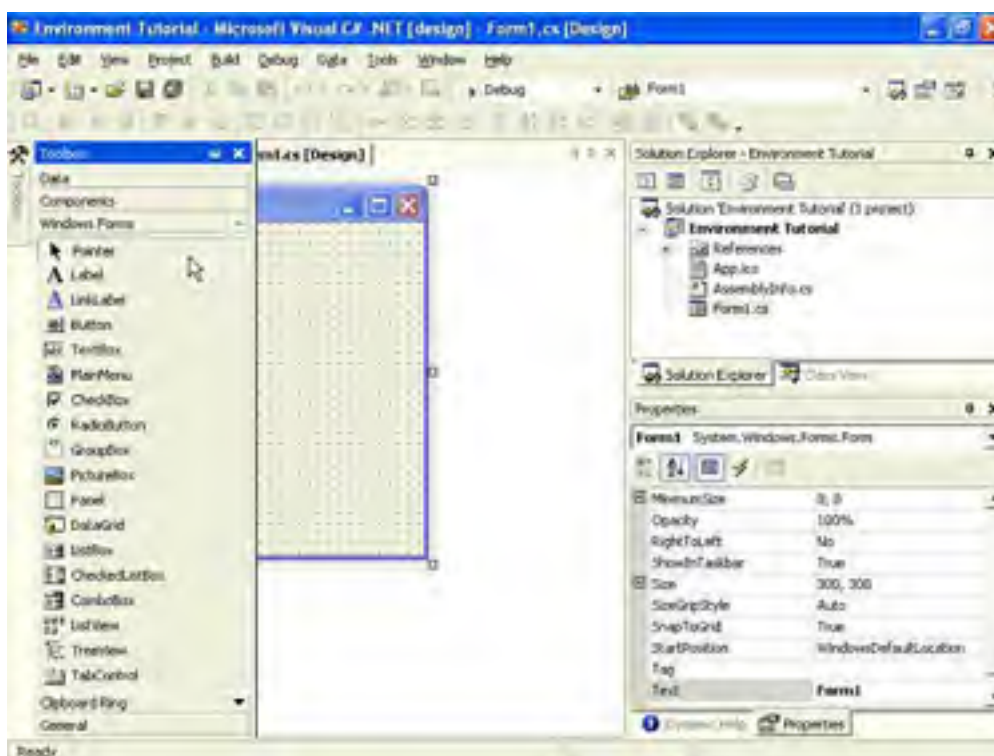
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Adding Controls to a Form Using the Toolbox

The IDE offers some fantastic tools for building a graphical user interface (GUI) for your applications. Most GUIs consist of one or more forms (Windows) with various elements on the forms, such as text boxes and list boxes. The toolbox is used to place controls onto a form. The default toolbox you see when you first open or create a Visual C# .NET project is shown in [Figure 2.14](#). The buttons labeled Data, Components, Windows Forms, and so on are actually tabs, although they don't look like standard tabs. Clicking any of these tabs causes a related set of controls to appear. The default tab is the Windows Forms tab, and it contains many great controls you can place on Windows forms (the forms used to build Windows applications, in contrast to Web applications discussed in [Hour 23](#), "Introduction to Web Development"). All the controls that appear by default on the tabs are included with Visual Studio .NET, and these controls are discussed in detail in [Hour 7](#), "Working with Traditional Controls," and [Hour 8](#), "Using Advanced Controls."

Figure 2.14. The standard toolbox contains many useful controls you can use to build robust user interfaces.



You can add a control to a form in one of three ways:

- In the toolbox, click the tool representing the control that you want to place on a form, and then click and drag on the form where you want the control placed (essentially, you're drawing the border of the control). The location at which you start dragging is used for the upper-left corner of the control, and the point at which you release the mouse button and stop dragging becomes the lower-right corner.
- Double-click the desired control type in the toolbox. When you double-click a control in the toolbox, a new control of the selected type is placed in the upper-left corner of the form. The control's height and width are set to the default height and width of the selected control type.
- Drag a control from the toolbox and drop it on a form.

Did you Know?

If you prefer to draw controls on your forms by clicking and dragging, I strongly suggest that you dock the toolbox to the right or bottom edge of the design environment or float it; the toolbar tends to interfere with drawing controls when it's docked to the left edge, because it obscures part of the form.

The very first item on the Windows Forms tab, titled Pointer, isn't actually a control. When the pointer item is selected, the design environment is placed in a select mode rather than in a mode to create a new control. With the pointer item selected, you can select a control by clicking it to display all its properties in the Properties window; this is the default behavior.

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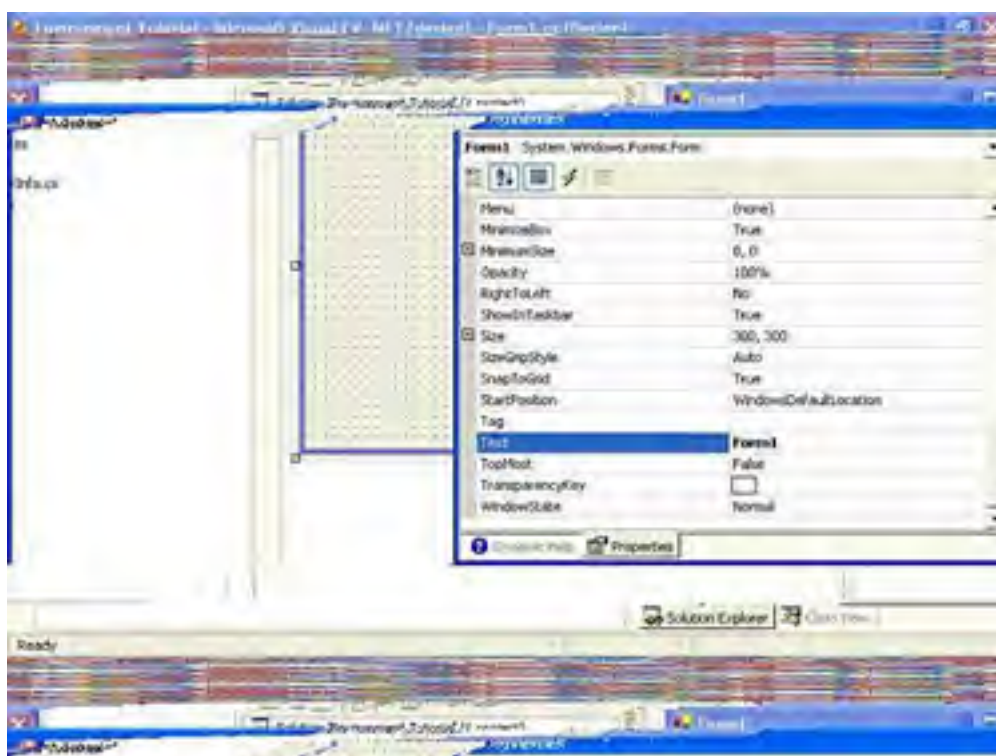
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Setting Object Properties Using the Properties Window

When developing the interface of a project, you'll spend a lot of time viewing and setting object properties using the Properties window (see [Figure 2.15](#)). The Properties window contains four items:

- An object drop-down list
- A list of properties
- A set of tool buttons used to change the appearance of the properties grid
- A section showing a description of the selected property

Figure 2.15. Use the Properties window to view and change properties of forms and controls.



Selecting an Object and Viewing Its Properties

The drop-down list at the top of the Properties window contains the name of the form with which you're currently working and all the controls (objects) on the form. To view the properties of a control, select it from the drop-down list or click the control on the form. You must have the pointer item selected in the toolbox to select an object by clicking it.

Viewing and Changing Properties

The first two buttons in the Properties window (Categorized and Alphabetic) enable you to select the format in which you view properties. When you select the Alphabetic button, the selected object's properties appear in the Properties window in alphabetical order. When you click the Categorized button, all the selected object's properties are listed by category. For example, the Appearance category contains properties such as BackColor and BorderStyle. When working with properties, select the view you're most comfortable with and feel free to switch back and forth between the views.

The Properties area of the Properties window is used to view and set the properties of a selected object. You can set a property in one of the following ways:

- Type in a value
- Select a value from a drop-down list
- Click a Build button for property-specific options

By the Way Many properties can be changed by more than one of these methods.

To better understand how changing properties works, follow these steps:

1. Start by creating a new Windows Application project. Name this project **Changing Properties**.
2. Add a new text box to a form by double-clicking the TextBox tool in the toolbox. You're now going to change a few properties of the new text box.
3. Select the "(Name)" property in the Properties window by clicking it. (If your properties are Alphabetic, it will be at the top of the list, not with the N's.) Type in a name for the text box—call it **txtComments**.
4. Click the BorderStyle property and try to type in the word **Big**—you can't; the BorderStyle property supports selecting values from a list only. You can, however, type a value that exists in the list. When you selected the BorderStyle property, a drop-down arrow appeared in the value column. Click this arrow now to display a list of the values that the BorderStyle property accepts. Select FixedSingle and notice how the appearance of the text box changes. To make the text box appear three-dimensional again, open the drop-down list and select Fixed3D.
5. Select the BackColor property, type in some text, and press the Tab key to commit your entry. Visual C# .NET displays an Invalid Property Value error. This happened because, although you can type in text, you're restricted to entering specific values (in the case of BackColor, the value must be a named color or a number that falls within a specific range). Click the drop-down arrow of the BackColor property and select a color from the drop-down list. (Selecting colors using the Color Palette is discussed later in this hour, and detailed information on using colors is provided in [Hour 18](#), "Working with Graphics.")
6. Select the Font property. Notice that a Build button appears (a small button with three dots on it). When you click the Build button, a dialog box specific to the property you've selected appears. In this instance, a dialog box that allows you to manipulate the font of the text box appears (see [Figure 2.16](#)). Different properties display different dialog boxes when you click their Build buttons.

Figure 2.16. The Font dialog box enables you to change the appearance of text in a control.



7. Notice how the Size property has a plus sign next to it. This indicates that the property has one or more subproperties. Click the plus sign now to expand the property, and you'll see that Size is composed of Width and Height.

By clicking a property in the Properties window, you can easily tell the type of input the property requires.

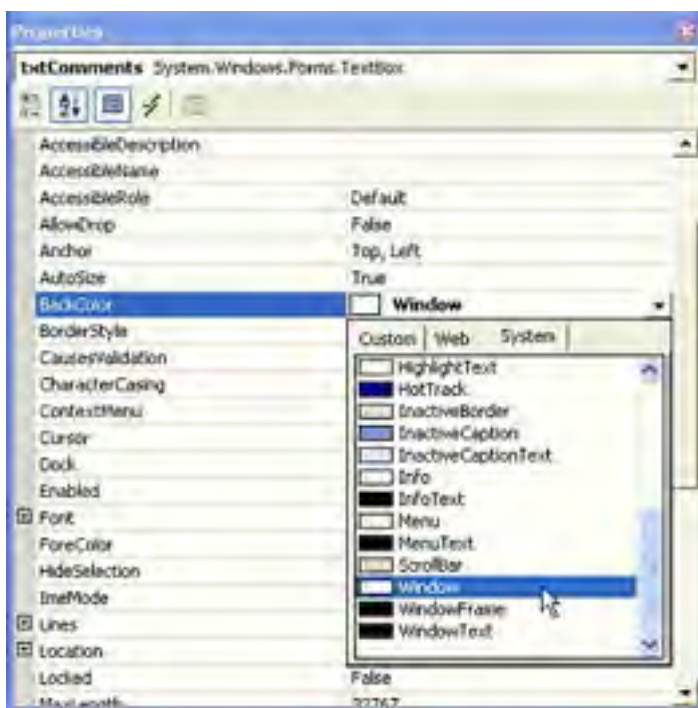
Working with Color Properties

Properties that deal with colors are unique in the way in which they accept values, yet all color-related properties behave the same way. In Visual C#, all colors are expressed as a set of three numbers, each number having a value from 0 to 255. A given set of numbers represents the Red, Green, and Blue (RGB) components of a color, respectively.

The value 0,255,0, for example, represents pure green, whereas the values 0,0,0 represent black and 255,255,255 represents white. (See [Hour 18](#) for more information on the specifics of working with color.)

A color rectangle is displayed for each color property in the Properties window; this color is the selected color for the property. Text is displayed next to the colored rectangle. This text is either the name of a color or a set of RGB values that defines the color. Clicking in a color property causes a drop-down arrow to appear, but the drop-down you get by clicking the arrow isn't a typical drop-down list. [Figure 2.17](#) shows what the drop-down list for a color property looks like.

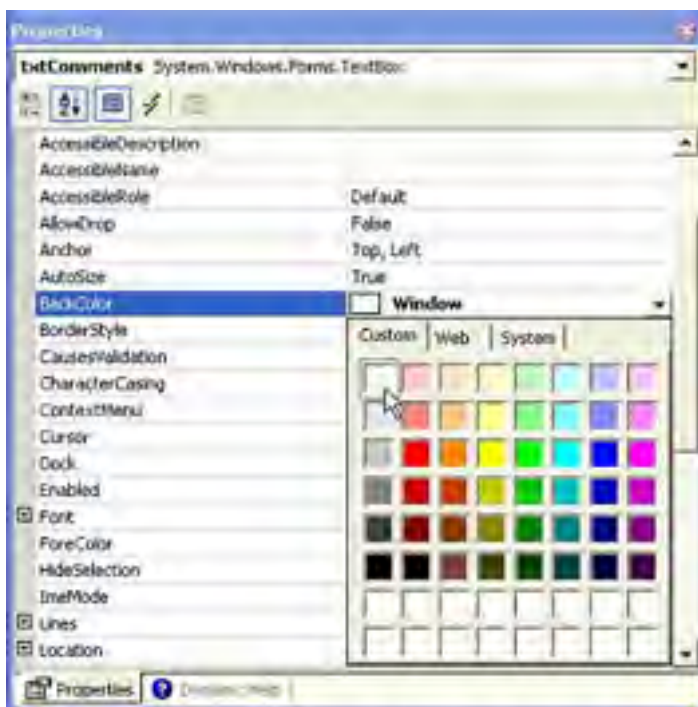
Figure 2.17. The color drop-down list enables you to select from three sets of colors.



The color drop-down list is composed of three tabs: Custom, Web, and System. Most color properties use a system color by default. [Hour 18](#) goes into great detail on system colors, so I only want to mention here that system colors vary from computer to computer; they are determined by the user when he or she right-clicks the desktop and chooses Properties from the desktop's shortcut menu. Use a system color when you want a color to be one of the user's selected system colors. When a color property is set to a system color, the name of the color appears in the property sheet.

The Custom tab shown in [Figure 2.18](#) is used to specify a specific color, regardless of the user's system color settings; changes to system colors have no effect on the property. The most common colors appear on the palette of the Custom tab, but you can specify any color you want.

Figure 2.18. The Custom tab of the color drop-down list lets you specify any color imaginable.

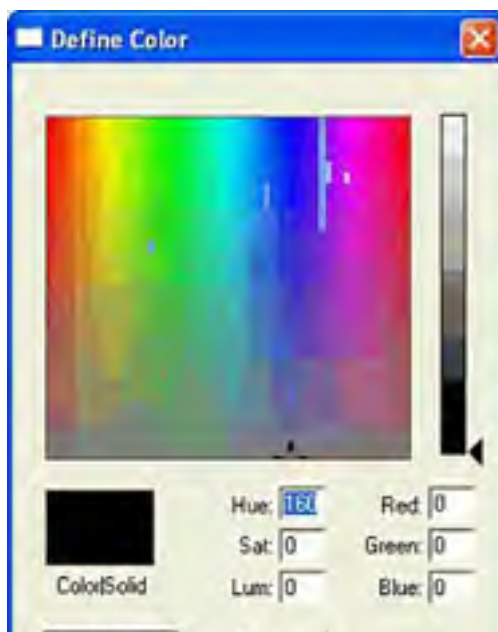


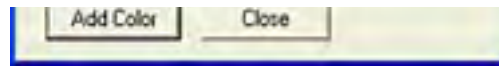
By the way

The colors visible in the various palettes are limited by the number of colors that can be produced by your video card. If your video card doesn't support enough colors, some will appear dithered, which means they will appear as dots of colors rather than as a true, solid color. Keep this in mind as you develop your applications; what looks good on your computer might turn to mush if a user's display isn't as capable.

The bottom two rows in the Custom color palette are used to mix your own colors. To assign a color to an empty color slot, right-click a slot in one of the two rows to access the Define Color dialog box (see [Figure 2.19](#)). Use the controls on the Define Color dialog box to create the color you want, and then click Add Color to add the color to the color palette in the slot you selected. In addition, the custom color is automatically assigned to the current property.

Figure 2.19. The Define Color dialog box lets you create your own colors.





The Web tab is used in Web applications to pick from a list of browser-safe colors.

Viewing Property Descriptions

It's not always immediately apparent just exactly what a property is or does—especially for new users of Visual Studio .NET. The Description section at the bottom of the Properties window shows a simple description of the selected property (refer to [Figure 2.15](#)). To view a description, click a property or value area of a property. For a more complete description of a property, click it once to select it and then press F1 to display Help about the property.

You can hide or show the Description section of the Properties window at any time by right-clicking anywhere within the Properties window (other than in the value column or on the title bar) to display the Properties window shortcut menu and choosing Description. Each time you do this, you toggle the Description section between visible and hidden. To change the size of the Description box, click and drag the border between it and the Properties area.

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Managing Projects

Before you can effectively create an interface and write code, you need to understand what makes up a Visual C# .NET project and how to add and remove various components from within your own projects. In this section, you'll learn about the Solution Explorer window and how it's used to manage project files. You'll also learn specifics about projects and project files, as well as how to change a project's properties.

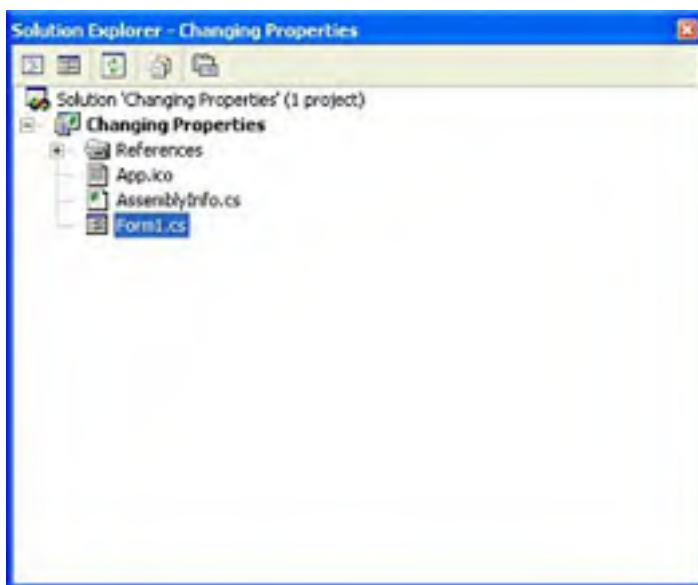
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Managing Project Files with the Solution Explorer

As you develop projects, they'll become more and more complex, often containing many objects such as forms and modules. Each object is defined by one or more files on your hard drive. In addition, you can build complex solutions composed of more than one project. The Solution Explorer window shown in [Figure 2.20](#) is the tool for managing all the files in a simple or complex solution. Using the Solution Explorer, you can add, rename, and remove project files, as well as select objects to view their properties. If the Solution Explorer window isn't visible on your screen, show it now by choosing View, Solution Explorer.

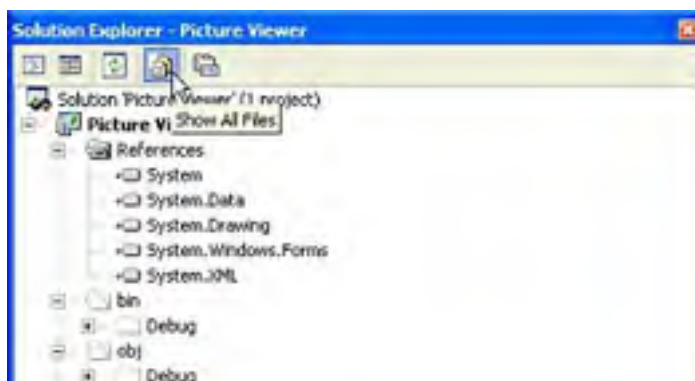
Figure 2.20. Use the Solution Explorer window to manage all the files that make up a project.



To get acquainted with the Solution Explorer window, follow these steps:

1. Locate the Picture Viewer program you created in the Quick Tour by choosing File, Open, and then clicking Project.
2. Open the Picture Viewer project. The file you need to select is located in the Picture Viewer folder that Visual Studio .NET created when the project was constructed. The file has the extension .sln (for solution). If you're asked whether you want to save the current project, choose No.
3. Select the Picture Viewer project item in the Solution Explorer (be sure to click the Project node, not the Solution node). When you do, a button becomes visible toward the top of the window. This button has a picture of pieces of paper and has the tooltip Show All Files (see [Figure 2.21](#)). Click this button and the Solution Explorer displays all files in the project.

Figure 2.21. Notice that the form you defined appears as two files in the Solution Explorer.





Your Solution Explorer should now look like the one in [Figure 2.21](#). Be sure to widen the Solution Explorer window so that you can read all the text it contains.

By the Way

Some forms and other objects may be composed of more than one file. By default, Visual Studio .NET hides project files that you don't directly manipulate. Click the plus sign (+) next to the form item and you'll see a subitem titled Form1.resx. You'll learn about these additional files in [Hour 5, "Building Forms—The Basics."](#) For now, click the Show All Files button again to hide these related files.

You can view any object listed within the Solution Explorer using the object's default viewer by double-clicking the object. Each object has a default viewer but may actually have more than one viewer. For instance, a form has a Form Design view as well as a Code view. By default, double-clicking a form in the Solution Explorer displays the form in Form Design view, where you can manipulate the form's interface.

You've already learned one way to access the code behind a form—double-click an object to access its default event handler. You'll frequently need to get to the code of a form without adding a new event handler. One way to do this is to use the Solution Explorer. When a form is selected in the Solution Explorer, buttons are visible at the top of the Solution Explorer window that allow you to display the code editor or the form designer, respectively.

You'll use the Solution Explorer window so often that you'll probably want to dock it to an edge and set it to Auto Hide, or perhaps keep it visible all the time. The Solution Explorer window is one of the easiest to get the hang of in Visual Studio .NET; navigating the Solution Explorer window will be second nature to you before you know it.

Working with Solutions

In truth, the Solution Explorer window is the evolution of the Project Explorer window from versions of Visual Studio prior to .NET, and the two windows are similar in many ways. Understanding solutions is easier when you understand projects.

A project is what you create with Visual C# .NET. Often, the words *project* and *program* are used interchangeably; this isn't much of a problem if you understand the important distinctions. A project is the set of source files that make up a program or component, whereas a program is the binary file that you build by compiling source files into something such as a Windows executable file (.exe). Projects always consist of a main project file and may be made up of any number of other files, such as form files or class module files. The main project file stores information about the project—all the files that make up the project, for example—as well as properties that define aspects of a project, such as the parameters to use when the project is compiled into a program.

What, then, is a solution? As your abilities grow and your applications increase in complexity, you'll find that you have to build multiple projects that work harmoniously to accomplish your goals. For instance, you might build a custom user control such as a custom data grid that you use within other projects you design, or you could isolate the business rules of a complex application into separate components to run on isolated servers. All the projects used to accomplish those goals are collectively called a *solution*. Therefore, a solution (at its most basic level) is really nothing more than a grouping of projects.

Did you Know?

You should group projects into a single solution only when the projects relate to one another. If you have a number of projects that you're working on, but each of them is autonomous, work with each project in a separate solution.

Understanding Project Components

As I stated earlier, a project always consists of a main project file, and it may consist of one or more secondary files, such as files that make up forms or code modules. As you create and save objects within your project, one or more corresponding files are created and saved on your hard drive. Each file that gets created for a Visual C# .NET source object has the extension `.cs`, denoting that it defines a Visual C# .NET object. Make sure that you save your objects with

understandable names, or things will get confusing as the size of your project grows.

All the files that make up a project are text files. Some objects need to store binary information, such as a picture for a form's `BackgroundImage` property. Binary data is stored in an XML file (which is still a text file). Suppose you had a form with an icon on it. You'd have a text file defining the form (its size, the controls on it, and the code behind it), and an associated *resource file* with the same name as the form file but with the extension `.resx`. This secondary file would be in XML format and would contain all the binary data needed to create the form.



If you want to see what the source file of a form file looks like, use Notepad to open one on your computer. Don't save any changes to the file, however, or it may never work again (</insert evil laugh here/>).

The following is a list of some of the components you can use in your projects:

- **Class Modules** Class modules are a special type of module that enable you to create object-oriented applications. Throughout the course of this book, you're learning how to program using an object-oriented language, but you're mostly learning how to use objects supplied by Visual C# .NET. In [Hour 16](#), "Designing Objects Using Classes," you'll learn how to use class modules to create your own objects.
- **Forms** Forms are the visual windows that make up the interface of your application. Forms are defined using a special type of class module.
- **User Controls** User controls (formerly ActiveX controls, which were formerly OLE controls) are controls that can be used on the forms of other projects. For example, you could create a User control with a calendar interface for a contact manager. Creating user controls requires the skill of an experienced programmer; therefore, I won't be covering them in this book.

Setting Project Properties

Visual C# .NET projects have properties, just as other objects such as controls do. Projects have lots of properties, many of them relating to advanced functionality that I won't be covering in this book. You need to be aware, however, of how to access project properties and how to change some of the more commonly used properties.

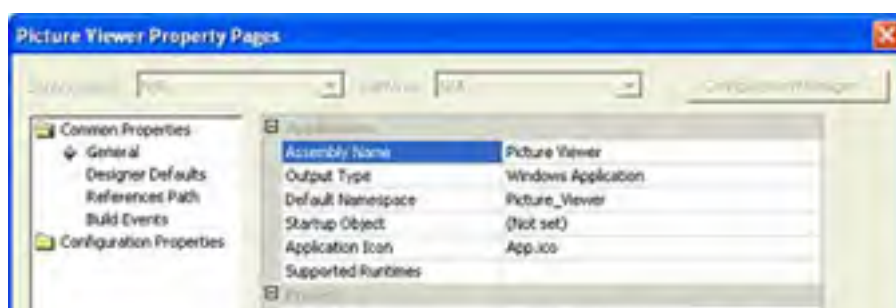
To access the properties for a project, right-click the project name (Picture Viewer) in the Solution Explorer window and choose Properties from the shortcut menu. Do this now.



If you select the project in the Solution Explorer, the last menu item on the Project menu will be Properties. If the last thing you selected was a form or other object, this menu item will read `<project name> properties`. These items display the same dialog box.

The Tree View control on the left side of the dialog box is used to display a property page (see [Figure 2.22](#)). When you first open the dialog box, the General page is visible. On this page, the setting you'll need to worry about most is the Startup Object property. The Startup Object setting determines the name of the class that contains the `Main()` method that is to be called on program startup. The (Not Set) option, as shown in [Figure 2.22](#), is valid if only one `Main()` method exists in your application. If more than one `Main()` method exists (this isn't recommended), you will have to specify which class contains the method to be called on startup.

Figure 2.22. Project properties enable you to tailor aspects of the project as a whole.





The Output Type option determines the type of compiled component defined by this source project. When you create a new project, you select the type of project to create (such as Windows Application), so this field is always filled in. At times, you might have to change this setting after the project has been created, and this is the place to do so.

Notice that the project folder, project filename, and output name are displayed on this page as well. If you work with a lot of projects, you may find this information valuable; this is certainly the easiest place to find it.



The output name determines the filename created when you build an executable. Distributing applications is discussed in [Hour 22](#), "Deploying a Visual C# .NET Solution."

As you work through the hours in this book, I'll refer to the Project Properties dialog box as necessary, explaining pages and items in context with other material.

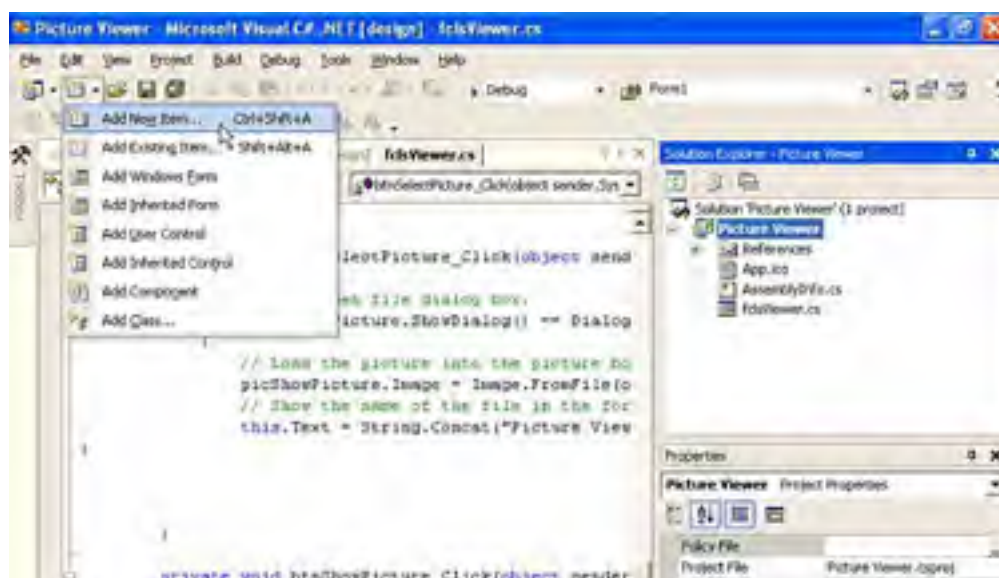
Adding and Removing Project Files

When you first start Visual Studio .NET and create a new Windows Application project, Visual Studio .NET creates the project with a single form. You're not limited to having one form in a project, however; you can create new forms or add existing forms to your project at will (feeling powerful yet?). You can also create and add classes, as well as other types of objects.

You can add a new or existing object to your project in one of three ways:

- Choose the appropriate menu item from the Project menu.
- Click the small drop-down arrow that is part of the Add New Item button on the Standard toolbar, and then choose the object type from the drop-down list that is displayed (see [Figure 2.23](#)).

Figure 2.23. This tool button drop-down is one of three ways to add objects to a project.

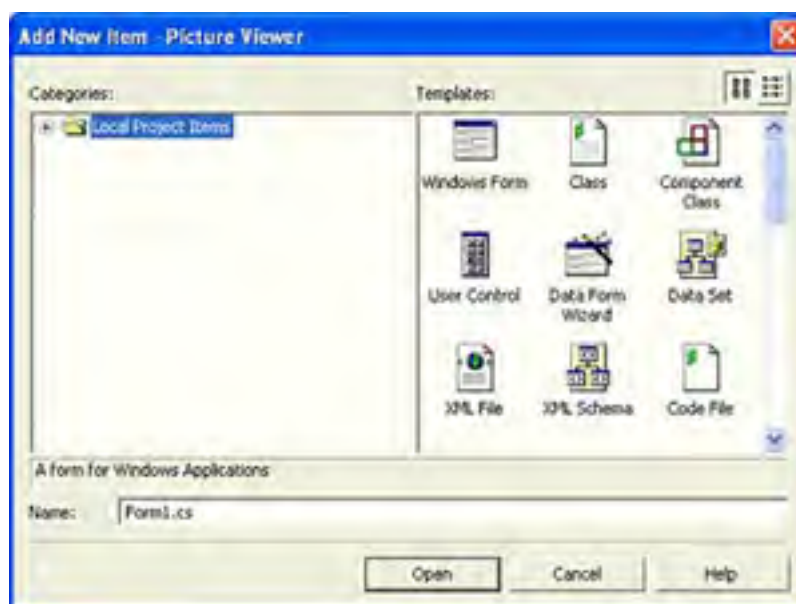




- Right-click the project name in the Solution Explorer window, and then choose Add from the shortcut menu to access a submenu from which you can select object types.

When you select Add *ObjectType* from any of these menus, a dialog box appears, showing you the objects that can be added to the project. Your chosen item is selected by default (see [Figure 2.24](#)). Simply name the object and click Open to create a new object of the selected type. To create an object of a different type, click the type to select it, name it, and then click Open.

Figure 2.24. Regardless of the menu option you select, you can add any type of object you want using this dialog box.



Adding new forms and modules to your project is easy, and you can add as many as you like. You'll come more and more to rely on the Solution Explorer to manage all the objects in the project as the project becomes more complex.

Although it won't happen as often as adding project files, you may sometimes need to remove an object from a project. Removing objects from your project is even easier than adding them. To remove an object, right-click the object in the Solution Explorer window and select Exclude from Project. This removes the object from the file but does not delete the source file from the disk. Selecting Delete, on the other hand, removes the file from the project and deletes it from the disk. Don't select Delete unless you want to totally destroy the file and you're sure that you'll never need it again in the future.

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Getting Help

Although Visual Studio .NET was designed to be as intuitive as possible, you'll find that you occasionally need assistance in performing a task. It doesn't matter how much you know; Visual Studio .NET is so complex and contains so many features that you'll have to use Help sometimes. This is particularly true when writing Visual C# .NET code; you won't always remember the command you need or the syntax of the command. Fortunately, Visual Studio .NET includes a comprehensive Help feature.

To access Help from within the design environment, press F1. Generally speaking, when you press F1, Visual Studio .NET shows you a help topic directly related to what you're doing. This is known as context-sensitive help, and when it works, it works well. For example, you can display help for any Visual C# .NET syntax or keyword (functions, objects, methods, properties, and so on) when writing Visual C# .NET code by typing the word into the code editor, positioning the cursor anywhere within the word (including before the first letter or after the last), and pressing F1. You can also get to help from the Help menu on the menu bar.

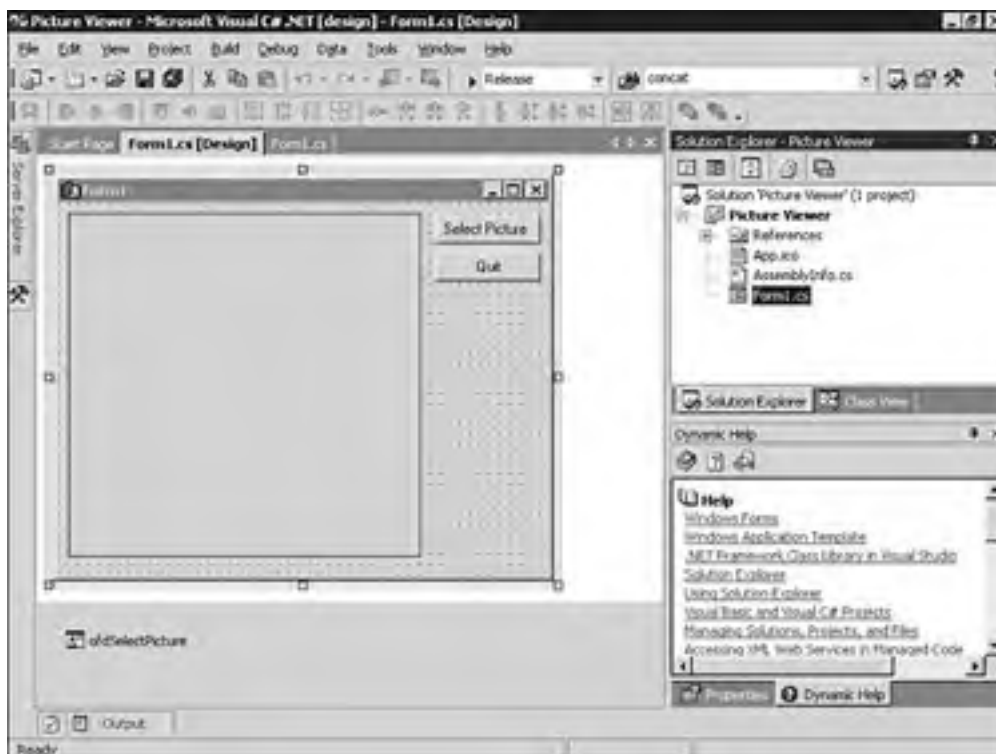


If your project is in run mode, Visual Studio .NET's Help won't be displayed. Instead, the help for your application will appear—if you've created Help.

Help displays topics directly within the design environment instead of in a separate window. This is a new feature of .NET. Personally, I think this method is considerably inferior to the old style of Visual Studio .NET having Help float above the design environment. When Help is displayed within the design environment, you can't necessarily see the code, form, or other object with which you're working. To make Help float above the design environment, choose Tools, Options to display the Options dialog box, click Help in the Tree view on the left, and choose External Help.

Visual Studio .NET includes a Help feature called Dynamic Help. To display the Dynamic Help window, choose Help, Dynamic Help. The Dynamic Help window shows Help links related to what it is you're working on (see [Figure 2.25](#)). For instance, if you select a form, the contents of the Dynamic Help window show you Help links related to forms. If you click a text box, the contents of the Dynamic Help window adjust to show you Help links related to text boxes. This is an interesting feature, and you may find it valuable.

Figure 2.25. Dynamic Help gives you a list of Help links related to the task you're performing.



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Summary

In this hour, you learned how to use the Visual Studio Start page—your gateway to Visual C# .NET. You learned how to create new projects and how to open existing projects. The Visual Studio .NET environment is your workspace, toolbox, and so much more. You learned how to navigate the environment, including how to work with design windows (hide, show, dock, and float).

You'll use toolbars constantly, and now you know how to modify them to suit your specific needs. You learned how to create new toolbars and how to modify existing toolbars. This is an important skill that shouldn't be overlooked.

Visual Studio .NET has many different design windows, and in this hour, you began learning about some of them in detail. You learned how to get and set properties using the Properties window, how to manage projects using the Solution Explorer, and how to add controls to a form using the toolbox. You'll use these skills often, so it's important to get familiar with them right away. Finally, you learned how to access Visual Studio .NET's Help feature, which I guarantee you will find very important as you learn to use Visual C# .NET.

Visual Studio .NET is a vast and powerful development tool. Don't expect to become an expert overnight; this is simply impossible. However, by learning the tools and techniques presented in this hour, you've begun your journey. Remember, you'll use most of what you learned in this hour each and every time you use Visual C# .NET. Get proficient with these basics and you'll be building cool programs in no time!

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Q&A

Q1: *How can I easily get more information about a property when the Description section of the Properties window just doesn't cut it?*

A1: Click the property in question to select it, and then press F1; context-sensitive help applies to properties in the Properties window, as well.

Q2: *I find that I need to see a lot of design windows at one time, but I can't find that "magic" layout. Any suggestions?*

A2: Run at a higher resolution. Personally, I won't develop in less than 1024x768. As a matter of fact, all my development machines have two displays, both running at this resolution (or higher). You'll find that any investment you make in having more screen real estate will pay you big dividends.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** How can you make the Visual Studio Start Page appear at startup if this feature has been disabled?
- 2:** Unless instructed otherwise, you are to create what type of project when building examples in this book?
- 3:** To make a docked design window appear when you hover over its tab and disappear when you move the mouse away from it, you change what setting of the window?
- 4:** How do you access the Toolbars menu?
- 5:** What design window do you use to add controls to a form?
- 6:** What design window is used to change the attributes of an object?
- 7:** To modify the properties of a project, you must select the project in what design window?
- 8:** Which Help feature adjusts the links it displays to match what it is you are doing?

Exercises

- 1:** Create a custom toolbar that contains Save All, Start, and Stop Debugging—three buttons you'll use a lot throughout this book.
- 2:** Use the Custom Color dialog box to create a color of your choice, and then assign the color to the BackColor property of a form.

Hour 3. Understanding Objects and Collections

In [Hour 1](#), "Jumping in with Both Feet: A Visual C# .NET Programming Tour," you were introduced to programming in Visual C# by building a Picture Viewer project. You spent [Hour 2](#), "Navigating Visual Studio .NET," digging into the IDE and learning skills critical to your success with Visual C#. In this hour, you're going to start learning about some important programming concepts, namely *objects*.

The term **object** as it relates to programming may have been new to you prior to reading this book. The more you work with Visual C# .NET, the more you'll hear about objects. Visual C# .NET is a true object-oriented language. This hour isn't going to discuss object-oriented programming in great detail—object-oriented programming is a very complex subject and is well beyond the scope of this book. Instead, you'll learn about objects in a more general sense.

Everything you use in Visual C# .NET is an object, so understanding this material is critical to your success with Visual C# .NET. For example, forms are objects, as are the controls you place on a form; pretty much every element of a Visual C# .NET project is an object and belongs to a *collection* of objects. All objects have attributes (called properties), most have methods, and many have events. Whether you're creating simple applications or building large-scale enterprise solutions, you must understand what an object is and how it works. In this hour, you'll also learn what makes an object an object, and you'll learn about collections.

The highlights of this hour include the following:

- Understanding objects
- Getting and setting properties
- Triggering methods
- Understanding method dynamism
- Writing object-based code
- Understanding collections
- Using the Object Browser

By the way

If you've listened to the programming press at all, you've probably heard the term *object-oriented*, and perhaps words such as polymorphism and inheritance. I won't cover all the details of object-oriented programming (OOP) theory in this book: You'll be introduced to object-oriented programming in this book, but if you want to take your programming skills to a more advanced level, you should progress to a book dedicated to the subject of OOP after you've completed this one.

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Understanding Objects

Object-oriented programming has been a technical buzzword for quite some time. Almost everywhere you look—the Web, publications, books—you read about **objects**. What exactly is an object? Strictly speaking, it is a programming structure that *encapsulates* data and functionality as a single unit. When data and functionality are encapsulated, the only public access to the data and functions is through the programming structure's interfaces (properties, methods, and events). In reality, the answer to this question can be somewhat ambiguous because there are so many types of objects—and the number grows almost daily. However, all objects share specific characteristics, such as properties and methods.

The most commonly used objects in Windows applications are the form object and the control object. Earlier hours introduced you to working with forms and controls and showed you how to set form and control properties. In your Picture Viewer project from [Hour 1](#), for instance, you added a picture box and two buttons to a form. Both the PictureBox and the Button control are *control objects*, but each is a specific type of control object. Another, less technical example uses pets. Dogs and cats are definitely different entities (objects), but they both fit into the category of Pet objects. Similarly, text boxes and buttons are each a unique type of object, but they're both considered a control object. This small distinction is important.

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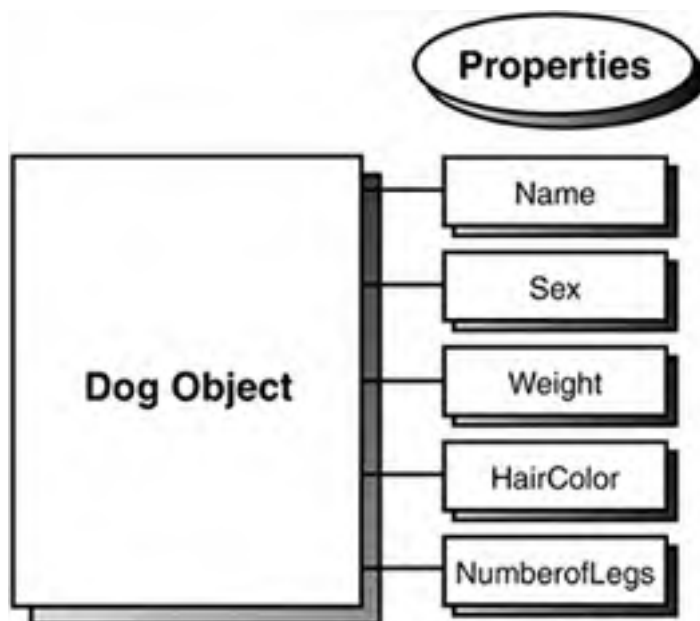
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Understanding Properties

All objects have attributes used to specify and return the state of the object. These attributes are properties, and you've already used some of them in previous hours using the Properties window. Indeed, every object **exposes** (provides for access by other code) a specific set of properties, but not every object exposes the same set of properties. To illustrate this point, I will continue with the hypothetical Pet object. Suppose you have an object, and the object is a dog. This Dog object has a certain set of properties that are common to all dogs. These properties include attributes such as the dog's name, the color of its hair, and even the number of legs it has. All dogs have these same properties; however, different dogs have different values for these properties. [Figure 3.1](#) illustrates such a Dog object and its properties.

Figure 3.1. Properties are the attributes that describe an object.



Getting and Setting Properties

You've already seen how to read and change properties using the Properties window. The Properties window is available only at design time, however, and is used only for manipulating the properties of forms and controls. Most getting (reading) and changing of properties you'll perform will be done with Visual C# .NET code, not by using the Properties window. When referencing properties in code, you specify the name of the object first, followed by a period (.), and then the property name, as in the following syntax:

```
{ObjectName}.{Property}
```

If you had a Dog object named Bruno, for example, you would reference Bruno's hair color this way:

```
Bruno.HairColor
```

This line of code would return whatever value was contained in the HairColor property of the Dog object Bruno. To set a property to some value, you use an equal (=) sign. For example, to change the Dog object Bruno's Weight property, you would use a line of code such as the following:

```
Bruno.Weight = 90;
```

When you reference a property on the left side of an equal sign, you're setting the value. When you reference a property on the right side of the equal sign, you're getting the value.

```
Bruno.Weight = 90;
```

The following line of code places the value of the Weight property of the Dog object called Bruno into a temporary variable. (Think of a variable as a storage location. For example, suppose that you wanted to add two numbers together and store the result for future use; you would store the result in a variable.) This statement retrieves the value of the Weight property because the Weight property is referenced on the right side of the equal sign.

```
fltWeight = Bruno.Weight;
```



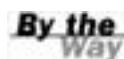
Variables are discussed in detail in [Hour 11](#), "Using Constants, Data Types, Variables, and Arrays."

When the processor executes this statement, it retrieves the value in the Weight property of the Dog object Bruno and places it in the variable (storage location) titled fltWeight. Assuming that Bruno's Weight is 90, as set in the previous example, the computer would process the following code statement like this

```
fltWeight = 90;
```

Just as in real life, some properties can be read but not changed. Suppose you have a Sex property to designate the gender of a Dog object. It's impossible for you to change a dog from a male to a female or vice versa (at least I think it is). Because the Sex property can be retrieved but not changed, it's known as a **read-only** property. You'll often encounter properties that can be set in design view but become read-only when the program is running.

One example of a read-only property is the Height property of the Combo Box control. Although you can view the value of the Height property in the Properties window, you cannot change the value—no matter how hard you try. If you attempt to change the Height property using Visual C# .NET code, Visual C# .NET simply changes the value back to the default—eerie.



The best way to determine which properties of an object are read-only is to consult the online help for the object in question.

Working with an Object and Its Properties

Now that you know what properties are and how they can be viewed and changed, you're going to experiment with properties in a simple project. In [Hour 1](#), you learned how to set the Height and Width properties of a form using the Properties window. Now, you're going to change the same properties using Visual C# .NET code.

The project you're going to create consists of a form with some buttons on it. One button will enlarge the form when clicked, whereas the other will shrink the form. This is a very simple project, but it illustrates rather well how to change object properties in Visual C# .NET code.

Follow the steps below to create the project:

1. Start by creating a new Windows Application project (choose File, New, Project).
2. Name the project **Properties Example**.
3. Use the Properties window to change the name of the form to **fcIsShrinkMe**. (Click the form once to select it and you'll be able to change its Name in the Properties window.)
4. Next, change the Text property of the form to **Grow and Shrink**.
5. Click the View Code button in Solution Explorer to view the code behind the form. Scroll down and locate the reference to Form1 and change it to **fcIsShrinkMe** (it will most likely appear toward the bottom of the class listing).
6. Click the Form1.cs [Design] tab to return to the form designer.

When the project first runs, the default form will have a Height and Width as specified in the Properties window. You're going to add buttons to the form that a user can click to enlarge or shrink the form at runtime.

Add a new button to the form by double-clicking the Button tool in the toolbox. Set the new button's properties as follows:

Property

Set To

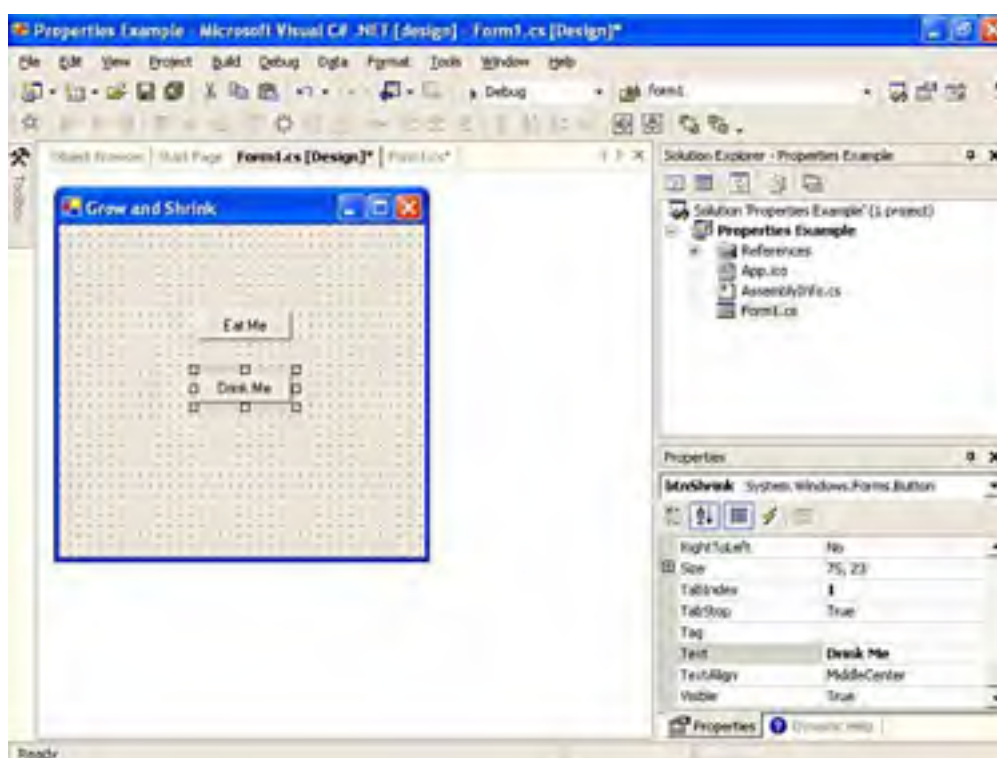
Name	btnEnlarge
Location	111,70
Text	Eat Me

Now for the Shrink button. Again, double-click the Button tool in the toolbox to create a new button on the form. Set this new button's properties as follows:

Property	Set To
Name	btnShrink
Location	111,120
Text	Drink Me

Your form should now look like the one shown in [Figure 3.2](#).

Figure 3.2. Each button is an object, as is the form the buttons sit on.

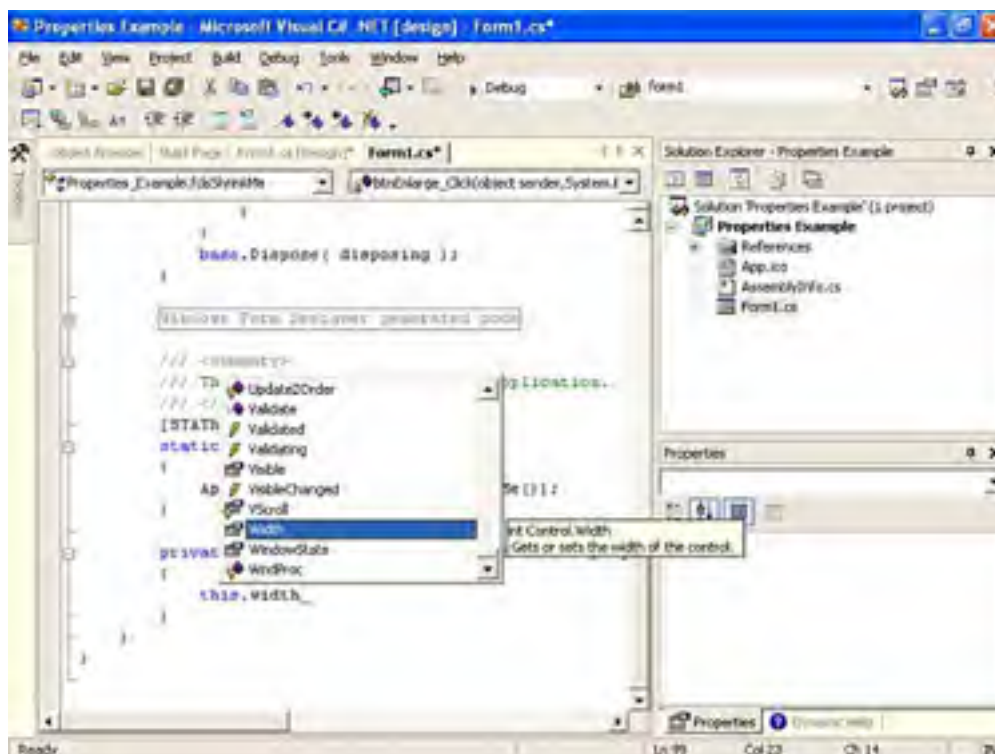


To complete the project, you need to add the small amount of Visual C# .NET code necessary to modify the form's Height and Width properties when the user clicks a button. Access the code for the Enlarge button now by double-clicking the Eat Me button. Type the following statement exactly as you see it here. Do not hit the Enter key or add a space after you've entered this text.

```
this.Width
```

When you typed the period, or "dot," as it's called, a small drop-down list appeared, like the one shown in [Figure 3.3](#). Visual C# .NET is smart enough to realize that this represents the current object (more on this in a moment), and to aid you in writing code for the object. It gives you a drop-down list containing all the properties and methods of the form. This feature is called **IntelliSense**, and it is relatively new to Visual Studio. When an IntelliSense drop-down list appears, you can use the up and down arrow keys to navigate the list, and press Tab to select the highlighted list item. This prevents you from misspelling a member name, thereby reducing compile errors. Because Visual C# .NET is fully object-oriented, you'll come to rely on IntelliSense drop-down lists in a big way; I think I'd rather dig ditches than program without them.

Figure 3.3. IntelliSense drop-down lists (also called auto-completion drop-down lists) make coding dramatically easier.



Use the Backspace key to completely erase the code you just entered and enter the following code in its place (press Enter at the end of each line):

```
this.Width = this.Width + 20;  
this.Height = this.Height + 20;
```

Again, the word `this` refers to the object to which the code belongs (in this case, the form). The word `this` is a *reserved* word; it's a word that you can't use to name objects or variables because Visual C# .NET has a specific meaning for it. When writing code within a form module, as you are doing here, you should always use the `this` reserved word rather than using the name of the form. `this` is much shorter than using the full name of the current form, and it makes the code more portable (you can copy and paste the code into another form module and not have to change the form name to make the code work). Also, if you change the name of the form at any time in the future, you won't have to change references to the old name.



Visual C# .NET is a case-sensitive language; if you type even one character in the wrong case (such as `.height` instead of `.Height`), the code won't work.

The code you've entered does nothing more than set the Width and Height properties of the form to whatever the current value of the Width and Height properties happens to be, plus 20 pixels.

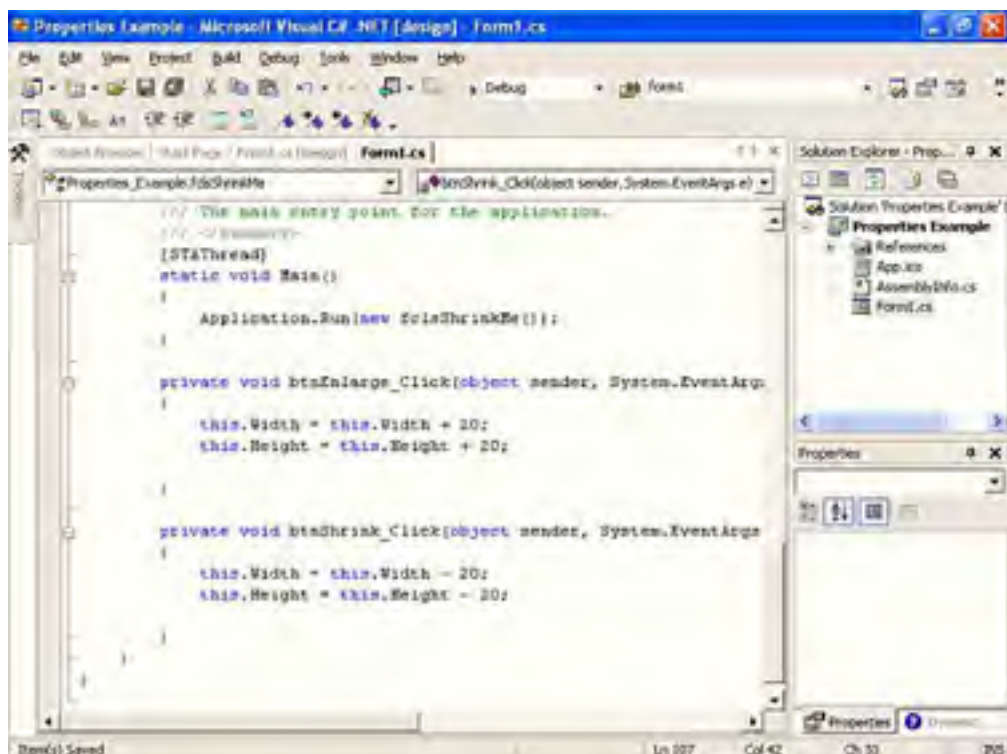
Redisplay the form designer by selecting the tab titled Form1.cs [Design]; then double-click the Shrink button to access its Click event and add the following code:

```
this.Width = this.Width - 20;  
this.Height = this.Height - 20;
```

This code is very similar to the code in the Enlarge_Click event, except that it reduces the Width and Height properties of the form by 20 pixels.

Your screen should now look like [Figure 3.4](#).

Figure 3.4. The code you've entered should look exactly like this.



Did you Know?

As you create projects, it's a very good idea to save frequently. Save your project now by clicking the Save All button on the toolbar.

Once again, display the form designer by clicking the tab Form1.cs [Design]. Your Properties Example is now ready to be run! Press F5 to put the project in Run mode (see [Figure 3.5](#)).

Figure 3.5. What you see is what you get—the form you created should look just as you designed it.

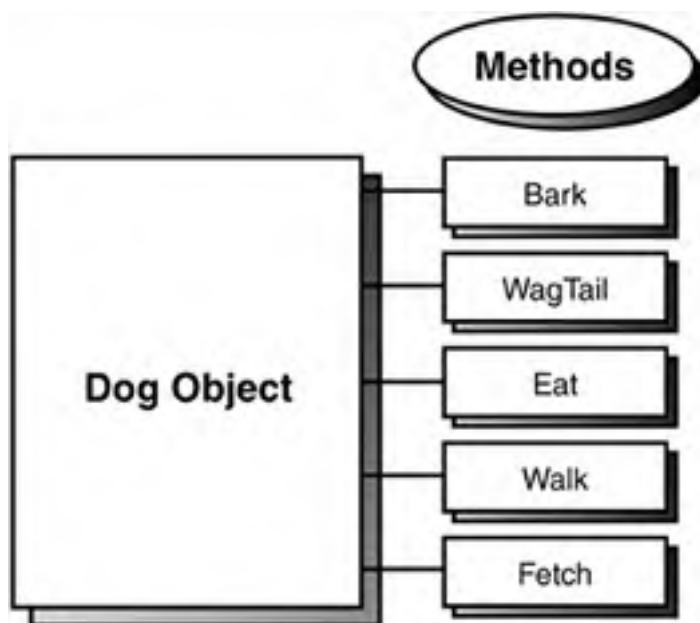


Click the Eat Me button a few times and notice how the form gets bigger. Next, click the Drink Me button to make the form smaller. When you've clicked enough to satisfy your curiosity (or until you get bored), end the running program and return to Design mode by clicking the Stop Debugging button on the toolbar.

Understanding Methods

In addition to properties, most objects have methods. Methods are actions the object can perform, in contrast to attributes, which describe the object. To understand this distinction, think about the Pet object example. A Dog object has a certain set of actions that it can perform. These actions, called methods in Visual C#, include barking, tail wagging, and chewing carpet (don't ask). [Figure 3.6](#) illustrates the Dog object and its methods.

Figure 3.6. Invoking a method causes the object to perform an action.



Triggering Methods

Think of methods as functions—which is exactly what they are. When you invoke a method, code is executed. You can pass data to a method, and methods can return values. However, a method is neither required to accept **parameters** (data passed by the calling code) nor to return a value; many methods simply perform an action in code. Invoking (triggering) a method is similar to referencing the value of a property; you first reference the object's name, then a "dot," then the method name, followed by a set of parentheses, which can optionally contain any parameters that must be passed to the method. As you might have noticed, all statements end in a semicolon; forget one, and your code won't compile.

```
{ObjectName}.{Method}();
```

For example, to make the hypothetical Dog object Bruno bark using Visual C# code, you would use this line of code:

```
Bruno.Bark();
```



Method calls in Visual C# .NET must always have parentheses. Sometimes they'll be empty, but at other times they'll contain data to pass to the method.



Methods are generally used to perform an action using an object, such as saving or deleting a record in a database. Properties, on the other hand,

are used to get and set attribute values of the object. One way to tell in code whether a statement is a property reference or method call is that the method call will have a set of parenthesis after it, as in `frmAlbum.ShowDialog();`.

Invoking methods is simple; the real skill lies in knowing what methods an object supports and when to use a particular method.

Understanding Method Dynamism

Properties and methods go hand in hand, and at times a particular method may become "unavailable" because of one or more property values. For example, if you were to set the `NumberOfLegs` on the Dog object Bruno equal to zero, the `Walk` and `Fetch` methods would obviously be inapplicable. If you were to set the `NumberOfLegs` property back to four, you could then trigger the `Walk` or `Fetch` methods again. In Visual C# .NET, a method or property won't physically become unavailable—you can still call it, but doing so might cause an exception (error) or the call may be ignored.

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Building a Simple Object Example Project

The only way to really grasp what objects are and how they work is to use them.

You're about to create a sample project that uses objects. If you're new to programming with objects, you'll probably find this a bit confusing. However, I'll walk you through step by step, explaining each section in detail.

The project you're going to create consists of a single form with one button on it. When the button is clicked, a line will be drawn on the form beginning at the upper-left corner of the form and extending to the lower-right corner.



In [Hour 18](#), "Working with Graphics," you'll learn all about the drawing functionality within Visual C# .NET.

Creating the Interface for the Drawing Project

Follow these steps to create the interface for your project:

1. Create a new Windows Application project titled **Object Example**.
2. Change the form's Text property to **Object Example** using the Properties window.
3. Add a new button to the form and set its properties as shown in the following table:

Property	Value
Name	btnDraw
Location	112,120
Text	Draw

Writing the Object-Based Code

You're now going to add code to the Click event of the new button. I'm going to explain each statement, and at the end of the steps, I'll show the complete code listing.

Object Example Project

1. Double-click the button to access its Click event.
2. Enter the first line of code as follows (remember to press Enter at the end of each statement):

```
System.Drawing.Graphics objGraphics = null;
```

Here you've just created a variable that will hold an instance of an object. Objects don't materialize out of thin air; they have to be created. When a form is loaded into memory, it loads all its controls (that is, creates the control objects), but not all objects are created automatically like this. The process of creating an instance of an object is called **instantiation**. When you load a form, you instantiate the form object, which in turn instantiates its control objects. You could load a second instance of the form, which in turn would instantiate a new instance of the form and new instances of all controls. You would then have two forms in memory and two of each controls used.

To instantiate an object in code, you create a variable that holds a reference to an instantiated object. You then manipulate the variable as an object. The statement you wrote in step 2 creates a new variable called objGraphics, which holds a reference to an object of type Graphics from the .NET Framework System.Drawing class. You also initialized the value for objGraphics to null. (You learn more about variables in [Hour 11](#).)

3. Enter the second line of code exactly as shown here:

```
objGraphics = CreateGraphics();
```

CreateGraphics is a method of the form. Under the hood, the CreateGraphics method is pretty complicated, and I discuss it in detail in [Hour 18](#). For now, understand that the method CreateGraphics instantiates a new object that represents the client area of the current form. The client area is the gray area within the borders and title bar of a form. Anything drawn onto the objGraphics object appears on the form. What you've done is set the variable objGraphics to point to an object that was returned by the CreateGraphics method. Notice how values returned by a property or method don't have to be traditional values such as numbers or text; they can also be objects.

4. Enter the third line of code as shown next:

```
objGraphics.Clear(System.Drawing.SystemColors.Control);
```

This statement clears the background of the form using whatever color the user has selected as the Windows Control color, which Windows uses to paint forms.

How does this happen? In step 3, you used the CreateGraphics method of the form to instantiate a new graphics object in the variable objGraphics. With the code statement you just entered, you're calling the Clear method of the objGraphics object. The Clear method is a method of all Graphics objects used to clear the graphics surface. The Clear method accepts a single parameter (a value passed to it from calling code)—the color you want used to clear the surface.

The value you're passing to the parameter looks fairly convoluted. Remember that "dots" are a way of separating objects from their properties and methods (properties, methods, and events are often called *object members*). Knowing this, you can discern that System is an object (technically it's a Namespace, as discussed in [Appendix A](#), "The 10,000-Foot View," but for our purposes it behaves just like an object) because it appears before any of the dots. However, there are multiple dots. What this means is that Drawing is an **object property** of the System object; it's a property that returns an object. So the dot following Drawing is used to access a member of the Drawing object, which in turn is a property of the System object. We're not done yet, however, because there is yet another dot. Again, this indicates that SystemColors, which follows a dot, is an object of the Drawing object, which in turn is...well, you get the idea. As you can see, object references can and do go pretty deep, and you'll use many dots throughout your code. The key points to remember are as follows:

- Text that appears to the left of a dot is always an object (or Namespace).
- Text that appears to the right of a dot is a property reference or a method call. If the text is followed by a set of parentheses, it is a method call. If not, it's a property.
- Methods can return objects, just as properties can. The only surefire way to know whether the text between two dots is a property or method is to look at the icon of the member in the IntelliSense drop-down or to consult the documentation of the object.

The final text in this statement is the word **Control**. Because Control isn't followed by a dot, you know that it's not an object; therefore, it must be a property or a method. Because you expect this string of object references to return a color value to be used to clear the Graphics object, you know that Control in this instance must be a property or a method that returns a value (because you need the return value to set the Clear() method). A quick check of the documentation (or simply realizing that the text isn't followed by a set of parentheses) would tell you that Control is indeed a property. The value of Control always equates to the color designated on the user's computer for the face of forms and buttons. By default, this is a light gray (often fondly referred to as battleship gray), but users can change this value on their computers. By using this property to specify a color rather than supplying the actual value for gray, you are assured that no matter what color scheme is used on a computer, the code will clear the form to the proper system color. System colors are explained in [Hour 18](#).

5. Enter the following statement. Press Enter at the end of each line—Visual C# .NET will know that this is a single statement because of the location of the semicolon, which is always used to denote the end of a code statement:

```
objGraphics.DrawLine(System.Drawing.Pens.Blue, 0, 0,  
this.DisplayRectangle.Width, this.DisplayRectangle.Height);
```

This statement draws a blue line on the form. Within this statement are a single method call and three property references. Can you tell what's what? Immediately following objGraphics (and a dot) is DrawLine. Because no equal sign is present (and the text is followed by parentheses), you can deduce that this is a method call. As with the Clear() method, the parentheses after DrawLine() are used to enclose a value passed to the method. The DrawLine() method accepts the following parameters in the order in which they appear here:

- A Pen
- X value of first coordinate
- Y value of first coordinate

- X value of second coordinate
- Y value of second coordinate

The `DrawLine()` method draws a straight line between coordinate one and coordinate two, using the pen specified in the `Pen` parameter. I'm not going to go into detail on pens here (refer to [Hour 18](#)), but suffice it to say that a pen has characteristics such as width and color. Looking at the dots once more, notice that you're passing the `Blue` property of the `Pen` object. `Blue` is an object property that returns a predefined `Pen` object that has a width of 1 pixel and the color `blue`.

You're passing 0 as the next two parameters. The coordinates used for drawing are defined such that 0,0 is always the upper-left corner of a surface. As you move to the right of the surface, X increases, and as you move down the surface, Y increases; you can use negative values to indicate coordinates that appear to the left or above the surface. The coordinate 0,0 causes the line to be drawn from the upper-left corner of the form's client area.

The object property `DisplayRectangle` is referenced twice in this statement. `DisplayRectangle` is a property of the form that holds information about the client area of the form. Here, you're simply getting the `Width` and `Height` properties of the client area and passing them to the `DrawLine()` method. The result is that the end of the line will be at the lower-right corner of the form's client area.

6. Last, you have to clean up after yourself by entering the following code statement:

```
objGraphics.Dispose();
```

Objects often make use of other objects and resources. The underlying mechanics of an object can be truly mind-boggling and are almost impossible to discuss in an entry-level programming book. The net effect, however, is that you must explicitly destroy most objects when you're done with them. If you don't destroy an object, it may persist in memory and it may hold references to other objects or resources that exist in memory. This means you can create a **memory leak** within your application that slowly (or rather quickly) munches system memory and resources. This is one of the cardinal no-no's of Windows programming, yet the nature of using resources and the fact you're responsible for telling your objects to clean up after themselves makes this easy to do. If your application causes memory leaks, your users won't call for a plumber, but they might reach for a monkey wrench...

Objects that must explicitly be told to clean up after themselves usually provide a `Dispose` method. When you're done with such an object, call `Dispose` on the object to make sure it frees any resources it might be holding.

For your convenience, following are all the lines of code:

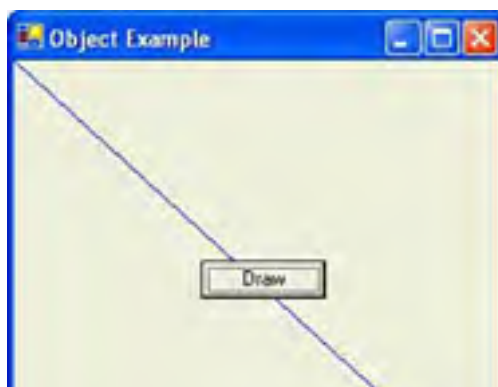
```
System.Drawing.Graphics objGraphics = null;
```

```
objGraphics = CreateGraphics();  
objGraphics.Clear(System.Drawing.SystemColors.Control);  
objGraphics.DrawLine(System.Drawing.Pens.Blue, 0, 0,  
    this.DisplayRectangle.Width, this.DisplayRectangle.Height);  
objGraphics.Dispose();
```

Testing Your Object Example Project

Now for the easy part: Run the project by pressing F5 or by clicking the `Start` button on the toolbar. Your form looks pretty much as it did at design time. Clicking the button causes a line to be drawn from the upper-left corner of the form's client area to the lower-right corner (see [Figure 3.7](#)).

Figure 3.7. Simple lines and complex drawings are accomplished using objects.





**By the
Way**

If you receive any errors when you attempt to run the project, go back and make sure the code you entered exactly matches the code I've provided.

Resize the form, larger or smaller, and click the button again. Notice that the form is cleared and a new line is drawn. If you were to omit the statement that invokes the Clear method (and you're welcome to stop your project and do so), the new line would be drawn, but any and all lines already drawn would remain.

**By the
Way**

If you use Alt+Tab to switch to another application after drawing one or more lines, the lines will be gone when you come back to your form. In fact, this will occur whenever you overlay the graphics with another form. In [Hour 18](#), you'll learn why this is so and how to work around this behavior.

Stop the project now by clicking Stop Debugging on the Visual C# .NET toolbar, and then click Save All to save your project. What I hope you've gained from building this example is not necessarily that you can now draw a line (which is cool), but rather an understanding of how objects are used in programming. As with learning almost anything, repetition aids in understanding. Therefore, you'll be working with objects a lot throughout this book.

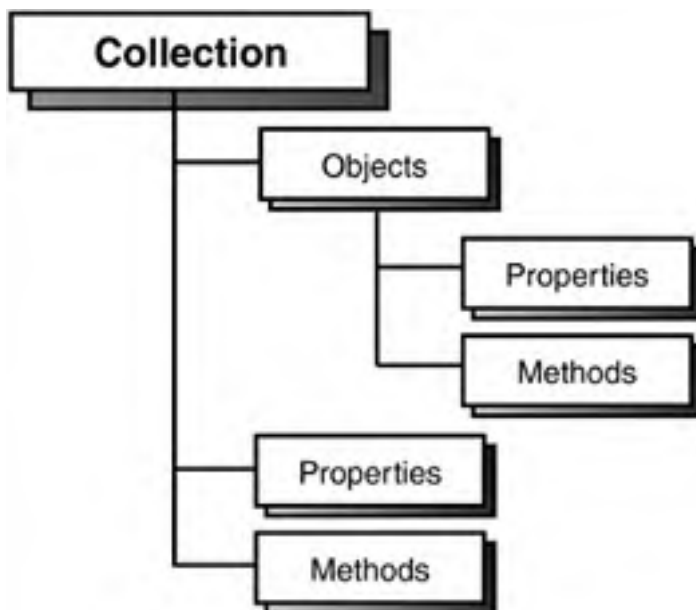
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Understanding Collections

A **collection** is just what its name implies: a collection of objects. Collections make it easy to work with large numbers of similar objects by enabling you to create code that performs iterative processing on items within the collection. *Iterative processing* is an operation that uses a loop to perform actions on multiple objects, rather than writing the operative code for each object. In addition to containing an indexed set of objects, collections also have properties and may have methods. [Figure 3.8](#) illustrates the structure of a collection.

Figure 3.8. Collections contain sets of like objects, and they have their own properties and methods.



Continuing with the Dog/Pet object metaphor, think about what an Animals collection might look like. The Animals collection might contain one or more Pet objects, or it might be empty (containing no objects). All collections have a `Count` property that returns the total count of objects contained within the collection. Collections can also have methods, such as a `Delete` method used to remove objects from the collection or an `Add` method used to add a new object to the collection.

To better understand collections, you're going to create a small Visual C# .NET project that cycles through the Controls collection of a form, telling you the value of the Name property of every control on the form.

To create your sample project, follow these steps:

1. Start Visual C# .NET now (if it's not already loaded) and create a new Windows Application project titled **Collections Example**.
2. Change the text of the form to **Collections Example** by using the Properties window.
3. Add a new button to the form by double-clicking the Button tool in the toolbox. Set the button's properties as follows:

Property	Value
Name	btnShowNames
Location	88,112
Size	120,23
Text	Show Control Names

4. Next, add some text box and label controls to the form. As you add the controls to the form, be sure to give each control a unique name. Feel free to use any name you like, but you can't use spaces in a control name. You may want to drag the controls to different locations on the form so that they don't overlap.
5. When you are finished adding controls to your form, double-click the Show Control Names button to add code to its Click event. Enter the following code:

```
for (int intIndex=0; intIndex < this.Controls.Count; intIndex++)  
{  
    MessageBox.Show ("Control # " + intIndex.ToString() +  
        " has the name " + this.Controls[intIndex].Name);  
}
```



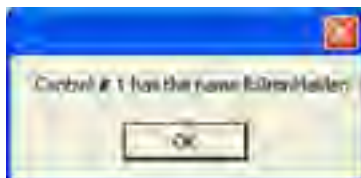
Every form has a Controls collection, which may or may not contain any controls. Even if no controls are on the form, the form still has a Controls collection.

The first statement (the one that begins with `for`) accomplishes a few tasks. First, it initializes the variable `intIndex` to 0, and then tests the variable. It also starts a loop executing the statement block (loops are discussed in [Hour 14](#), "Looping for Efficiency"), incrementing `intIndex` by one until `intIndex` equals the number of controls on the form, less one. The reason that `intIndex` must always be less than the `Count` property is that when referencing items in a collection, the first item is always item zero—collections are zero-based. Thus, the first item is in location zero, the second item is in location one, and so forth. If you tried to reference an item of a collection in the location of the value of the `Count` property, an error would occur because you would be referencing an index that is one higher than the actual locations within the collection.

The `MessageBox.Show()` method (discussed in detail in [Hour 17](#), "Interacting with Users") is a class available in the .NET Framework that is used to display a simple dialog box with text. The text that you are providing, which the `MessageBox.Show()` method will display, is a concatenation of multiple strings of text. (*Concatenation* is the process of adding strings together; it is discussed in [Hour 12](#), "Performing Arithmetic, String Manipulation, and Date/Time Adjustments.")

Run the project by pressing F5 or by clicking Start on the toolbar. Ignore the additional controls that you placed on the form, and click the Show Control Names button. Your program will then display a message box similar to the one shown in [Figure 3.9](#) for each control on your form (because of the loop). When the program is finished displaying the names of the controls, choose Stop Debugging from the Debug toolbar to stop the program, and then save the project.

Figure 3.9. The Controls collection enables you to get to each and every control on a form.



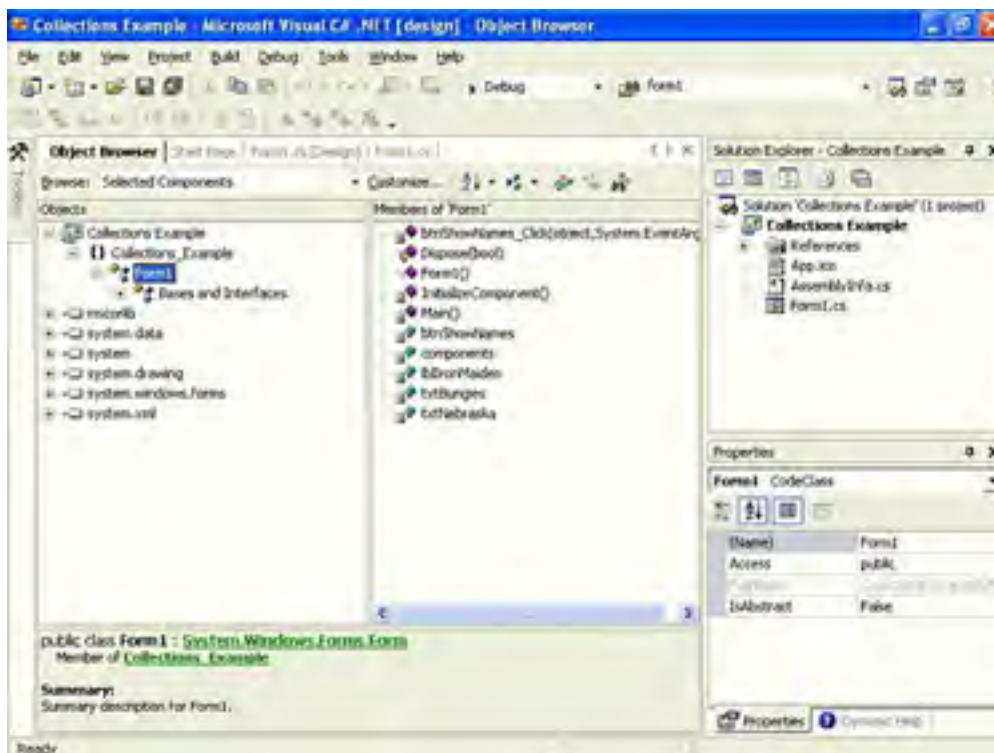
Because everything in Visual C# is an object, you can expect to use numerous collections as you create your programs. Collections are powerful, and the more quickly you become comfortable using them, the more productive you'll become.

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Using the Object Browser

Visual C# .NET includes a useful tool that lets you easily view the *members* (properties, methods, and events) of all the objects in a project: the Object Browser (see [Figure 3.10](#)). This is extremely useful when dealing with objects that aren't well documented, because it enables you to see all the members an object supports. To view the Object Browser, choose View, Object Browser.

Figure 3.10. The Object Browser enables you to view all properties and methods of an object.



The Browse drop-down list in the upper-left corner of the Object Browser is used to determine the **browsing scope**. You can choose Active Project to view only the objects referenced in the active project, or you can choose Selected Components (the default) to view a set of selected objects. The Object Browser shows a preselected set of objects for Selected Components, but you can customize the object set by clicking the Customize button next to the Browse drop-down list. I wouldn't recommend changing the custom object setting until you have some experience using Visual C# .NET objects as well as experience using the Object Browser.

The top-level nodes in the Objects tree are **libraries**. Libraries are usually DLL or EXE files on your computer that contain one or more objects. To view the objects within a library, simply expand the library node. As you select objects within a library, the list to the right of the Objects tree will show information regarding the members of the selected object (refer to [Figure 3.10](#)). For even more detailed information, click a member in the list on the right, and the Object Browser will show information about the member in the gray area below the two lists.

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Summary

In this hour, you learned about objects. You learned how objects have properties, which are attributes that describe the object. Some properties can be set at design time using the Properties window, and most can also be set at runtime in Visual C# .NET code. You learned that referencing a property on the left side of the equal sign has the effect of changing a property, whereas referencing a property on the right side of the equal sign retrieves the property's value.

In addition to properties, you learned that objects have executable functions, called methods. Like properties, methods are referenced by using a "dot" at the end of an object reference. An object may contain many methods and properties, and some properties can even be objects themselves. You learned how to "follow the dots" to interpret a lengthy object reference.

Objects are often used as a group, called a collection. You learned that a collection often contains properties and methods, and that collections let you easily iterate through a set of like objects. Finally, you learned that the Object Browser can be used to explore all the members of an object in a project.

The knowledge you've gained in this hour is fundamental to understanding programming with Visual C# .NET, because objects and collections are the basis on which applications are built. After you have a strong grasp of objects and collections—and you will have by the time you've completed all the hours in this book—you'll be well on your way to fully understanding the complexities of creating robust applications using Visual C# .NET.

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Q&A

Q1: *Is there an easy way to get help about an object's member?*

A1: Absolutely. Visual C# .NET's context-sensitive Help extends to code as well as to visual objects. To get help on a member, write a code statement that includes the member (it doesn't have to be a complete statement), position the cursor within the member text, and press F1. For instance, to get help on the Count property of the controls collection, you could type **this.Controls.Count**, position the cursor within the word Count, and press F1.

Q2: *Are there any other types of object members besides properties and methods?*

A2: Yes. An event is actually a member of an object, although it's not always thought of that way. Not all objects support events, however, but most objects do support properties and methods.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** True or False: Visual C# .NET is a true object-oriented language.
- 2:** An attribute that defines the state of an object is called a what?
- 3:** To change the value of a property, the property must be referenced on which side of an equal sign?
- 4:** What is the term for creating a new object from a template?
- 5:** An external function of an object (one that is available to code using an object) is called a what?
- 6:** True or False: A property of an object can be another object.
- 7:** A group of like objects is called what?
- 8:** What tool is used to explore the members of an object?

Exercises

- 1:** Create a new project and add text boxes and a button to the form. Write code that, when clicked, places the text in the first text box into the second text box. Hint: Use the Text property of the text box controls.
- 2:** Modify the collections example in this hour to print the Height of all controls, rather than the name.

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Hour 4. Understanding Events

It's fairly easy to produce an attractive interface for an application using Visual C# .NET's integrated design tools. You can create beautiful forms that have buttons to click, text boxes in which to type information, picture boxes that display pictures, and many other creative and attractive elements with which users can interact. However, this is just the start of producing a Visual C# .NET program. In addition to designing an interface, you have to empower your program to perform actions in response to how a user interacts with the program and how Windows interacts with the program. You accomplish this by using *events*. In the preceding hour, you learned about objects and their members—notably, properties and methods. In this hour, you'll learn about object events and event-driven programming, and you'll learn how to use events to make your applications responsive.

The highlights of this hour include the following:

- Understanding event-driven programming
- Triggering events
- Avoiding recursive events
- Accessing an object's events
- Working with event parameters
- Creating event handlers
- Dealing with orphaned events

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Understanding Event-Driven Programming

With "traditional" programming languages (often referred to as *procedural* languages), the program itself fully dictates what code is executed as well as when it's executed. When you start such a program, the first line of code in the program executes, and the code continues to execute in a completely predetermined path. The execution of code may, on occasion, branch and loop, but the execution path is completely determined by the program. This often means that a program is quite restricted in how it can respond to the user. For example, the program might expect text to be entered into controls on the screen in a predetermined order. This is quite unlike a Windows application, where a user can interact with different parts of the interface—often in any order the user chooses.

Visual C# incorporates an event-driven programming model. Event-driven applications aren't bound by the constraints of procedural programs. Instead of the top-down approach of procedural languages, event-driven programs have logical sections of code placed within *events*. There is no predetermined order in which events occur; the user often has complete control over what code is executed in an event-driven program by interactively triggering specific events, such as clicking a button. An event, along with the code it contains, is called an *event procedure*.

Triggering Events

In the preceding hour, you learned that a method is simply a function of an object. Events are a special kind of method; they are a way for objects to signal state changes that may be useful to clients of that object. Events are methods that can be called in special ways—usually by the user interacting with something on a form or by Windows itself rather than being called from a statement in your code.

There are many types of events and many ways to trigger those events. You've already seen how a user can trigger the Click event of a button by clicking it. User interaction isn't the only thing that can trigger an event; an event can be triggered in one of the following four ways:

- Users can trigger events by interacting with your program.
- Objects can trigger their own events, as needed.
- The operating system (whichever version of Windows the user is running) can trigger events.
- You can trigger events by calling them using Visual C# code.

Events Triggered Through User Interaction

The most common way an event is triggered is by a user interacting with a program. Every form, and almost every control you can place on a form, has a set of events specific to its object type. For example, the Button control has a number of events, including the Click event, which you've already used in previous hours.

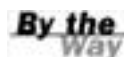
The Click event is triggered, and then the code within the Click event executes when the user clicks the button.

The Textbox control allows users to enter information using the keyboard, and it also has a set of events. The TextBox control has some of the same types of events as the Button control, such as a Click event, but the Textbox control also has events not supported by the Button control, such as the TextChanged event. The TextChanged event occurs each time the contents of the text box changes, for example, when the user types information into the text box. Because you can't enter text into a Button control, it makes sense that the Button control doesn't have a TextChanged event. Every object that supports events supports a unique set of events.

Each type of event has its own behavior, and it's important to understand the events with which you work. The TextChanged event, for example, exhibits a behavior that may not be intuitive to a new developer because the event fires each time the contents of the text box change. Suppose that you type the following sentence into an empty text box:

Visual C# is very cool!

The TextChange event would be triggered 23 times—once for each character typed—because each time you enter a new character, the contents of the text box are changed. Although it's easy to think that the Change event fires only when you commit your entry, such as by leaving the text box or pressing Enter, this isn't how it works. Again, it's important to learn the nuances and the exact behavior of the events you're using. If you use events without fully understanding how they work, your program may produce unusual, and often very undesirable, results.



Triggering events (which are just a type of procedure) using Visual C# .NET code is discussed in detail in [Hour 10](#), "Creating and Calling Methods."

Events Triggered by an Object

Sometimes an object triggers its own events. The most common example of this is the Timer control's Timer event. The Timer control doesn't appear on a form when the program is running; it appears only when you're designing a form. The Timer control's sole purpose is to trigger its Timer event at an interval that's specified in its Interval property.

By setting the Timer control's Interval property, you control the interval (in milliseconds) when the Timer event executes. After firing its Timer event, a Timer control resets itself and again fires its Timer event when the interval has passed. This occurs until the interval is changed, the Timer control is disabled, or the Timer control's form is unloaded. A common use of timers is to create a clock on a form. You can display the time in a label and update the time at regular intervals by placing the code to display the current time in the Timer event. You'll create a project with a Timer control in [Hour 8](#), "Using Advanced Controls."

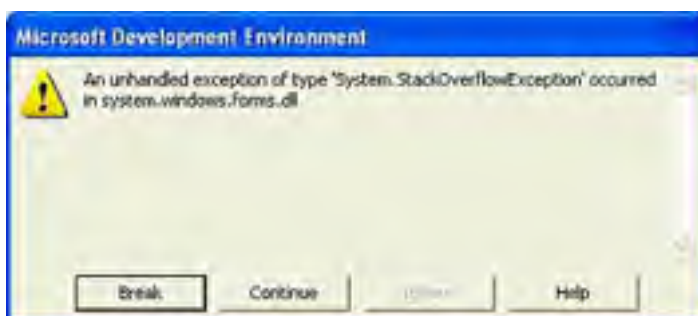
Events Triggered by the Operating System

The third way an event can be triggered is by Windows itself. Often, you might not even realize these events exist. For example, when a form is fully or partially obstructed by another window, the program needs to know when the offending window is resized or moved so that it can repaint the area of the window that's been hidden. Windows and Visual C# .NET work together in this respect. When the obstructing window is moved or resized, Windows tells Visual C# .NET to repaint the form, which Visual C# .NET does. This also causes Visual C# .NET to raise the form's Paint event. You can place code into the Paint event to create a custom display for the form, such as drawing shapes on the form using a graphics object. If you do that, every time the form repaints itself, your custom drawing code would execute.

Avoiding Recursive Events

You must make sure never to cause an event to trigger itself endlessly. An event that continuously triggers itself is called a **recursive** event. To illustrate a situation that causes a recursive event, think of the text box's TextChanged event discussed earlier. The TextChanged event fires every time the text within the text box changes. Placing code into the TextChanged event that alters the text within the text box would cause the Change event to be fired again, which could result in an endless loop. Recursive events terminate when Windows returns a StackOverflow exception (see [Figure 4.1](#)), indicating that Windows no longer has the resources to follow the recursion.

Figure 4.1. When you receive a StackOverflow exception, you should look for a recursive event as the culprit.



Recursive behavior can occur with more than one event in the loop. For example, if Event A triggers Event B, which in turn triggers Event A, you can have infinite looping of the two events. Recursive behavior can take place among a sequence of many events, not just one or two.

By the Way

Uses for recursive procedures actually exist, such as when writing complex math functions. For instance, recursive events are often used to compute factorials. However, when you purposely create a recursive event, you must ensure that the recursion isn't infinite.

Accessing an Object's Events

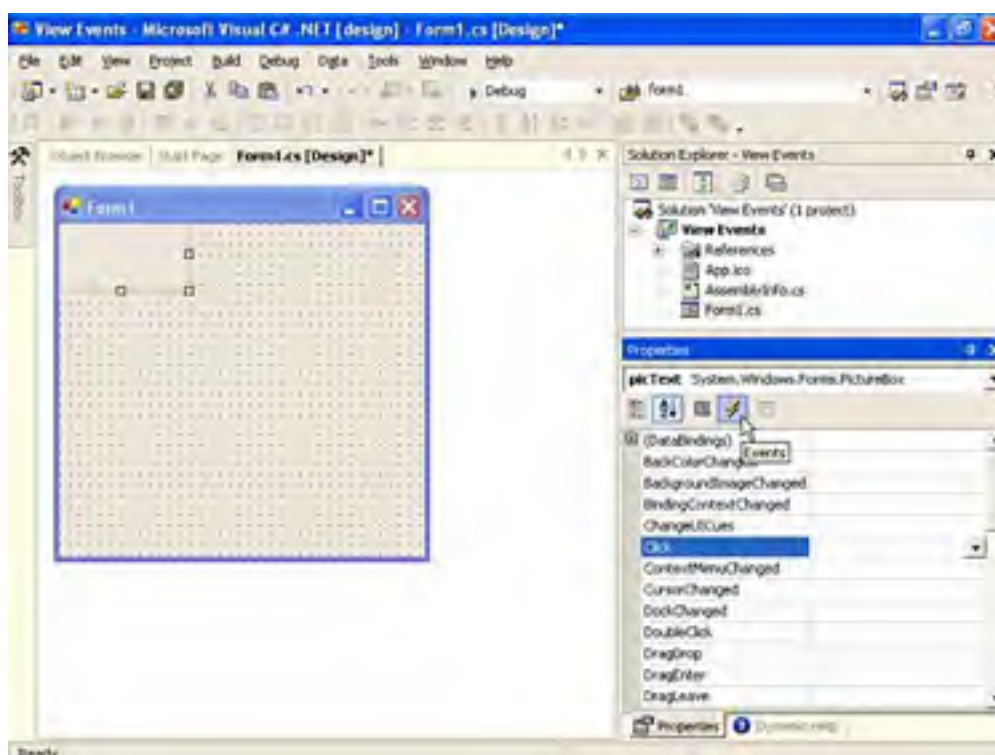
Accessing an object's events is simple, and if you've been following the examples in this book, you've already accessed a number of objects' default events. To access all of an object's events, you can use the Events icon (the lightning bolt) in the Properties window.

You're now going to create a project to get the feel for working with events. Start Visual C# .NET and create a new Windows Application project titled **View Events**, and then follow these steps:

1. Use the toolbox to add a picture box to the form.
2. Change the name of the picture box to **picText**.
3. Click the Events button on the Properties window toolbar (the lightning bolt icon).

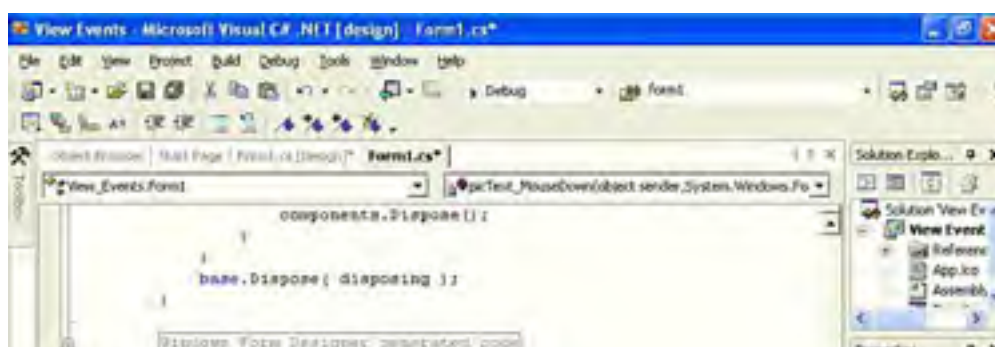
Your screen should look like the one in [Figure 4.2](#). Notice that the Properties window now lists all the events for the selected object; in this case, it is the picText PictureBox object.

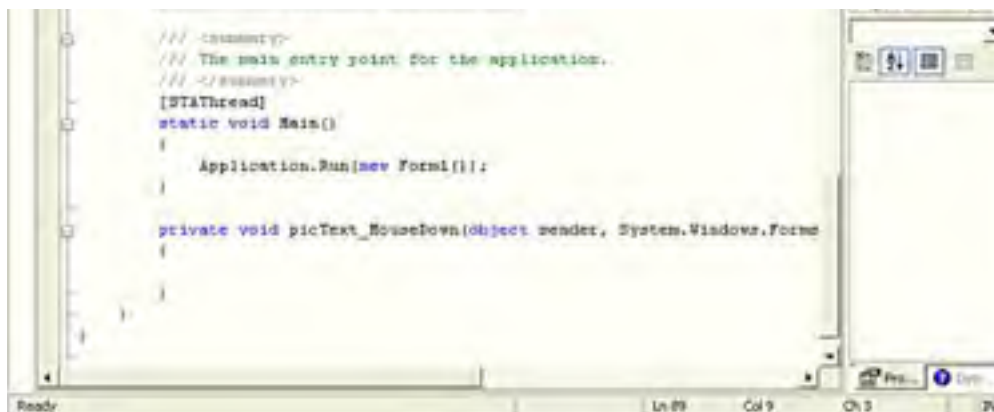
Figure 4.2. Double-click an event in the Properties window to create the desired event.



When you access a control's events, the default event for that type of control is selected. As you can see, the Click event is the default for a PictureBox. Scroll through the picText events and select the MouseDown event. Double-click the word MouseDown and Visual C# .NET will create the MouseDown event procedure and position you within it, ready to enter code (see [Figure 4.3](#)).

Figure 4.3. Visual C# creates an empty event procedure the first time you select an object's event.





The code statement above the cursor is the **event declaration**. An event declaration is a statement that defines the structure of an event handler. Notice that this event declaration contains the name of the object, an underscore character (`_`), and then the event name. Following the event name is a set of parentheses. The items within the parentheses are called **parameters**, which are the topic of the next section. This is the standard declaration structure for an event procedure.

The full event declaration for the MouseDown event is the following:

```
private void picText_MouseDown(object sender, _  
    System.Windows.Forms.MouseEventArgs e)
```



The words **Private** and **Void** are reserved words that indicate the scope and type of the method. Scope and type are discussed in [Hour 10](#), "Creating and Calling Methods."

Working with Event Parameters

As mentioned previously, the items within the parentheses of an event declaration are called **parameters**. An event parameter is a variable that is created and assigned a value by Visual C# .NET. These parameter variables are used to get, and sometimes set, relevant information within the event. This data may be a number, text, an object—almost anything. Multiple parameters within an event procedure are always separated by commas. As you can see, the MouseDown event has two parameters. When the MouseDown event procedure is triggered, Visual C# .NET automatically creates the parameter variables and assigns them values for use in this single execution of the event procedure; the next time the event procedure occurs, the values in the parameters are reset. You use the values in the parameters to make decisions or perform operations in your code.

The MouseDown event of a form has the following parameters:

object sender

and

System.Windows.Forms.MouseEventArgs e

The first word identifies the type of data the parameter contains, followed by the name of the parameter. The first parameter, `sender`, holds a generic object. Object parameters can be any type of object supported by Visual C#—and pretty much everything is an object. It's not critical that you understand data types right now: just be aware that different parameter variables contain different types of information. Some contain text, others contain numbers, and still others (many others) contain objects. In the case of the `sender` parameter, it will always hold a reference to the control causing the event.

The `e` parameter of the MouseDown event, on the other hand, is where the real action is. The `e` parameter also holds an object; in this case, the object is of the type `System.Windows.Forms.MouseEventArgs`. This object has properties that relate to the MouseDown event. To see them, type in the following code, but don't press anything after typing the dot (period):

`e.`

When you type the period, you'll get a drop-down list showing you the members (properties and methods) of the `e`

object (see [Figure 4.4](#)). Using the `e` object, you can determine a number of things about the occurrence of the `MouseDown` event. I've listed some of the more interesting items in [Table 4.1](#).

Figure 4.4. IntelliSense drop-down lists alleviate the need for memorizing the makeup of hundreds of objects.

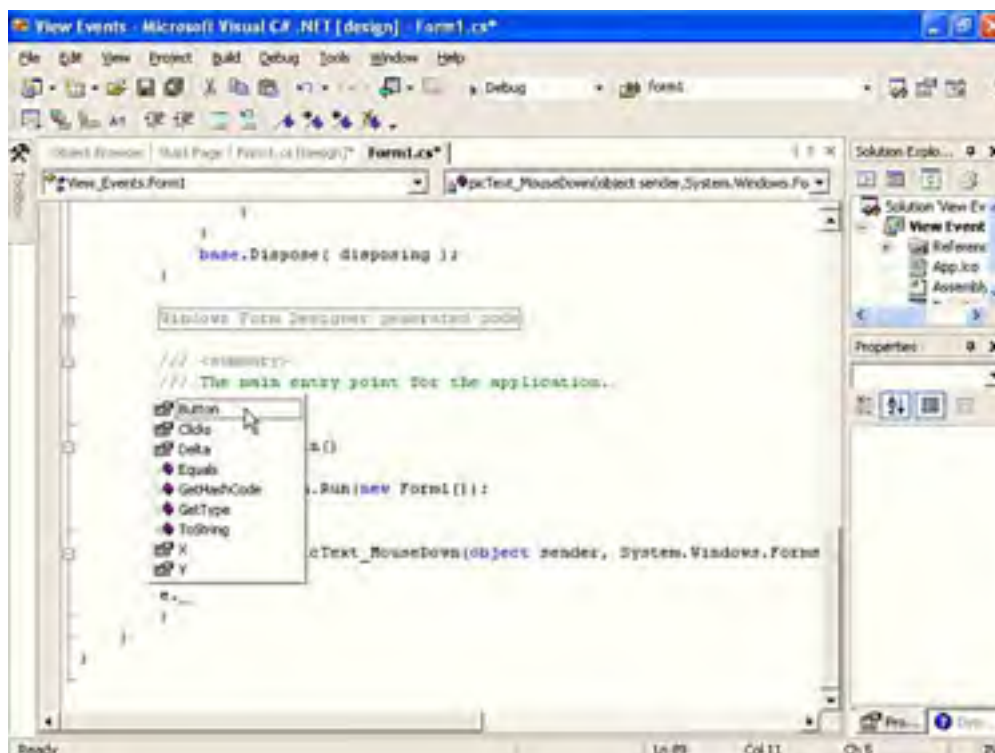


Table 4.1. Commonly Used Members of `System.Windows.Forms.MouseEventArgs`

Property	Description
<code>Clicks</code>	Returns the number of times the user clicked the mouse button
<code>Button</code>	Returns the button that was clicked (left, middle, right)
<code>X</code>	Returns the horizontal coordinate at which the pointer was located when the user clicked
<code>Y</code>	Returns the vertical coordinate at which the pointer was located when the user clicked



Each time the event occurs, the parameters are initialized by Visual C# so that they always reflect the current occurrence of the event.

Each event has parameters specific to it. For instance, the `TextChanged` event returns parameters that are different from the `MouseDown` event. As you work with events—and you'll work with a *lot* of events—you'll quickly become familiar with the parameters of each event type. You'll learn how to create parameters for your own methods in [Hour 10](#), "Creating and Calling Methods."

Deleting an Event Handler

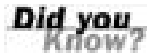
Deleting an event handler involves more than just deleting the event procedure. When you add a new event handler to a class, Visual C# .NET automatically creates the event procedure for you and positions you to enter code within the event. However, Visual C# .NET does a little bit more "under the hood" to hook the event procedure to the control. It does this by creating a code statement in the hidden code of the class. Ordinarily, you don't have to worry about this statement. However, when you delete an event procedure, Visual C# .NET doesn't automatically delete the hidden code statement, and your code won't compile. The easiest way to correct this is simply to run the project; when Visual C# .NET encounters the error, it will show you the offending statement, which you can delete. Try this now:

1. Delete the MouseDown procedure (don't forget to delete the open and close braces of the procedure, as well as any code within them). This deletes the procedure.
2. Press F5 to run the project. You'll receive a message that a build error has occurred. Click No to return to the code editor.
3. A task for the error has been created in the Task List. Double-click the task and C# will take you to the offending statement. It will read:

```
this.pictureBox1.MouseDown += new  
    System.Windows.Forms.MouseEventHandler(this.pictureBox1_MouseDown);
```

4. Delete this statement, and now your code will compile and run.

Whenever you delete an event procedure, you'll have to delete the corresponding statement that links the procedure to its object before the code will run.



Now that you've learned the process of deleting an event handler, here's the quickest and easiest way: View the object in design view and click the Events button on the Properties window to view the object's events. Then, highlight the event name to delete and press the Delete key.

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Building an Event Example Project

You're now going to create a very simple project in which you'll use the event procedures of a text box. Specifically, you're going to write code to display a message when a user clicks a mouse button on the text box, and you'll write code to clear the text box when the user releases the button. You'll be using the `e` parameter to determine which button the user has clicked.

Creating the User Interface

Create a new Windows application titled **Events Example**. Change the form's Text property to **Events Example**.

Next, add a text box to the form by double-clicking the TextBox tool in the toolbox. Set its properties as follows:

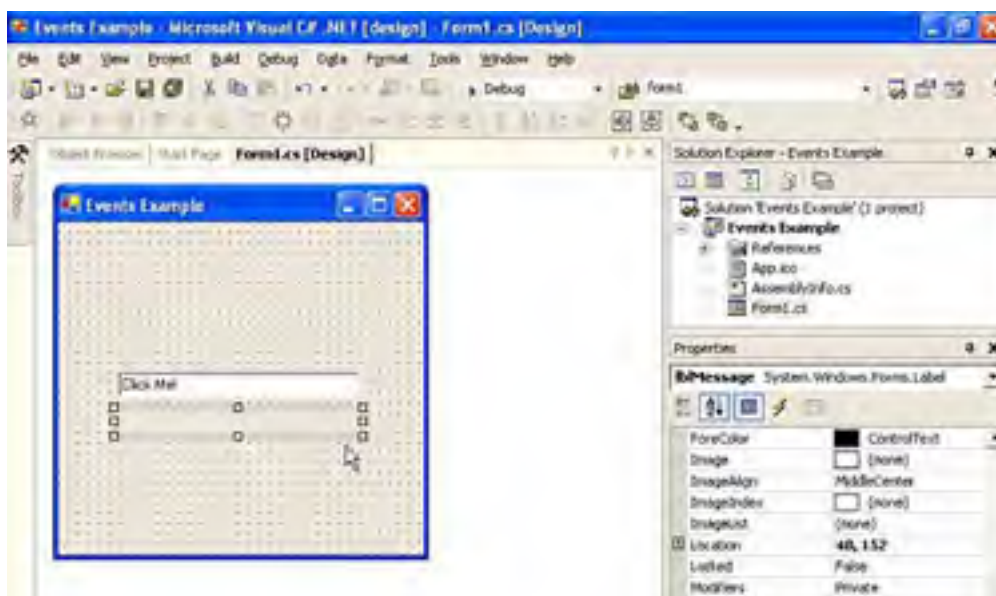
Property	Value
Name	txtEvents
Location	48,120
Size	193, 20
Text	Click Me!

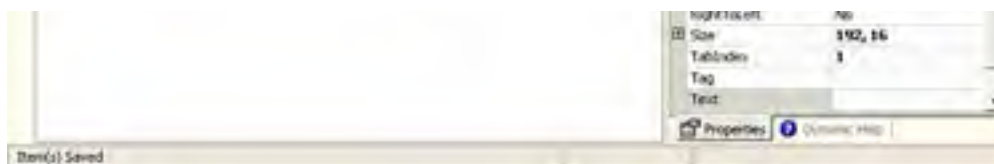
The only other control you need on your form is a label. Label controls are used to display static text; users cannot type text into a label. Add a new label to your form now by double-clicking the Label tool in the toolbox, and then set the Label control's properties as follows:

Property	Value
Name	lblMessage
Location	48,152
Size	192, 16
Text	(make blank)

Your form should now look like the one in [Figure 4.5](#). It's a good idea to save frequently, so save your project now by clicking the Save All button on the toolbar.

Figure 4.5. A Label control that has an empty Text property can be hard to see unless selected.



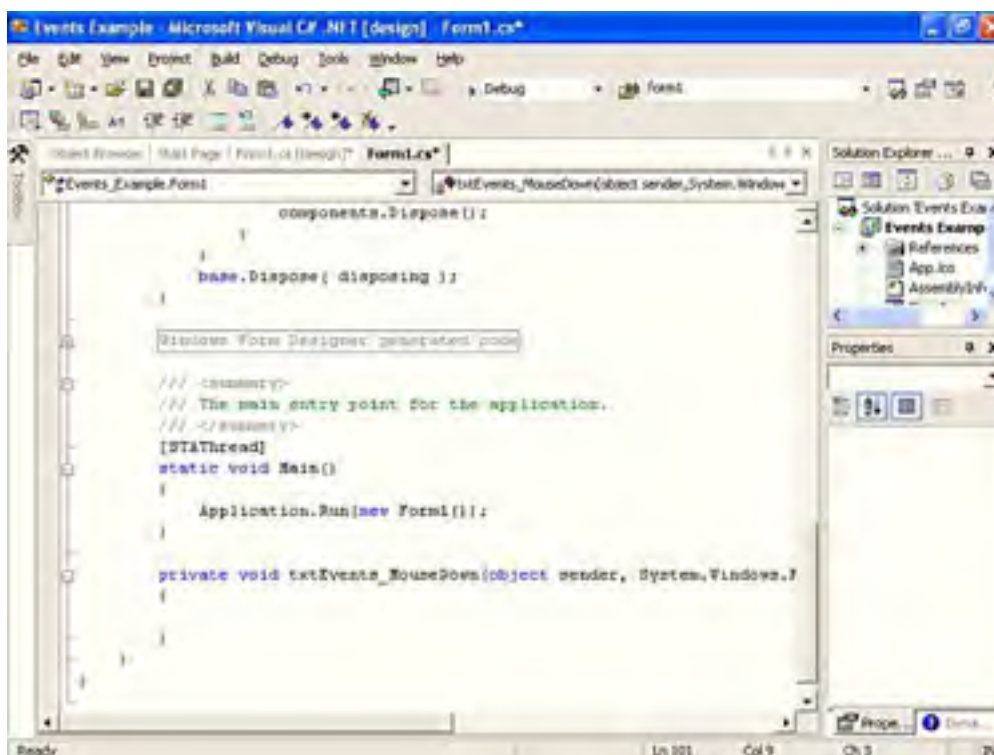


Creating Event Handlers

The interface for the Events Example project is complete—on to the fun part. You're now going to create the event procedures that empower the program to do something. The event that we're interested in first is the MouseDown event. Select the TextBox on your design form, and then click the Events icon (the lightning bolt) on the Properties window toolbar.

The default event for text boxes is the TextChanged event, so it's the one selected for you. We're not interested in the TextChanged event at this time, however. Scroll through the event list and find the MouseDown event. Double-click MouseDown; Visual C# .NET then creates a new MouseDown event procedure for the text box (see [Figure 4.6](#)).

Figure 4.6. Each time you double-click a new event, Visual C# .NET creates an empty event procedure—if one hasn't been created previously for the control.



Enter the following code into the MouseDown event procedure:

```
switch(e.Button)
{
    case MouseButton.Left:
        lblMessage.Text = "You are clicking the left button!";
        break;
    case MouseButton.Right:
        lblMessage.Text = "You are clicking the right button!";
        break;
    case MouseButton.Middle:
        lblMessage.Text = "You are clicking the middle button!";
        break;
}
```

The `Switch` construct, which is discussed in detail in [Hour 13](#), "Making Decisions in Visual C# .NET Code," compares the value of an expression to a list of possible values. In this instance, the expression is the value of `e.Button` (the `Button` property of the object `e`). When this code executes, the expression is compared to each `Case` statement in the order in which the statements appear. If and when a match is found, the code immediately following the `Case` statement that

was matched gets executed. In a nutshell, the code you wrote looks at the value of `e.Button` and compares it to three values—one at a time. When the `Switch` construct concludes which button has been clicked, it displays a message about it in the Label control.



In a more robust application, you would probably execute more useful and more complicated code. For example, you may want to display a custom pop-up menu when the user clicks with the right button and perhaps execute a specific function when the user clicks with the middle button. All this is possible, and more.

The nice thing about objects is that you don't have to commit every detail about them to memory. For example, you don't need to memorize the return values for each type of button (who wants to remember `MouseButtons.Left` anyway?). Just remember that the `e` parameter contains information about the event. When you type `e` and type the period, the IntelliSense drop-down list appears and shows you the members of `e`, one of which is `Button`. If you select `Button` and type a space followed by an equal sign, you'll see another drop-down list showing you the possible values of `Buttons` (you saw this when you entered the code for this procedure).

Don't feel overwhelmed by all the object references you'll encounter throughout this book. Simply accept that you can't memorize them all, nor do you need to; you'll learn the ones that are important, and you'll use Help when you're stuck. Also, after you know the parent object in a situation (such as the `e` object in this example), it's easy for you to determine the objects and members that belong to it by using the IntelliSense drop-down lists.

You're now going to add code to the `MouseUp` event to clear the label's `Text` property when the user releases the button. First, you'll need to create the `MouseUp` event procedure. To do this, return to the Form Design view (click the `Form1.cs [Design]` tab). The Properties window should still be displaying the `txtEvents` object's events. If the events aren't shown in the Properties window, select `txtEvents` from the drop-down list box in the Properties window and click the Events icon. Locate and double-click the `MouseUp` event from the events list.

All you're going to do in the `MouseUp` event is clear the label. Enter the following code:

```
lblMessage.Text = "";
```

Testing Your Events Project

Run your project now by pressing F5. If you entered all the code correctly and you don't receive any errors, your form will be displayed as shown in [Figure 4.7](#).

Figure 4.7. A simple but functional example.



Remember that Visual C# .NET is case sensitive. Entering only one character in the wrong case will cause Visual C# .NET to fail to compile.

Click the text box with the left mouse button and watch the label. It will display a sentence telling you that the left button was clicked. When you release the button, the text is cleared. Try this with the middle and right buttons as well. When you click the text box with the right button, Windows displays the standard shortcut menu for text boxes. When this menu appears, you have to select something from it or click somewhere off the menu to trigger the MouseUp event. In [Hour 9](#), "Adding Menus and Toolbars to Forms," you'll learn how to add your own shortcut menus to forms and controls. When you're satisfied that your project is behaving as it should, choose Stop Debugging from the Debug menu or toolbar to stop the project (or click the Close button on your form). Be sure to save your work by clicking Save All on the toolbar.

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Summary

In this hour, you learned about event-driven programming, including what events are, how to trigger events, and how to avoid recursive events. In addition, you've learned how to access an object's events and how to work with parameters. Much of the code you'll write will execute in response to an event of some kind. By understanding how events work, including being aware of the available events and their parameters, you'll be able to create complex Visual C# .NET programs that react to a multitude of user and system inputs.

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Q&A

Q1: *Is it possible to create custom events for an object?*

A1: Yes, you can create custom events for your own objects (which you'll learn about in [Hour 16](#)), and you can also create them for existing objects. Creating custom events, however, is beyond the scope of this book.

Q2: *Is it possible for objects that don't have an interface to support events?*

A2: Yes. However, to use the events of such an object, the object variable must be dimensioned a special way or the events aren't available. This gets a little tricky and is beyond the scope of this book. If you have an object in code that supports events, look in Help for the keyword WithEvents for information on how to use such events.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** Name three things that can cause events to occur.
- 2:** True or False: All objects support the same set of events.
- 3:** What is the default event type for a button?
- 4:** Writing code in an event that causes that same event to be triggered, setting off a chain reaction with the event triggered again and again is called what?
- 5:** What is the easiest way to access a control's default event handler?
- 6:** All control events pass a reference to the control causing the event. What is the name of the parameter that holds this reference?

Exercises

- 1:** Create a project with a text box and a button. When the user clicks the button, change the Text of the button to the text the user has entered into the text box.
- 2:** Create a project with a form and a text box. Add code to the TextChanged event to cause a recursion when the user types in text. Hint: Concatenate a character (join it to another string) to the end of the user's text using a statement such as this:

```
txtMyTextBox.Text = String.Concat(this.txtMyTextBox.Text,"a");
```

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Part II: Building a User Interface

HOOR 5 [Building Forms: The Basics](#)

HOOR 6 [Building Forms: Advanced Techniques](#)

HOOR 7 [Working with the Traditional Controls](#)

HOOR 8 [Using Advanced Controls](#)

HOOR 9 [Adding Menus and Toolbars to Forms](#)

HOOR 10 [Creating and Calling Methods](#)

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Hour 5. Building Forms: The Basics

With few exceptions, forms are the cornerstone of every Windows application's interface. Forms are essentially windows, and the two terms are often used interchangeably. More accurately, "window" refers to what's seen by the user and what the user interacts with, whereas "form" refers to what you see when you design. Forms enable users to view and enter information in a program (such as the form you built in your Picture Viewer program in [Hour 1](#), "Jumping in with Both Feet: A Visual C# .NET Programming Tour"). Such information can be text, pictures, graphs—almost anything that can be viewed on the screen. Understanding how to design forms correctly will enable you to begin creating solid interface foundations for your programs.

Think of a form as a canvas on which you build your program's interface. On this canvas, you can print text, draw shapes, and place controls with which users can interact. The wonderful thing about Visual C# .NET forms is that they behave like a dynamic canvas; not only can you adjust the appearance of a form by manipulating what's on it, but you can also manipulate specific properties of the form itself.

In previous hours, you manipulated the following appearance properties of a form:

- Text
- Height
- Left
- Top
- Width

The capability to tailor your forms goes far beyond these simple manipulations, however.

There is so much to cover about Windows Forms that I've broken the material into two hours. In this hour, you'll learn the basics of forms—adding them to a project, manipulating their properties, and showing and hiding them using Visual C# .NET code. Although you've done some of these things in previous hours, here you'll learn the nuts and bolts of the tasks you've performed. In the following hour, you'll learn more advanced form techniques.

The highlights of this hour include the following:

- Changing the name of a form
- Changing the appearance of a form
- Displaying text on a form's title bar
- Adding an image to a form's background
- Giving a form an icon
- Preventing a form from appearing in the taskbar
- Specifying the initial display position of a form
- Displaying a form in a normal, maximized, or minimized state
- Changing the mouse pointer
- Showing and hiding forms

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Changing the Name of a Form

The first thing you should do when you create a new object is to give it a descriptive name, so that's the first thing I'll talk about in this hour. Start Visual C# .NET now (if it's not already running) and create a new Windows Application titled **Forms Example**. Using the Properties window, change the name of the form to **fclsFormsExample**. When you need to create a new instance of this form, you'll use this name rather than the default generic name of Form1.

You may have noticed that the tabs in the designer refer to the name of the form file—not the name you give it in code. Change the filename of the form now by right-clicking Form1.cs in the Solutions Explorer, choosing Rename, and then changing the name of the form to **fclsFormsExample.cs**. (I prefer not to use spaces in my filenames—old habits I suppose.)

By the Way

You should change the filename for all of the forms in your projects. I haven't done this throughout the book, however, because it adds yet another step to each example and I don't want to complicate things too much.

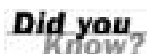
Remember, when you change the name of the startup form for your application, you need to update the class name in the entry point of your application (`static void Main()`). To do this, click the Form1.cs tab to display the code for the form, and then locate the reference to Form1 and replace it with **fclsFormsExample**.

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Changing the Appearance of a Form

The properties window can actually show two different sets of properties for a form. Right now, it's probably showing the file properties of the form (the properties that describe the physical file(s) on the hard drive). If so, click the form in the designer once again to view its development properties. Take a moment to browse the rest of the form's properties in the Properties window. In this hour, I'll show you how to use the more common properties of the form to tailor its appearance.



Remember, to get help on any property at any time, select the property in the Properties window and press F1.

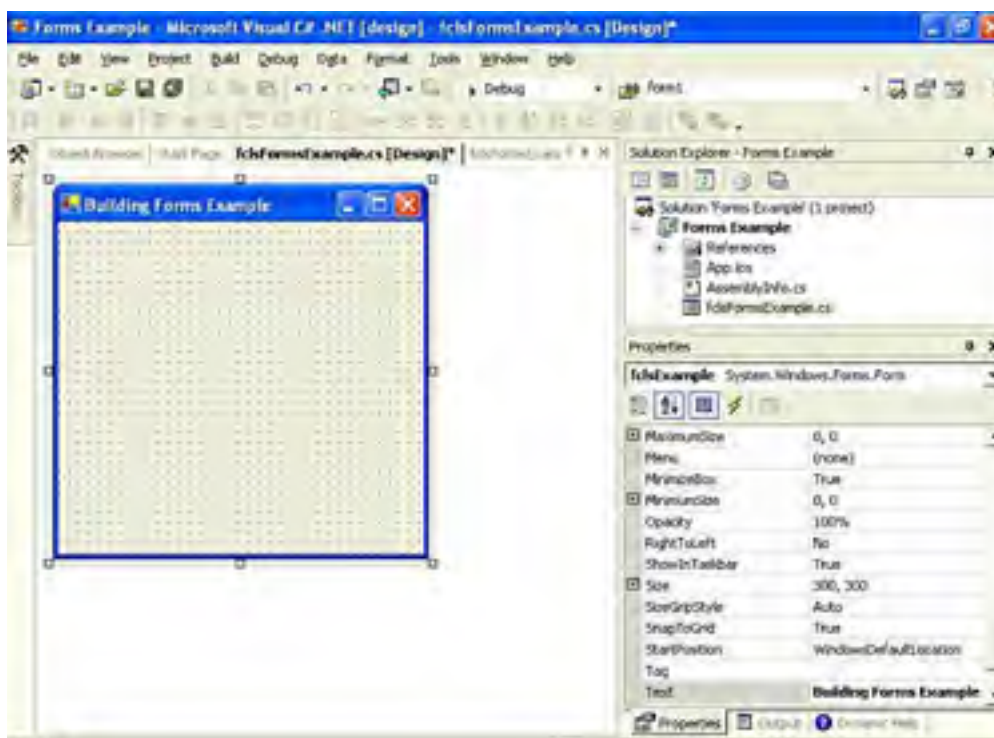
Displaying Text on a Form's Title Bar

You should always set the text in a form's title bar to something meaningful. (Note: Not all forms have title bars, as you'll see later in this hour.) The text displayed in the title bar is the value placed in the form's Text property. Generally, the text should be one of the following:

- The name of the program. This is most appropriate when the form is the program's main or only form.
- The purpose of the form. This is perhaps the most common type of text displayed in a title bar. For example, if a form is used to select a printer, consider setting the Text property to Select Printer. When you take this approach, use active verbs (for instance, don't use Printer Select).
- The name of the form. If you choose to place the name of the form into the form's title bar, use the "English" name, not the actual form name. For instance, if you've used a naming convention and named a form fclsLogin, use the text **Login** or **Login User**.

Change the Text property of your form to **Building Forms Example**. Your form should now look like the one in [Figure 5.1](#).

Figure 5.1. Use common sense when setting title bar text.





As with most other form properties, you can change the Text property at any time using Visual C# code.

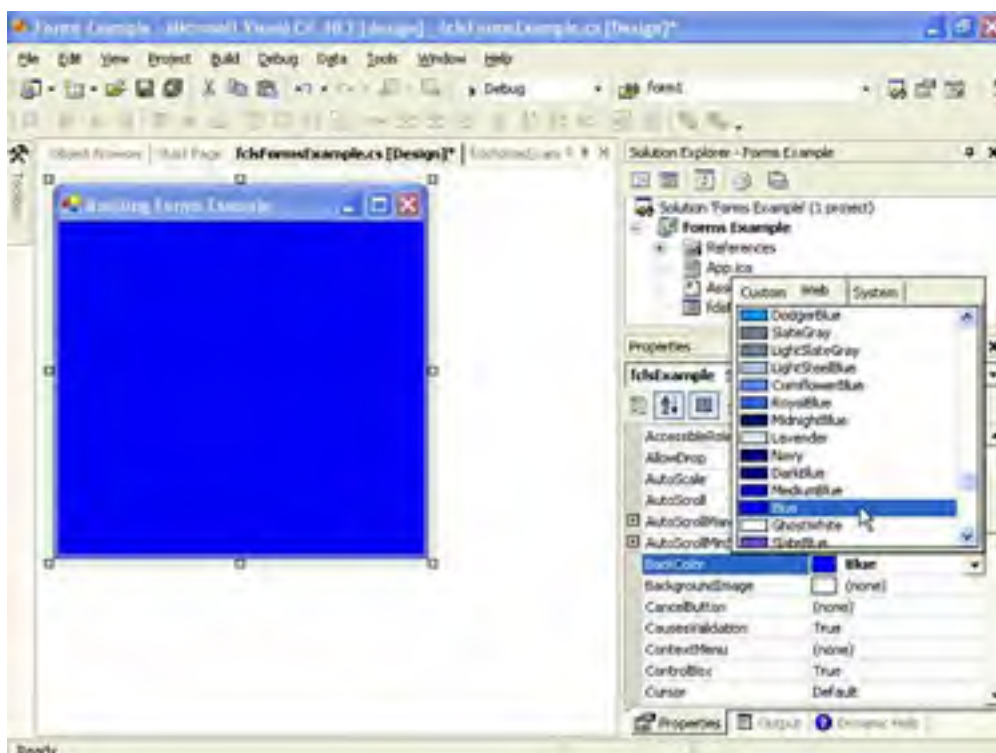
Changing a Form's Background Color

Although most forms appear with a gray background (this is part of the standard 3D color scheme in Windows), you can change a form's background to any color you want. To change a form's background color, you change its BackColor property. The BackColor property is a unique property in that you can specify a named color or an RGB value in the format Red, Green, Blue.

By default, the BackColor is set to the color named Control. This color is a system color, and might not be gray. When Windows is first installed, it's configured to a default color scheme. In the default scheme for all versions of Windows other than XP, the color for forms and other objects is the familiar "battleship" gray. For Windows XP installations, this color is a light tan (though it still looks gray on most monitors). However, as a Windows user, you're free to change any system color you want. For instance, some people with color blindness prefer to change their system colors to colors that have more contrast than the defaults so that objects are more clearly distinguishable. When you assign a system color to a form or control, the appearance of the object adjusts itself to the current user's system color scheme. This doesn't just occur when a form is first displayed; changes to the system color scheme are immediately propagated to all objects that use the affected colors.

Change the background color of your form to blue now by deleting the word Control in the BackColor property in the Properties window; in its place enter **0,0,255** and press Enter or Tab to commit your entry. Your form should now be blue because you entered an RGB value in which you specified no red, no green, and maximum blue (color values range from 0 to 255). In reality, you probably won't enter RGB values often. Instead, you'll select colors from color palettes. To view color palettes from which you can select a color for the BackColor property, click the drop-down arrow in the BackColor property in the Properties window (see [Figure 5.2](#)).

Figure 5.2. All color properties have palettes from which you can choose a color.



System colors are discussed in detail in [Hour 18](#), "Working with Graphics."

When the drop-down list appears, the color Blue on the Web tab is selected. This happens because when you entered the RGB value 0,0,255, Visual C# .NET looked for a named color composed of the same values and it found blue. The color palettes were explained in [Hour 2](#), "Navigating Visual Studio .NET," so I'm not going to go into detail about them here. For now, select the System tab to see a list of the available system colors and choose Control from the list to change the BackColor of your form back to the default Windows color

Adding an Image to a Form's Background

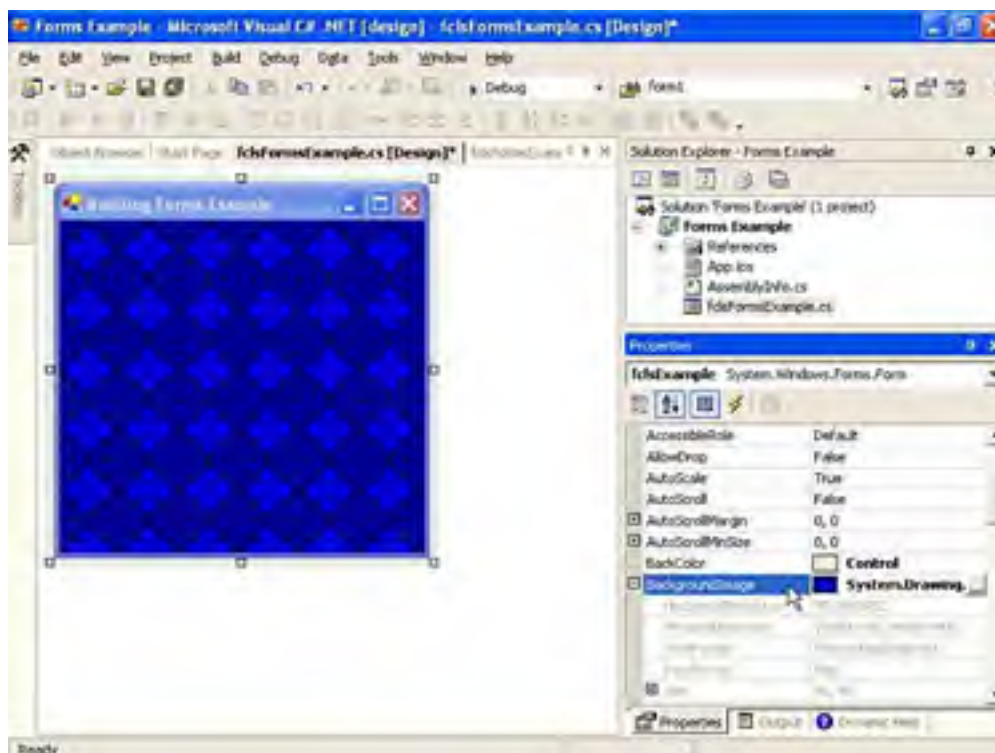
In addition to changing the color of a form's background, you can also place a picture on it. To add a picture to a form, set the form's BackgroundImage property. When you add an image to a form, the image is "painted" on the form's background. All the controls that you place on the form appear on top of the picture.

Add an image to your form now by following these steps:

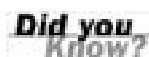
1. Select the form.
2. Click the BackgroundImage property in the Properties window.
3. Click the Build button that appears next to the property (the small button with three dots).
4. Use the Open dialog box that appears to locate and select an image file from your hard drive. (I used Blue Lace 16.BMP, which I found in my \Windows folder.)

Visual C# .NET always tiles an image specified in a BackgroundImage property (see [Figure 5.3](#)). This means that if the selected picture isn't big enough to fill the form, Visual C# .NET will display additional copies of the picture, creating a tiled effect. If you want to display a single copy of an image on a form, anywhere on the form, you should use a picture box, as discussed in [Hour 18](#).

Figure 5.3. Background images are tiled to fill the form.



Notice that to the left of the BackgroundImage property is a small box containing a plus sign. This indicates that there are related properties, or *subproperties*, of the BackgroundImage property. Click the plus sign now to expand the list of subproperties (refer to [Figure 5.3](#)). In the case of the BackgroundImage property, Visual C# .NET shows you a number of properties related to the image assigned to the property, such as its dimensions and image format. Note that these subproperties are read-only, but not all subproperties that you encounter will be



Adding a background image to a form can add pizzazz to a program, but it can also confuse users by making the form unnecessarily busy. Try to

avoid adding images just because you can. Use discretion, and add an image to a form only when the image adds value to the interface.

Removing an image from a form is just as easy as adding the image in the first place. To remove the picture that you just added to your form, right-click the BackgroundImage property name and choose Reset from the shortcut menu that appears.



You must right-click the Name column of the property, not the Value column. If you right-click the value of the property, you get a different shortcut menu that doesn't have a Reset option.

Giving a Form an Icon

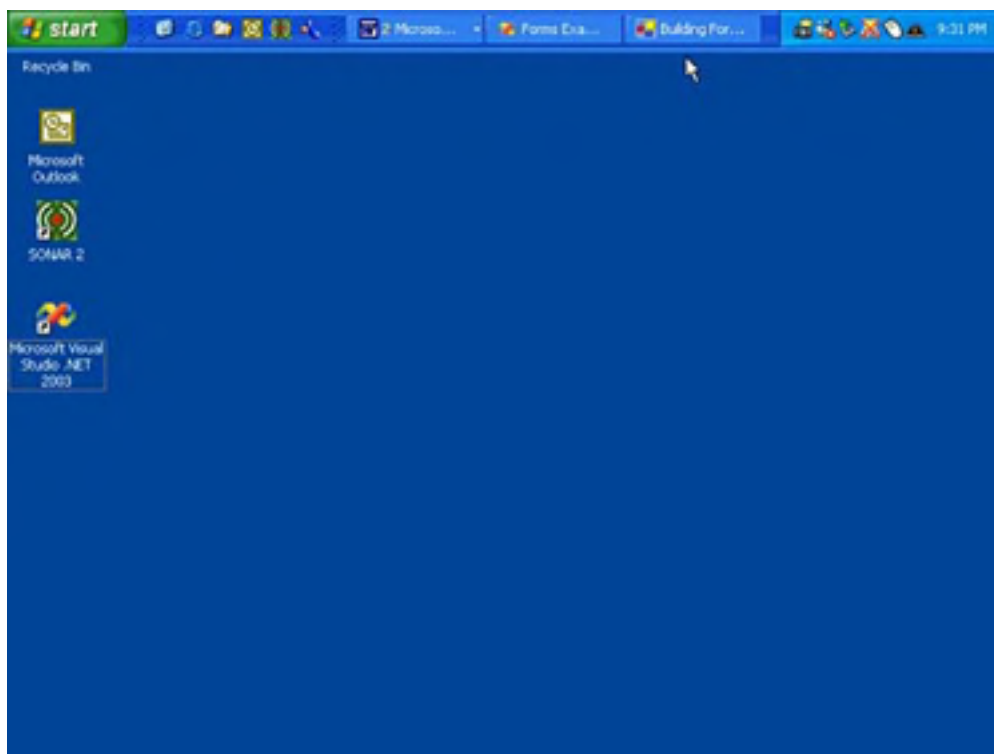
The icon assigned to a form appears in the left side of the form's title bar, in the taskbar when the form is minimized, and in the iconic list of tasks when you press Alt+Tab to switch to another application. The icon often represents the application; therefore, you should assign an icon to any form a user can minimize. If you don't assign an icon to a form, Visual C# .NET supplies a default icon to represent it when the form is minimized. This default icon is generic, unattractive, and doesn't really represent anything; you should avoid it.

In the past, it was recommended that every form have a unique icon that represented the form's purpose. This proved very difficult to accomplish in large applications containing dozens or even hundreds of forms. Instead, it's usually just best to set the icon property of all of your forms to the icon that best represents your application.

You assign an icon to a form in much the same way that you assign an image to the BackgroundImage property. Add an icon to your form now by clicking the form's Icon property in the Properties window, clicking the Build button that appears, and selecting an icon file from your hard drive. After you've selected the icon, it appears in the form's title bar to the left.

Run your project by pressing F5, and then click the form's Minimize button to minimize it to the taskbar. Look at the form in the taskbar; you'll see both the form's caption and the form's icon displayed (see [Figure 5.4](#)).

Figure 5.4. Assigning meaningful icons to your forms makes your application easier to use.



Stop the project now by choosing Debug, Stop Debugging.

Preventing a Form from Appearing in the Taskbar

Being able to display an icon for a minimized form is nice, but sometimes it's necessary to prevent a form from even appearing in the taskbar. If your application has a number of palette windows that float over a main form, for example, it's unlikely that you'd want any but your main form to appear in the taskbar. To prevent a form from appearing in the taskbar, set the form's ShowInTaskbar property to `false`. If the user minimizes a form with its ShowInTaskbar property set to `false`, the user can still get to the application by pressing Alt+Tab, even though the program can't be accessed via the taskbar; Visual C# .NET won't allow the application to become completely inaccessible to the user.

Changing the Appearance and Behavior of a Form's Border

You might have noticed while working with other Windows programs that the borders of forms can vary. Some forms have borders that you can click and drag to change the size of the form, some have fixed borders that can't be changed, and still others have no borders at all. The appearance and behavior of a form's border is controlled by its FormBorderStyle property.

The FormBorderStyle property can be set to one of the following values:

- None
- FixedSingle
- Fixed3D
- FixedDialog
- Sizable
- FixedToolWindow
- SizableToolWindow

Follow these steps to see how the FormBorderStyle property works:

1. Run your project now by pressing F5, and move the mouse pointer over one of the borders of your form. This form has a sizable border, which means that the border can be resized by the user. Notice how the pointer changes from a large arrow to a line with arrows pointing on either side, indicating the direction in which you can stretch the border. When you move the pointer over a corner, you get a diagonal cursor that indicates you can stretch both of the sides that meet at the corner.
2. Stop the project now by choosing Debug, Stop Debugging (or click the Close button on the form) and change the form's FormBorderStyle property to None. Your form should look like the one in [Figure 5.5](#). When you choose to not give a form a border, the title bar of the form is removed. Of course, when the title bar is gone, there is no visible title bar text, no control box, and no Minimize or Maximize buttons.

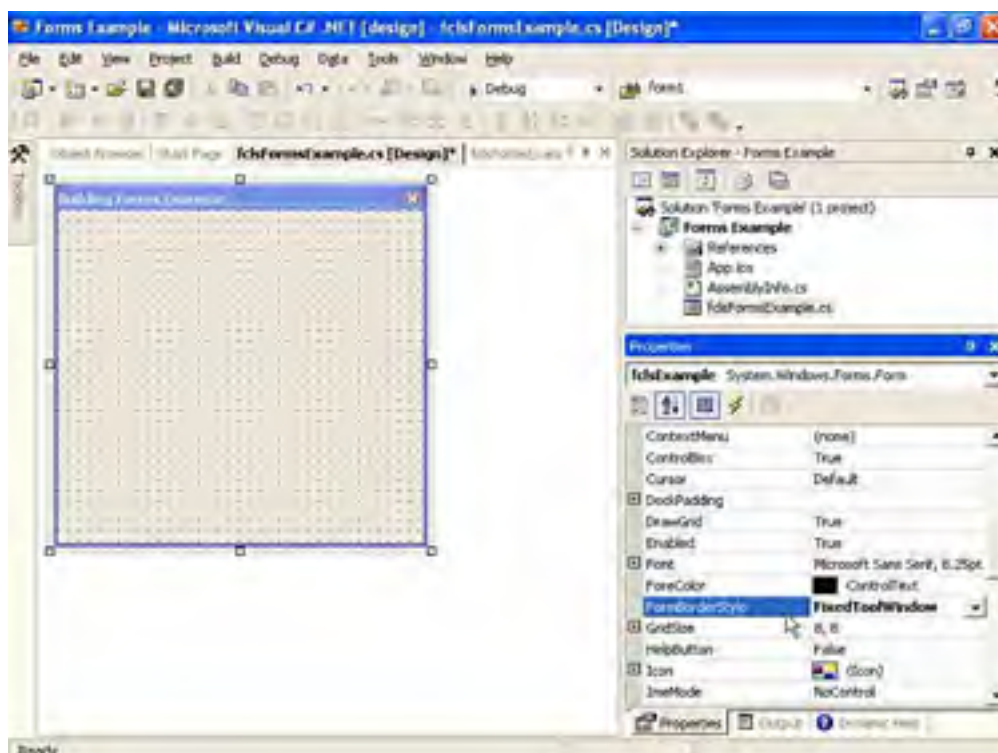
Figure 5.5. You can create forms without borders.





3. Run your project by pressing F5, and notice how the form appears as it did in Form Design view—with no border or title bar. Without a border, the form cannot be resized by the user, and without a title bar, the form cannot be repositioned. Rarely is it appropriate to specify None for a form's BorderStyle, but in the event you need to do this, it's entirely possible.
4. Stop the project (you'll have to do this by clicking the Stop Debugging button on the toolbar since there is no way to close your form) and change the FormBorderStyle to FixedDialog.
5. Press F5 to run the project again, and move the mouse pointer over a border of the form; the mouse pointer won't change, and you won't be able to stretch the borders of the form.
6. Stop the project again and set the form's FormBorderStyle property to FixedToolWindow. This setting causes the title bar of the form to appear smaller than normal and the text to display in a smaller font (see [Figure 5.6](#)). In addition, the only thing displayed on the title bar besides the text is a Close button. Visual C# .NET's various design windows, such as the Properties window and the toolbox, are good examples of tool windows.

Figure 5.6. A tool window is a special window whose title bar takes up the minimum space possible.



The FormBorderStyle is a good example of how changing a single property can greatly affect the look and behavior of an object. Set the FormBorderStyle of the form back to Sizable, the default setting for new forms.

Adding Minimize, Maximize, and Control Box Buttons to a Form

Minimize and Maximize buttons make it easy for a user to quickly hide a form or make it fill the entire display. Adding a Minimize or Maximize button to your forms is as easy as setting a property (or two). To add a Minimize button to a form's title bar, set the form's MinimizeBox property to **true**. To add a Maximize button to a form, set its MaximizeBox property to **true**. Conversely, set the appropriate property to **false** to hide a button.

By the Way

The form's `ControlBox` property must be set to `true` to display a Maximize and/or Minimize button on a form. When the `ControlBox` property of a form is set to `true`, a button with an X appears in the title bar at the right side, which the user can click to close the form. In addition, the form's icon is displayed in the left side of the title bar, and clicking it opens the form's System menu.

Notice that the title bar of your form shows all three buttons to the far right. From left to right, these are Minimize, Maximize, and Close. Run the project now and click the icon in the far left of the title bar to open the control box's menu, as shown in [Figure 5.7](#). Close the form now by either selecting Close from the menu or clicking the Close button on the far right of the title bar.

Figure 5.7. Clicking the icon of a form with a control box (or right-clicking a title bar) displays a system menu.



Changing the `MaximizeBox` or `MinimizeBox` properties of a form enables or disables the corresponding item on the system menu in addition to the button on the toolbar. Save your project now by clicking the Save All button on the toolbar

Specifying the Initial Display Position of a Form

The location on the display (monitor) where a form first appears isn't random but is controlled by the form's `StartPosition` property. The `StartPosition` property can be set to one of the values in [Table 5.1](#).

Table 5.1. Values for the StartPosition Property

Value	Description
Manual	The Location property of the form determines where the form first appears.
CenterScreen	The form appears centered in the display.
WindowsDefaultLocation	The form appears in the Windows default location, which is toward the upper left of the display.
WindowsDefaultBounds	The form appears in the Windows default location with its bounds (size) set to the Windows default bounds.
CenterParent	The form is centered within the bounds of its parent form.

By the Way

Generally, it's best to set the `StartPosition` property of all your forms to `CenterParent`, unless you have a specific reason to do otherwise. For the very first form that appears in your project, you might consider using the `WindowsDefaultLocation` (but I generally prefer `CenterScreen`).

Displaying a Form in a Normal, Maximized, or Minimized State

Using the Size and Location properties of a form in conjunction with the StartPosition property enables you to display forms at any location and at any size. You can also force a form to appear minimized or maximized. Whether a form is maximized, minimized, or shown normally is known as the form's *state*, and it's determined by the WindowState property.

Look at your form's WindowState property now. New forms have their WindowState property set to Normal by default. When you run the project, as you have several times, the form displays in the same size as it appears in the form designer, at the location specified by the form's Location property. Change the WindowState property now to Minimized. Nothing happens in the Form Design view, but run your project by pressing F5 and you'll see that the form is immediately minimized to the taskbar.

Stop the project and change the WindowState property to Maximized. Again, nothing happens in the Form Design window. Press F5 to run the project and notice how the form immediately maximizes to fill the entire screen.

By the Way When a form is maximized, it fills the entire screen regardless of the current screen resolution being used in Windows.

Stop the project and change the WindowState property back to Normal. Rarely will you set a form's WindowState property at design time to Minimize, but you'll probably encounter situations in which you need to change (or determine) the WindowState at runtime. As with most properties, you can accomplish this using code. For example, the following statement would minimize a form:

```
this.WindowState = FormWindowState.Minimized
```

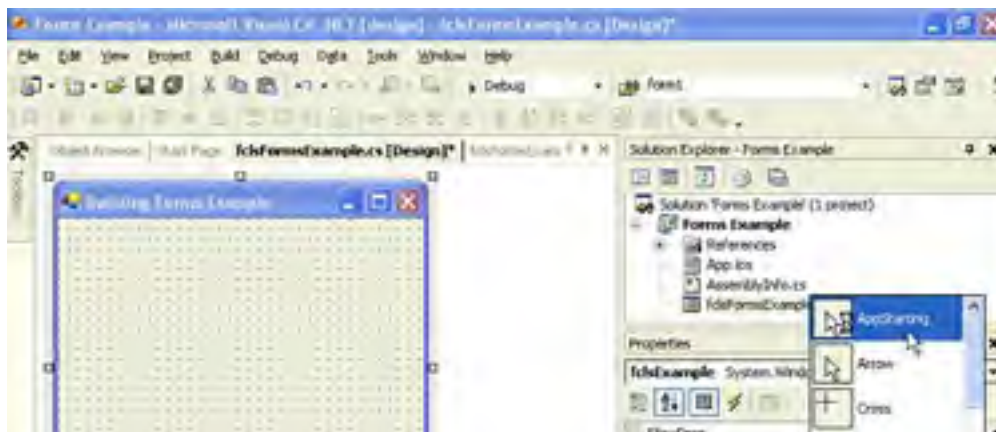
You don't have to remember the names of the values when you're entering code; you'll get an IntelliSense drop-down list when you type the period.

Changing the Mouse Pointer

You've no doubt used a program that altered the cursor when the pointer was moved over an object. This behavior is prevalent in Web browsers, in which the cursor is changed to the shape of a pointing hand when moved over a hyperlink. Using the Cursor property, you can specify the image of the pointer displayed when the pointer is over a form (or control).

Click the Cursor property of the form in the Properties window now and a drop-down arrow appears. Click the arrow to view a list of cursors (see [Figure 5.8](#)). Selecting a cursor from the list causes the pointer to change to that cursor when positioned over the form. Change the Cursor property of the form to AppStarting and press F5 to run the project. Move the pointer over the form and notice that the cursor changes to the AppStarting cursor while over the form and reverts to the default cursor when moved off the form. Stop the project now and click Save All on the toolbar to save your work.

Figure 5.8. Use the Cursor property to designate the image of the pointer when it's moved over the object.





**By the
Way**

Rarely will you want to change the cursor for a form, but you might occasionally want to change the Cursor property for specific controls. Whenever you find yourself changing the default cursor for a form or control, choose a cursor that is consistent in purpose with well-known commercial applications.

Showing and Hiding Forms

[Part III](#), "Making Things Happen—Programming," is devoted to programming in Visual C# .NET, and I've avoided going into much programming detail in this hour so that you can focus on the concepts at hand. However, knowing how to create forms does nothing for you if you don't have a way to show and hide them; Visual C# .NET can display a single form automatically only when a program starts. To display other forms, you have to write code.

Showing Forms

In Visual C#, everything is an object, and objects are based on classes (see [Hour 16](#), "Designing Objects Using Classes," for information on creating classes). Because the definition of a form is a class, you have to create a new Form object using the class as a template. In [Hour 3](#), "Understanding Objects and Collections," I discussed objects and object variables, and these principles apply to creating forms.

As discussed in [Hour 3](#), the process of creating an object from a class (template) is called instantiation. The syntax you'll use most often to instantiate a form is the following:

```
{ formclassname } {objectvariable} = new {formclassname()};
```

The parts of this declaration are as follows:

- *formclassname* The name of the class that defines the form.
- *objectvariable* The name for the form that you will use in code.
- The keyword *new* Indicates that you want to instantiate a new object for the variable.

Last, you specify the name of the class used to derive the object—your form class. If you have a form class named `fclsLoginDialog`, for example, you could create a new Form object using the following code:

```
fclsLoginDialog frmLoginDialog = new fclsLoginDialog();
```

Thereafter, for as long as the object variable remains in scope (scope is discussed in [Hour 11](#), "Using Constants, Data Types, Variables, and Arrays"), you can manipulate the Form object using the variable. For instance, to display the form, you call the `Show` method of the form or set the `Visible` property of the form to `true` using code such as this:

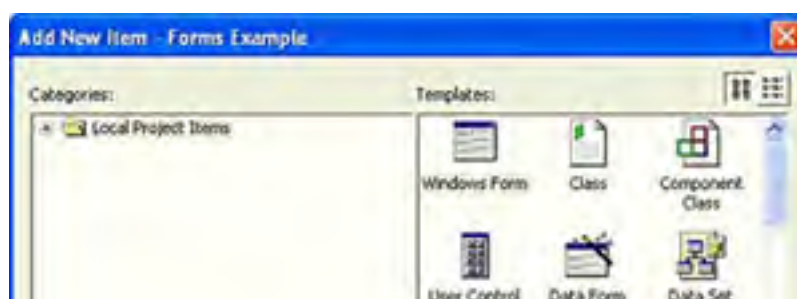
```
frmLoginDialog.Show();
```

or

```
frmLoginDialog.Visible = true;
```

The easiest way to get the hang of this is to actually do it. To begin, choose `Project, Add Windows Form` to display the `Add New Item` dialog box. Change the name of the form to `fclsMyNewForm.cs` (as shown in [Figure 5.9](#)), and click `Open` to create the new form.

Figure 5.9. When you change the default name of a form, remember to leave the .cs extension.





Your project now has two forms, as you can see by viewing the Solution Explorer window. The new form is displayed in the form designer, but right now you need to work with the main form, so follow these steps:

1. At the top of the main design area is a set of tabs. Currently, the tab `fclsMyNewForm.cs [Design]` is selected. Click the tab titled `fclsFormsExample.cs [Design]` to show the designer for the first form.
2. Add a new button to your original form by double-clicking the Button item on the toolbox (be careful not to add the button to the new form by mistake). Set the button's properties as follows:

Property	Value
Name	<code>btnShowForm</code>
Location	<code>112,112</code>
Text	<code>Show Form</code>

3. Double-click the button to access its Click event (double-clicking a control is a shortcut for accessing its default event) and enter the following code:

```
fclsMyNewForm frmTest = new fclsMyNewForm();  
frmTest.Show();
```

The first statement creates a new object variable and instantiates an instance of the `fclsMyNewForm` form. The second statement uses the object variable (now holding a reference to a Form object) to display the form. Press F5 to run the project, and click the button. (If the button doesn't appear on the form, you might have accidentally added it to the wrong form.) When you click the button, a new instance of the second form is created and displayed. Move this form and click the button again. Each time you click the button, a new form is created. Stop the project now and click Save All on the toolbar.

Understanding Form Modality

You can present two types of forms to the user: modal and nonmodal forms. The modality of a form is determined by how you show the form rather than by how you create the form (both modal and nonmodal forms are created the same way).

A **nonmodal window** is a window that doesn't cause other windows to be disabled. The forms you created in this example are nonmodal, which is why you were able to continue clicking the button on the first form even though the second form was displayed. Another example of a nonmodal window is the Find and Replace window in Word (and in Visual C# .NET, as well). When the Find and Replace window is visible, the user can still access other windows.

When a form is displayed as a modal form, on the other hand, all other forms in the same application become disabled until the modal form is closed; the other forms won't accept any keyboard or mouse input. The user is forced to deal only with the modal form. When the modal form is closed, the user is free to work with other visible forms within the program. Modal forms are most often used to create dialog boxes in which the user works with a specific set of data and controls before moving on. For instance, the Print dialog box of Microsoft Word is a modal dialog box. When the Print dialog box is displayed, the user can't work with the document in the main Word window until the Print dialog box is closed. Most secondary windows in any given program are modal windows.



You can display one modal form from another modal form, but you cannot display a nonmodal form from a modal form.

To show a form as a modal form, you call the form's `ShowDialog` method rather than its `Show` method. Change the code in your button's Click event to read:

```
fclsMyNewForm frmTest = new fclsMyNewForm();  
frmTest.ShowDialog();
```

When your code looks like this, press F5 to run the project. Click the button to create an instance of the second form. Then, move the second form away from the first window and try to click the button again. You can't—because you've created a modal form. Close the modal form now by clicking the Close button in the title bar. Now, the first form is enabled again and you can click the button once more. When you are done testing this, stop the running project.



You can test to see whether a form has been shown modally by testing the form's `Modal` property.

Unloading Forms

After a form has served its purpose, you'll want it to go away. However, "go away" can mean one of two things. First, you can make a form disappear without closing it or freeing its resources (this is called *hiding*). To do so, set its `Visible` property to `false`. This hides the visual part of the form, but the form still resides in memory and can still be manipulated by code. In addition, all the variables and controls of the form retain their values when a form is hidden, so that if the form is displayed again, the form looks the same as it did when its `Visible` property was set to `false`.

Second, you can completely close a form and release the resources it consumes. You should close a form when it's no longer needed so that Windows can reclaim all resources used by the form. To do so, you invoke the `Close` method of the form like this:

```
this.Close();
```

In [Hour 3](#), you learned how this is used to reference the current Form object. Because this represents the current Form object, you can manipulate properties and call methods of the current form using `this`. (`this.Visible = false`, and so forth).

The `Close` method tells Visual C# .NET to not simply hide the form, but to destroy it completely. If variables in other forms are holding a reference to the form you close, their references will be set to null and will no longer point to a valid Form object (refer to [Hour 11](#) for information on null).

Follow these steps to create the close button for your form:

1. Select the `fclsMyNewForm.cs` [Design] tab to display the form designer for the second form, add a new button to the form, and set the button's properties as follows:

Property	Value
Name	<code>btnCloseMe</code>
Location	<code>112,112</code>
Text	<code>Close Me</code>

2. Double-click the button to access its Click event and then enter the following statement:

```
this.Close();
```

3. Next, run the project by pressing F5. Click the Show Form button to display the second form, and then click the second form's button. The form will disappear. Again, the form isn't just hidden; the form instance is unloaded from memory and no longer exists.

You can create a new one by single-clicking the Show Form button on the first form. When you're finished, stop the running project and save your work.

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Summary

In this hour, you've learned the basics of creating forms. You've learned how to add them to your project, how to set basic appearance properties, and how to show and hide them using Visual C# .NET code. In the next hour, you'll learn more advanced functionality for working with forms. After you've mastered the material in this hour as well as in the next hour, you'll be ready to dig into Visual C# .NET's controls; that's where the fun of building an interface really begins!

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Q&A

Q1: *How many form properties should I define at design time versus runtime?*

A1: You should set all properties that you can at design time. First, it'll be easier to work with the form because you can see exactly what the user will see. Also, debugging is easier because there's less code.

Q2: *Should I let the user minimize and maximize all forms?*

A2: Probably not. First, there's no point in letting a form be maximized if you haven't anchored and aligned controls so that they adjust their appearance when the form is resized. In fact, if a form's contents don't change when a form is resized (including maximized), the form should not have a sizable border or a Maximize button.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** True or False: The text displayed in the form's title bar is determined by the value in the TitleBarText property.
- 2:** The color named Control is what kind of color?
- 3:** In what three places are a form's icon displayed?
- 4:** A window with a smaller than normal title bar is called what?
- 5:** For a Minimize or Maximize button to be visible on a form, what other element must be visible?
- 6:** What, in general, is the best value to use for the StartPosition property of a form?
- 7:** To maximize, minimize, or restore a form in code, you set what property?
- 8:** True or False: To display a form, you must create a variable in code.
- 9:** What property do you set to make a hidden form appear?

Exercises

- 1:** Create a semitransparent form with a picture in its background. Does the image become transparent? Add some controls to the form. Does the image appear behind or in front of the controls? (Hint: To create a transparent form, set the form's Opacity to something other than 100%—try 50%.)
- 2:** Create a Windows Application with three forms. Give the startup form two buttons. Make the other two forms tool windows, and make one button display the first tool window and the other button display the second tool window.

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Hour 6. Building Forms: Advanced Techniques

A form is just a canvas, and although you can tailor a form by setting its properties, you'll need to add controls to it to make it functional. In the preceding hour, you learned how to add forms to a project, how to set basic form properties, and how to show and hide forms. In this hour, you'll learn all about adding controls to a form, including arranging and aligning controls to create an attractive and functional interface. You also learn how to create advanced multiple document interfaces (MDIs), as used in applications such as Photoshop. After you complete the material in this hour, you'll be ready to learn the details about the various controls available in Visual C# .NET.

The highlights of this hour include the following:

- Adding controls to a form
- Positioning, aligning, sizing, spacing, and anchoring controls
- Creating intelligent tab orders
- Adjusting the z-order of controls
- Creating transparent forms
- Creating forms that always float over other forms
- Creating multiple-document interfaces

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Working with Controls

Controls are the objects that you place on a form for users to interact with. If you've followed the examples in the previous hours, you've already added controls to a form. However, you'll be adding a lot of controls to forms, and it's important for you to understand all aspects of the process. Following the drill-down in this hour, the next two hours will teach you the ins and outs of the very cool controls provided by Visual C# .NET.

Adding Controls to a Form

All the controls that you can add to a form can be found in the toolbox. The toolbox appears as a docked window on the left side of the design environment by default. This location is useful when you're only occasionally adding controls to forms. However, when doing serious form-design work, I find it best to dock the toolbox to the right edge of the design environment, where it doesn't overlap so much (if at all) of the form with which I'm working with.



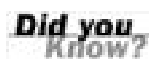
Remember that before you can undock a toolbar to move it to a new location, you must make sure it isn't set to Auto Hide.

The buttons on the toolbox are actually considered tabs because clicking one of them displays a specific page of controls. For most of your design, you'll use the controls on the Windows Forms tab. As your skills progress, however, you might find yourself using more complex and highly specialized controls found on the other tabs.

You can add a control to a form in three ways, and you're now going to use all three methods. Create a new Windows Application called **Adding Controls**. Change the name of the default form to **fclsAddingControls** and set its Text property to **Adding Controls**. Update the main entry point in the Main() function to reflect the new class name by clicking the View Code button on the Solution Explorer toolbar and then locating the reference to Form1 and replacing it with fclsAddingControls. Click Form1.cs [Design] to return to the form designer.

Follow these steps:

1. The easiest way to add a control to a form is to double-click the control in the toolbox. Try this now: first click the Form1.cs [Design] tab to view the form designer. Then, display the toolbox and double-click the TextBox tool. Visual C# .NET creates a new text box in the upper-left corner of the form. When you double-click a control in the toolbox (excluding controls that are invisible-at-runtime), Visual C# .NET creates the new control on top of the last control you just added, with the default size for the type of control you're adding. If there are no other controls on the form, the new control is placed in the upper-left corner as you've seen here. You're free, of course, to move and size the text box as you please.
2. If you want a little more authority over where the new control is placed, you can drag a control to the form. Try this now: display the toolbox and then click the Button control and drag it to the form. When the cursor is roughly where you want the button created, release the mouse button.
3. The last and most precise method of placing a control on a form is to "draw" the control on a form. Display the toolbox now and click the ListBox tool once to select it. Next, move the pointer to where you want the upper-left corner of the list box to appear and then click and hold the mouse button. Drag the pointer to where you want the bottom-right corner of the list box to be and release the button. The list box is created with its dimensions set to the rectangle you drew on the form. This is by far the most precise method of adding controls to a form.



If you prefer to draw controls on your forms by clicking and dragging, I strongly suggest that you dock the toolbox to the right or bottom edge of the design environment, or float it. The toolbox tends to interfere with drawing controls when it's docked to the left edge, because it obscures a good bit of the underlying form.

It's important to note that the very first item on the Windows Forms tab, titled Pointer, isn't actually a control. When the pointer item is selected, the design environment is placed in Select mode rather than in a mode to create a new control. With the pointer chosen, you can select a control simply by clicking it, displaying all its properties in the Properties window. This is the default behavior of the development environment.

Manipulating Controls

Getting controls on a form is the easy part. Arranging them so that they create an intuitive and attractive interface is the challenge. Interface possibilities are nearly endless, so I can't tell you how to design any given interface. However, I can show you the techniques to move, size, and arrange controls so that they appear the way you want them to. By mastering these techniques, you'll be much more efficient at building interfaces, freeing your time for writing the code that makes things happen.

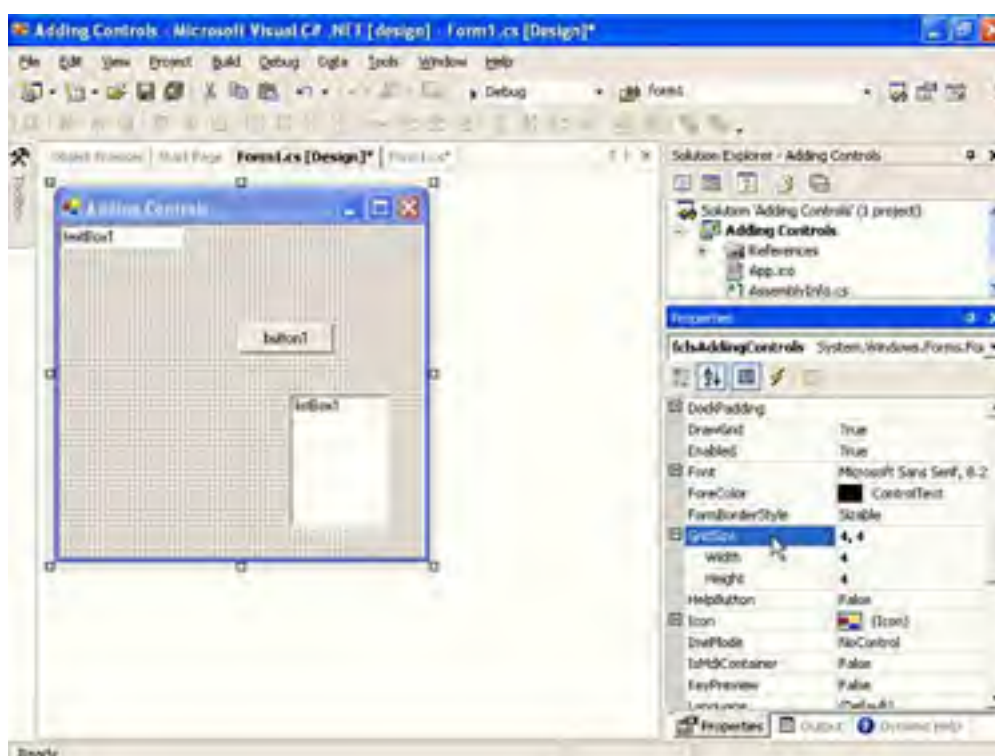
Using the Grid (Size and Snap)

When you first install Visual C# .NET, all forms appear with a grid of dots on them. When you draw or move controls on a form with a grid, the coordinates of the control automatically snap to the nearest grid coordinate. This offers some precision when adjusting the size and location of controls. In practical use, I often find the grid to be only slightly helpful because the size or location you want often doesn't fit neatly with the grid locations. You can, however, control the granularity and even the visibility of the grid, and I suggest you do both.

You're now going to assign a higher level of granularity to the grid (the space between the grid points will be smaller). I find that this helps with design because edges aren't so easily snapped to unwanted places.

To adjust the granularity of the grid, you change the form's GridSize property (or the Width and Height subproperties of the GridSize property). Setting the Width or Height of the grid to a smaller number creates a more precise grid, which allows for finer control over sizing and placement, whereas using larger values creates a much coarser grid and offers less control. With a larger grid, you'll find that edges snap to grid points much more easily and at larger increments, making it impossible to fine-tune the size or position of a control. Change the GridSize property of your form now to **4,4**. Notice that many more grid dots appear (see [Figure 6.1](#)).

Figure 6.1. Grids can be distracting.



Try dragging the controls on your form or dragging their edges to size them. Notice that you have more control over the placement with the finer grid. Try changing the GridSize to a set of higher numbers, such as **25,25**, and see what happens. When you're finished experimenting, change the GridSize values back to **4,4**.

An unfortunate side effect of a smaller grid is that the grid can become quite distracting. Again, you'll decide what you like best, but I generally turn the grids off on my forms. You do this by setting the DrawGrid property of the form to **false**. Try hiding the grid of your form now.



This property determines *only* whether the grid is drawn, not whether it's active; whether or not a grid is active is determined by the form's SnapToGrid property.

Selecting a Group of Controls

As your skills increase, you'll find your forms becoming increasingly complex. Some forms may contain dozens, or even hundreds, of controls. Visual C# .NET has a set of features that makes it easy to align groups of controls.

Create a new Windows Application titled **Align Controls**. Change the name of the default form to **fclsAlignControls** and set its Text property to **Control Alignment Example**. Next, update the main entry point in the Main() function to reflect the new class name by clicking the View Code button on the Solution Explorer toolbar and then locating the reference to Form1 and replacing it with **fclsAlignControls**. Click Form1.cs [Design] to return to the form designer.

You're now going to add three text boxes to the form by following these steps:

1. Double-click the TextBox tool in the toolbox to add a text box to the form. Set its properties as follows:

Property	Value
Name	txt1
Location	20,20
Multiline	True
Size	100,30
Text	txt1



If you don't set the Multiline property of a text box to **true**, Visual C# .NET ignores the Height setting (the second value of the Size property) and instead keeps the height at the standard height for a single-line text box.

2. Use the same technique (double-click the TextBox item in the toolbox) to add two more text boxes to the form. Set their properties as follows:

Text Box 2:

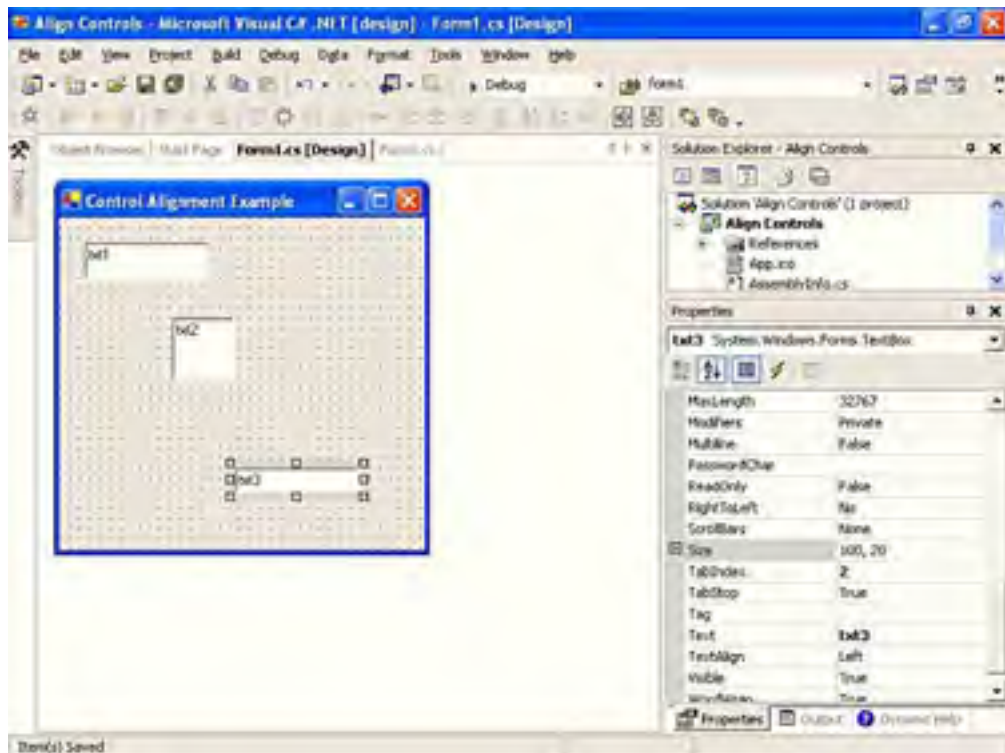
Property	Value
Name	txt2
Location	90,80
Multiline	True
Size	50,50
Text	txt2

Text Box 3:

Property	Value
Name	txt3
Location	140,200
Multiline	True
Size	100,60
Text	txt3

Your form should now look like the one in [Figure 6.2](#). Save the project now by clicking the Save All button on the toolbar.

Figure 6.2. It's easy to align and size controls as a group.



By default, clicking a control on a form selects it while simultaneously deselecting any controls that were previously selected. To perform actions on more than one control, you need to select a group of controls. You can do this in one of two ways, the first of which is to *lasso* the controls. To lasso a group of controls, you first click and drag the mouse pointer anywhere on the form. As you drag the mouse, a rectangle is drawn on the form. When you release the mouse button, all controls intersected by the rectangle become selected. Note that you don't have to completely surround a control with the lasso (also called a marquee); you only have to intersect part of the control to select it. Try this now: click somewhere in the upper-left corner of the form and drag the pointer toward the bottom-right corner of the form without releasing the button (see [Figure 6.3](#)). When the rectangle has surrounded or intersected all the controls, release the button and the controls will be selected (see [Figure 6.4](#)).

Figure 6.3. Click and drag to create a selection rectangle.

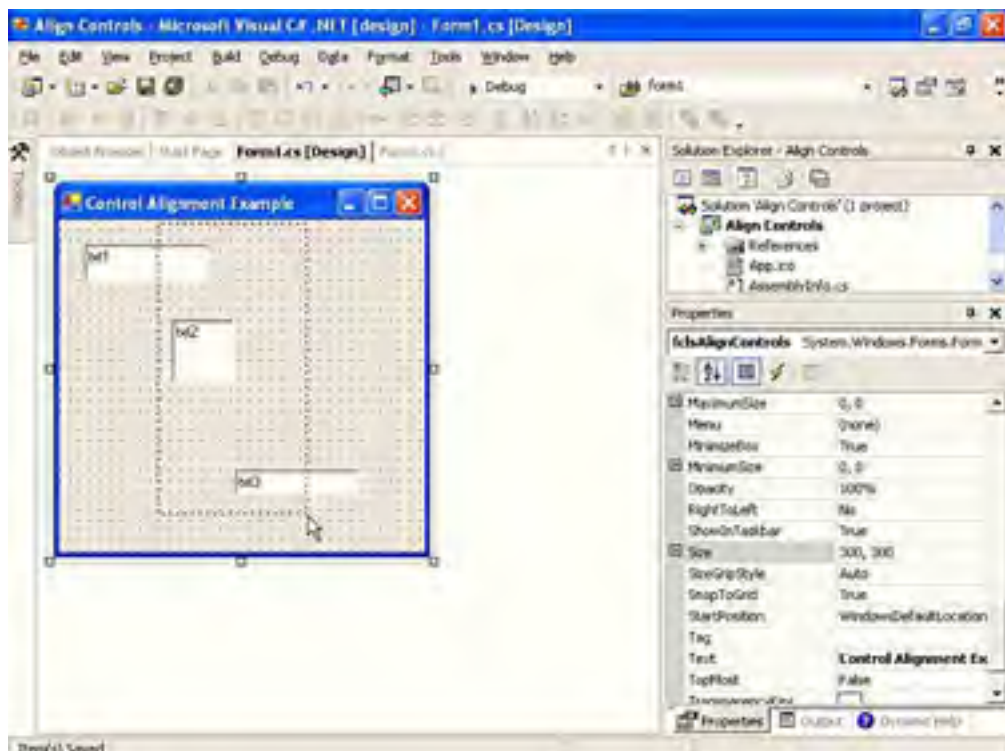
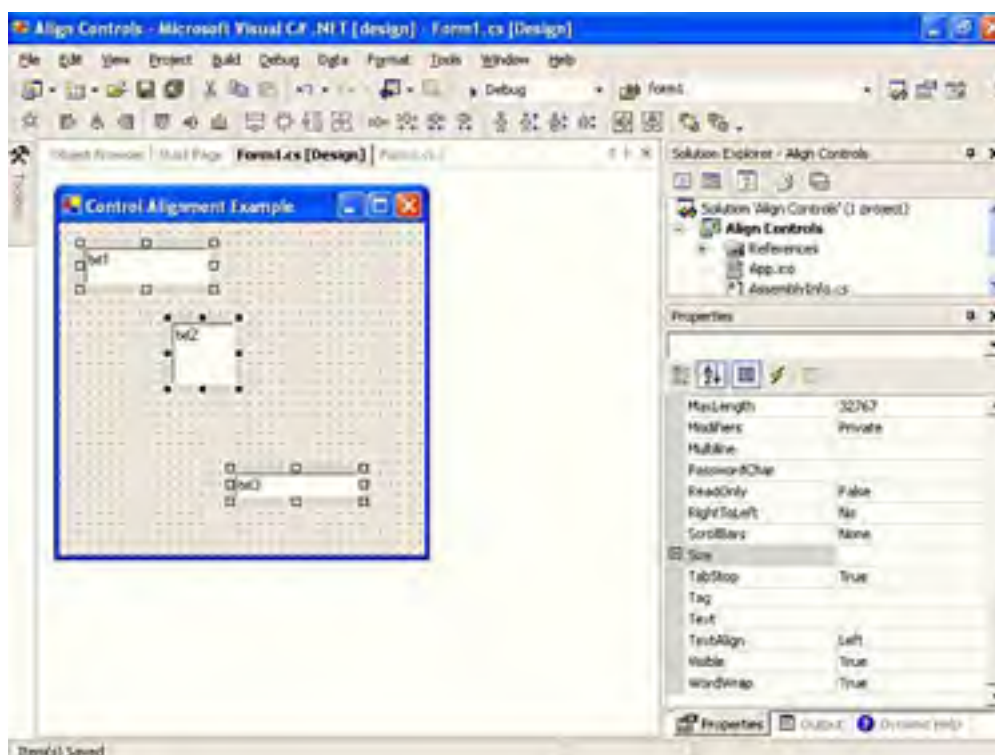


Figure 6.4. All selected controls appear with a hatched border and sizing handles.



When a control is selected, it has a hatched border and a number of sizing handles (the squares in the hatched border at the corners and midpoints of the control). Pay careful attention to the sizing handles. The control with the black-centered sizing handles is the *active control* in the selected group. When you use Visual C# .NET's tools, such as the alignment and formatting features, to work on a group of selected controls (such as the alignment and formatting tools shown in [Figure 6.4](#), each of the controls would have its Left property value set to that of the active control. When you use the lasso technique to select a group of controls, you really don't have much authority over which control Visual C# .NET makes the active control. In this example, you want to align all controls to the control at the top, so you'll have to use a different technique to select the controls. Deselect all the controls now by clicking anywhere on the form (other than on a control).

By the Way

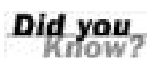
Not all sizing handles are movable at all times. Before you set the Multiline property of a text box to **true**, for example, Visual C# won't allow you to change the height of the text box, so only the sizing handles at the left and right edges are movable and therefore colored white.

The second technique for selecting multiple controls is to use the Shift or Ctrl key (either can be used to the same effect); this method is much like selecting multiple files in Windows Explorer. Click the bottom control (txt3) now to select it. (When only one control is selected, it's considered the active control.) Now hold down the Shift key and click the center control (txt2); txt2 and txt3 are now selected. The text box txt2 is now the active control. (When more than one control is selected, the active control has its sizing handles set to black so that you can identify it.) When you add a control to a group of selected controls, the newly selected control is always made the active control. Finally, with the Shift key still held down, click txt1 to add it to the group of selected controls. All the controls should now be selected and txt1 should be the active control.

By the Way

Clicking a selected control while Shift is held down deselects the control.

You can combine the two selection techniques when needed. For instance, you could first lasso all controls to select them. If the active control isn't the one you want it to be, you could hold the Shift key down and click the control you want made active, thereby deselecting it. Clicking the control a second time while still holding down the Shift key would again select the control. Because the control would then be the last control added to the selected group, it would be made active. You're going to do this now. With all three controls selected, hold Ctrl while clicking the third (bottom) text box. It will be deselected. Keep holding Ctrl and click the text box once more. It will now be selected with the rest of the controls, and it will be the active control because it was the last control added to the group.



If you must click the same control twice, such as to deselect and then reselect it, do so s-l-o-w-l-y. If you click too fast, Visual C# .NET interprets your actions as a double-click, and it creates a new event handler for the control.

Aligning Controls

Now that you've selected all three controls, open Visual C# .NET's Format menu (see [Figure 6.5](#)). The Format menu has a number of submenus containing functions to align, size, and format groups of controls. Open the Align submenu now to see the available options (see [Figure 6.6](#)).

Figure 6.5. Use the Format menu to quickly whip an interface into shape.

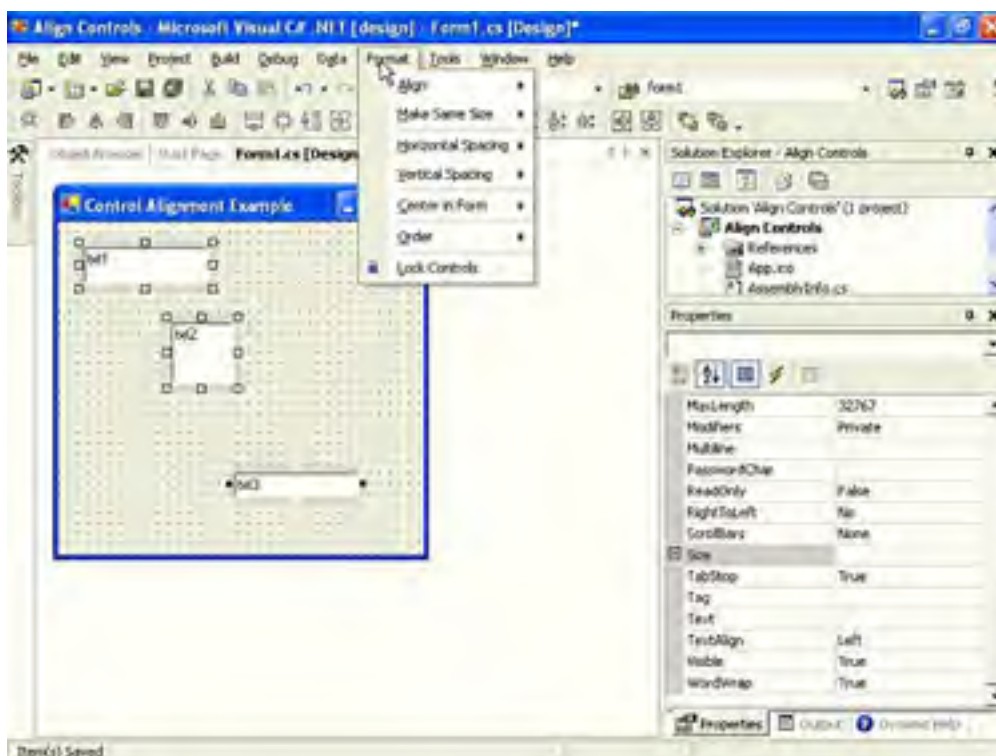
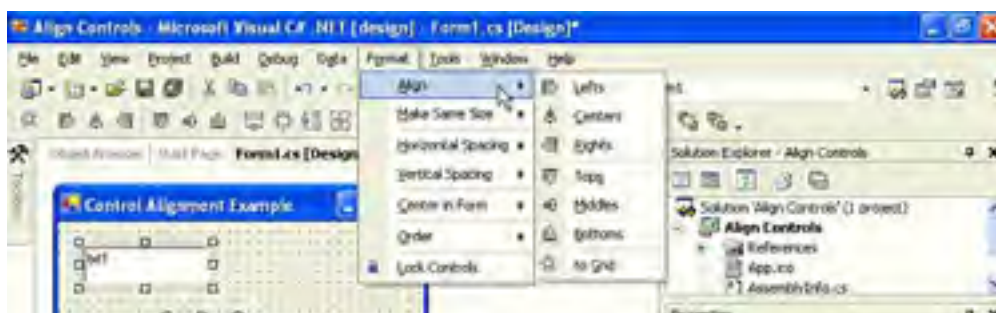


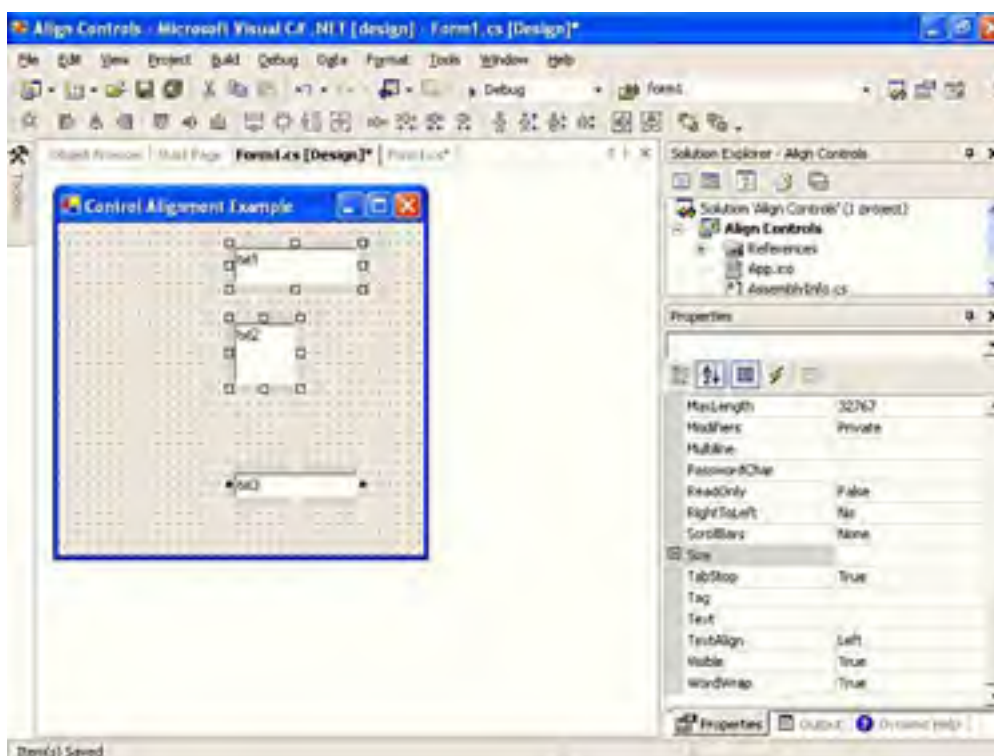
Figure 6.6. The Align menu makes it easy to align an edge of a group of controls.





The top three items on the Align menu are used to align the selected controls horizontally, and the middle three items align the selected controls vertically. The last item, to Grid, will snap the corners of all the selected controls to the nearest grid points. Choose Align Lefts now, and Visual C# .NET aligns the left edges of the selected controls. Notice how the Left edge of the active control is used as the baseline for the alignment (see [Figure 6.7](#)).

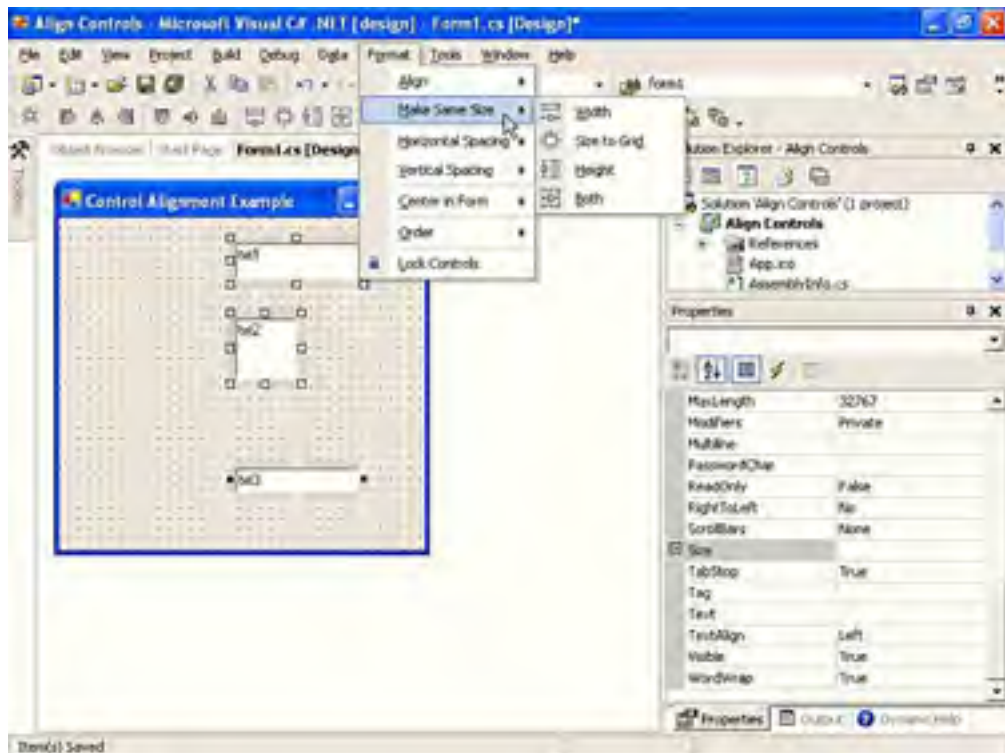
Figure 6.7. The property values of the active control are always used as the baseline values.



Making Controls the Same Size

In addition to aligning controls, you can make all selected controls the same size—Height, Width, or Both. To do this, use the Make Same Size submenu on the Format menu (see [Figure 6.8](#)). Make all your controls the same size now by choosing Both from the Make Same Size menu. As with the Align function, the values of the active control are used as the baseline values.

Figure 6.8. Use this menu to quickly make a group of controls the same size.



Evenly Spacing a Group of Controls

As many a salesman has said, "...and that's not all!" You can also make the spacing between controls uniform using the Format menu. Try this now: open the Vertical Spacing submenu of the Format menu and then choose Make Equal. All the controls are now evenly spaced. Next, choose Decrease from the Vertical Spacing submenu and notice how the spacing between the controls decreases slightly. You can also increase the vertical spacing or completely remove vertical space from between controls using this menu. To perform the same functions on the horizontal spacing between controls, use the Horizontal Spacing submenu of the Format menu. Save your project now by clicking the Save All button on the toolbar.

Setting Property Values for a Group of Controls

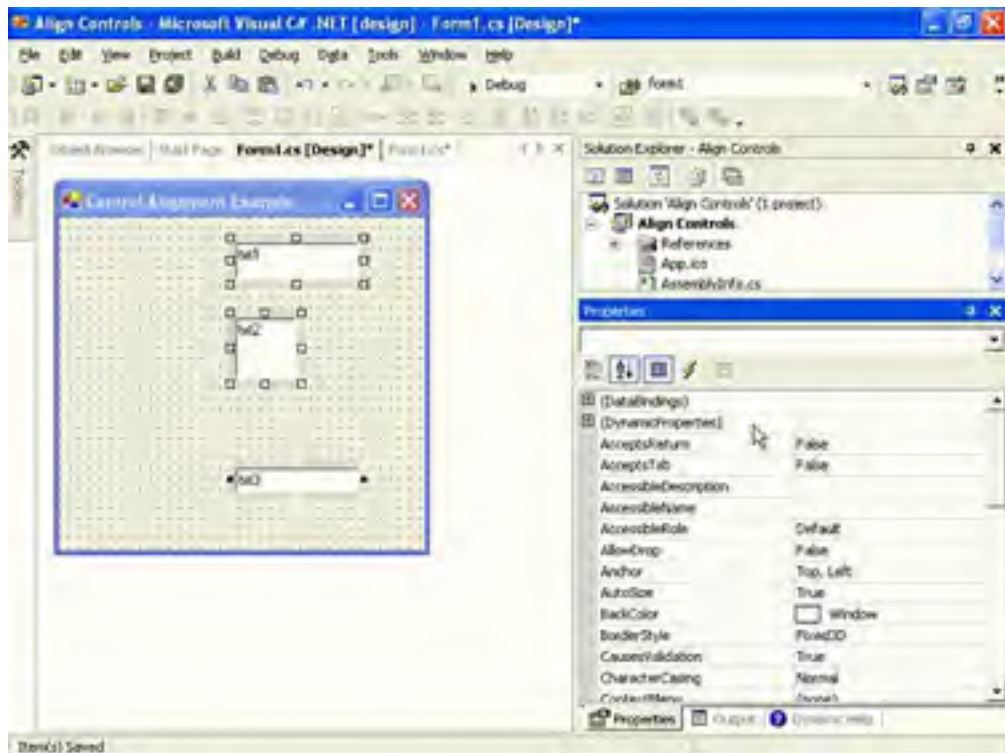
You can change a property value in the Properties window when multiple controls are selected. This causes the corresponding property to change for all selected controls.

Make sure all three controls are still selected and then display the Properties window.

When a group of controls is selected, the Properties window appears with some modifications (see [Figure 6.9](#)):

- No Name property is shown. This occurs because you're not allowed to have two controls with the same name, so Visual C# .NET won't even let you try.
- Only properties shared by all controls are displayed. If you had selected a label control and a text box, only the properties shared by both control types would appear.
- For properties in which the values of the selected controls differ (such as the Location property in this example), the value is left empty in the Properties window.

Figure 6.9. You can view the property values of many controls at once, with some caveats.



Entering a value in a property changes the corresponding property for all selected controls. To see how this works, change the BackColor property to a shade of yellow, and you'll see that all controls have their BackColor set to yellow.

Anchoring and Autosizing Controls

Some of my favorite additions to the forms engine in Visual C# .NET are the capability to anchor controls to one or more edges of a form so that controls can now size themselves appropriately when the user sizes the form. In the past, you had to use a (usually cumbersome) third-party component or resort to writing code in the form Resize event to get this behavior, but it's an intrinsic capability of Visual C# .NET's form engine.

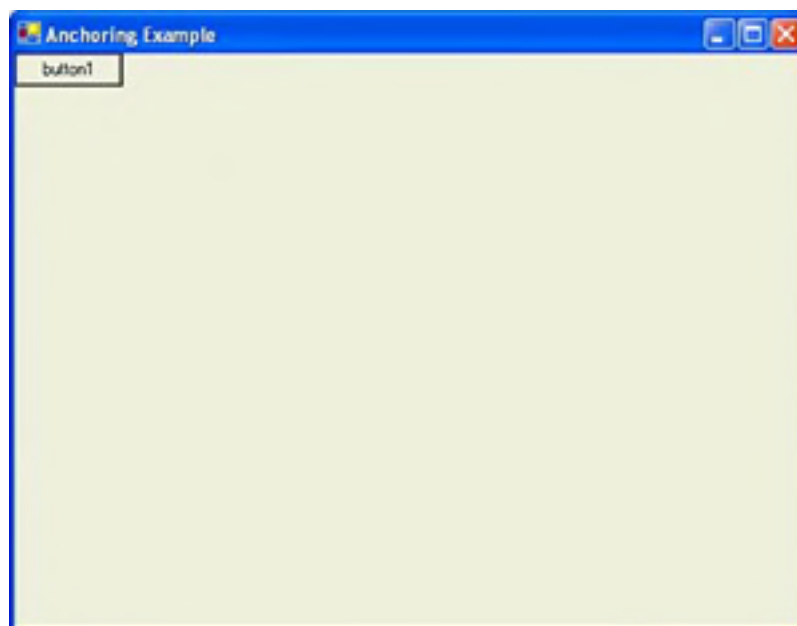
The default behavior is that controls are docked to the top and left edges of their containers. What if you want a control to always appear in the lower-left corner of a form? This is precisely what the Anchor property is designed to handle.

The easiest way to understand how anchoring works is to do it, so follow these steps:

1. Create a new Windows Application called **Anchoring Example**.
2. Change the name of the default form to **fcIsAnchoringExample** and set the form's Text property to **Anchoring Example**.
3. Change the main entry point to reflect the new form name.
4. Add a new button to the form and name it **btnAnchor**.
5. Run the project by pressing F5.
6. Click and drag the border of the form to change its size.

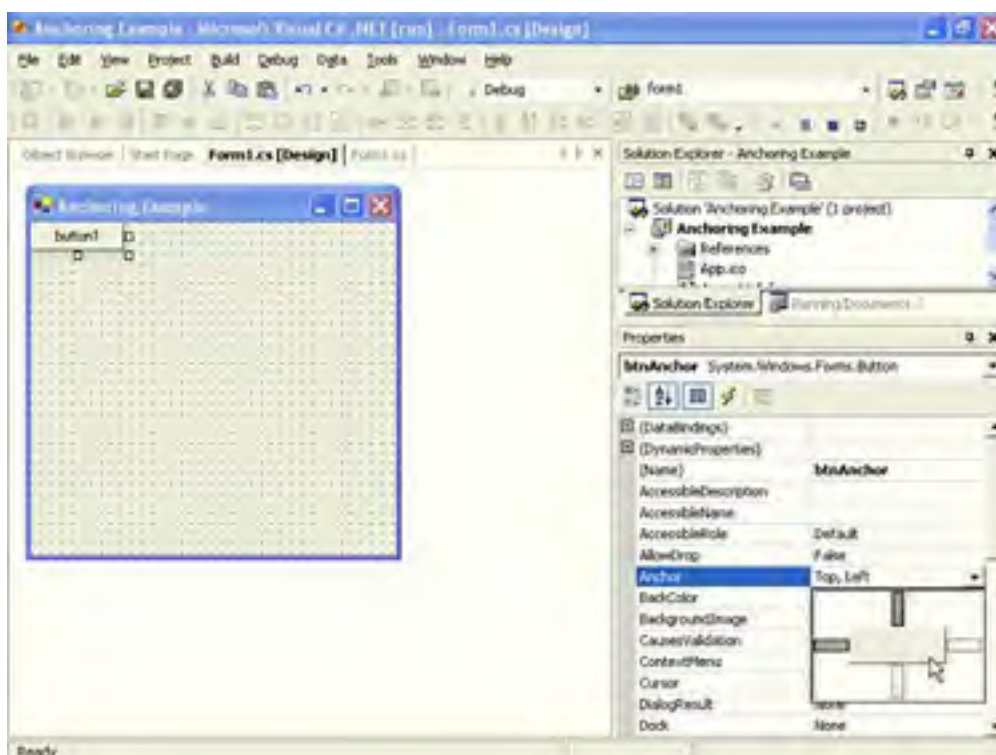
Notice that no matter what size you change the form to, the button stays in the upper-left corner of the form (see [Figure 6.10](#)).

Figure 6.10. By default, controls are anchored to the upper-left corner of the form.



Stop the running project now by choosing Debug, Stop Debugging. Click the button on the form to select it, click the Anchor property in the Properties window, and then click the drop-down arrow that appears. You'll see a drop-down box that is unique to the Anchor property (see [Figure 6.11](#)).

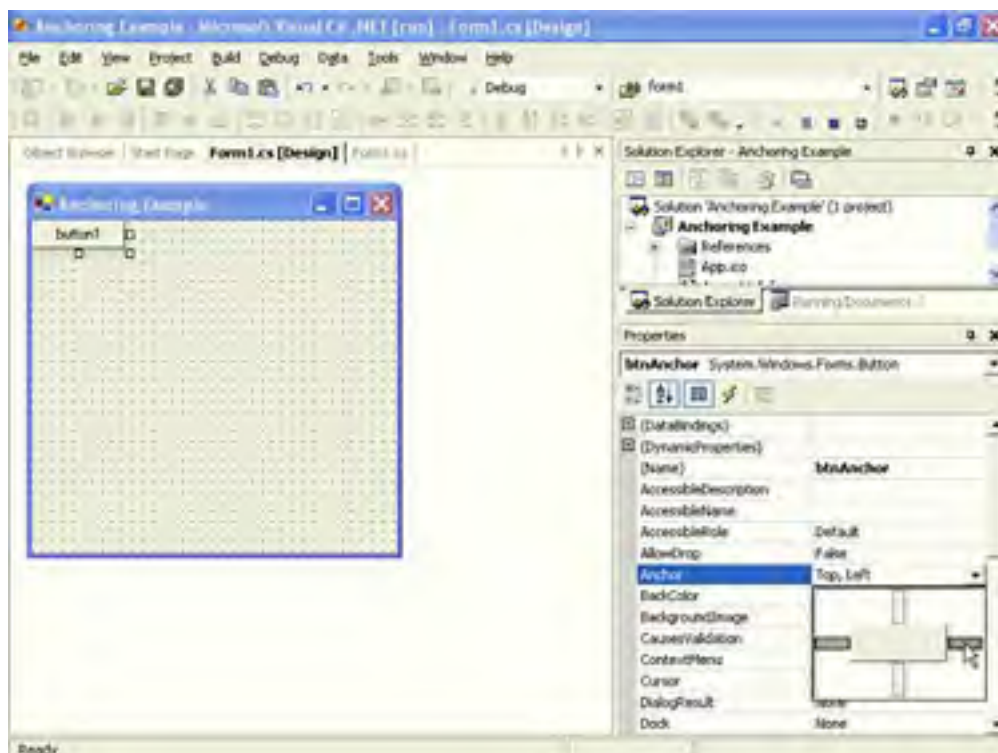
Figure 6.11. You use this unique drop-down box to set the Anchor property of a control.



The gray square in the center of the drop-down box represents the control whose property you're setting. The thin rectangles on the top, bottom, left, and right represent the possible edges to which you can dock the control; if a rectangle is filled in, the edge of the control facing that rectangle is docked to that edge of the form.

1. Click the rectangle above the control so that it's no longer filled in, and then click the rectangle to the right of the control so that it is filled in (see [Figure 6.12](#)).

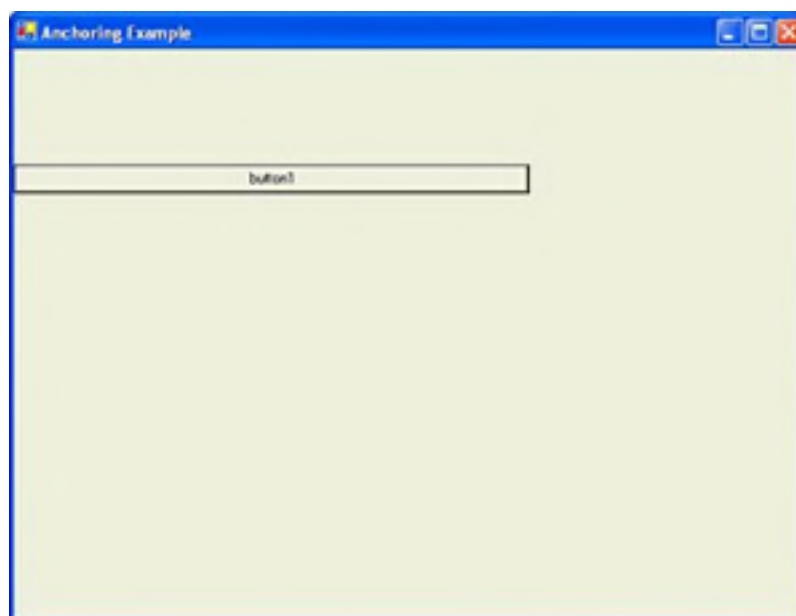
Figure 6.12. This setting will anchor the control to the left and right edges.



2. Click any other property to close the drop-down box. The Anchor property should now read Left, Right.
3. Press F5 to run the project, and then drag an edge of the form to make it larger.

Pretty odd, huh? What Visual C# .NET has done is anchored the left edge of the button to the left edge of the form and anchored the right edge of the button to the right edge of the form (see [Figure 6.13](#)). Actually, anchoring means keeping an edge of the control a constant, relative distance from an edge of the form, and it's an unbelievably powerful tool for building interfaces. Now you can make forms that users can resize, but you have to write little or no code to make the interface adjust accordingly. One caveat: depending on its anchor setting, a control might disappear if the form is shrunk quite small.

Figure 6.13. Anchoring is a powerful feature for creating adaptable forms.



Creating a Tab Order

Tab order is something that is often (emphasis on *often*) overlooked. You're probably familiar with tab order as a user, although you may not realize it. When you press Tab while on a form, the focus moves from the current control to the next control in the tab order. This facilitates easy keyboard navigation on forms. The tab order for controls on a form is determined by the TabIndex properties of the controls. The control with the TabIndex value of 0 is the first control that receives the focus when the form is shown. When you press Tab, the control with the TabIndex of 1 receives the focus. When you add a control to a form, Visual C# .NET assigns the next available TabIndex value. Each control has a unique TabIndex value, and TabIndex values are always used in ascending order.

If the tab order isn't set correctly for a form, pressing Tab will cause the focus to jump from control to control in no apparent order. This really isn't a way to impress users.

The forms engine in Visual C# .NET has a great way to set the tab order for controls on a form. Create a new Windows Application named **Tab Order**, change the name of the default form to **fcIsTabOrder**, set the Text property of the form to **Tab Order Example** and update the entry point in Main() to reference **fcIsTabOrder**.

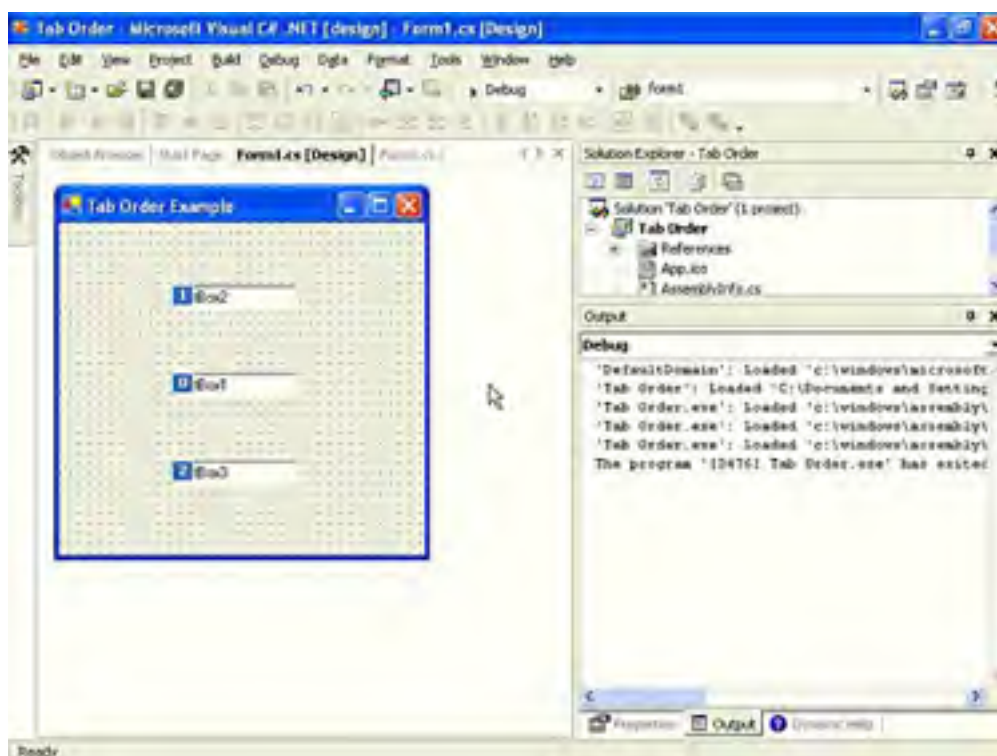
Add three text box controls to the form now and set their properties as follows:

Property	Value	Property	Value	Property	Value
Name	TextBox1	Name	TextBox2	Name	TextBox3
Location	90,120	Location	90,50	Location	90,190

Save the project by clicking the Save All button on the toolbar and then press F5 to run the project. Notice how the middle text box is the one with the focus. This is because it's the first one you added to the form and therefore has a TabIndex value of 0. Press Tab to move to the next control in the tab order (the top control); then press Tab once more and the focus jumps to the bottom control. Obviously, this isn't productive. Stop the project now by choosing Debug, Stop Debugging (or simply close the form).

You're now going to set the tab order via the new visual method. Choose View, Tab Order; notice how Visual C# .NET superimposes a set of numbers over the controls (see [Figure 6.14](#)). The number on a control indicates its TabIndex property value. Now it's very easy to see that the tab order is incorrect. Click the top control. Notice how the number over the control changes to 0. Click the middle control and you'll see its number change to 1. As you click controls, Visual C# .NET assigns the next highest number to the clicked control. Choose View, Tab Order again to take the form out of Tab Order mode. Run the project again and you'll see that the top control is the first to get the focus, and pressing Tab now moves the focus logically.

Figure 6.14. The numbers over each control indicate the control's TabIndex.



By the way

To programmatically move the focus via the tab order, use the `SelectNextControl()` method of a control or a form.

To remove a control from the tab sequence, set its `TabStop` property to `false`. When a control's `TabStop` property is set to false, users can still select the control with the mouse but they can't enter the control using the Tab key. You should still set the `TabIndex` property to a logical value so that if the control receives the focus (for example by being clicked), pressing Tab will move the focus to the next logical control.

Layering Controls (Z-Order)

Tab order and visual alignment are key elements for effectively placing controls on forms. However, these two elements address control placement in only two dimensions—the x,y axis. At times, you may need to have controls overlap, although it's rare that you'll need to do so. Whenever two controls overlap, whichever control is added to the form most recently appears on top of the other (see [Figure 6.15](#)). You can control the ordering of controls using the `Order` submenu of the `Format` menu (see [Figure 6.16](#)).

Figure 6.15. Controls can overlap.

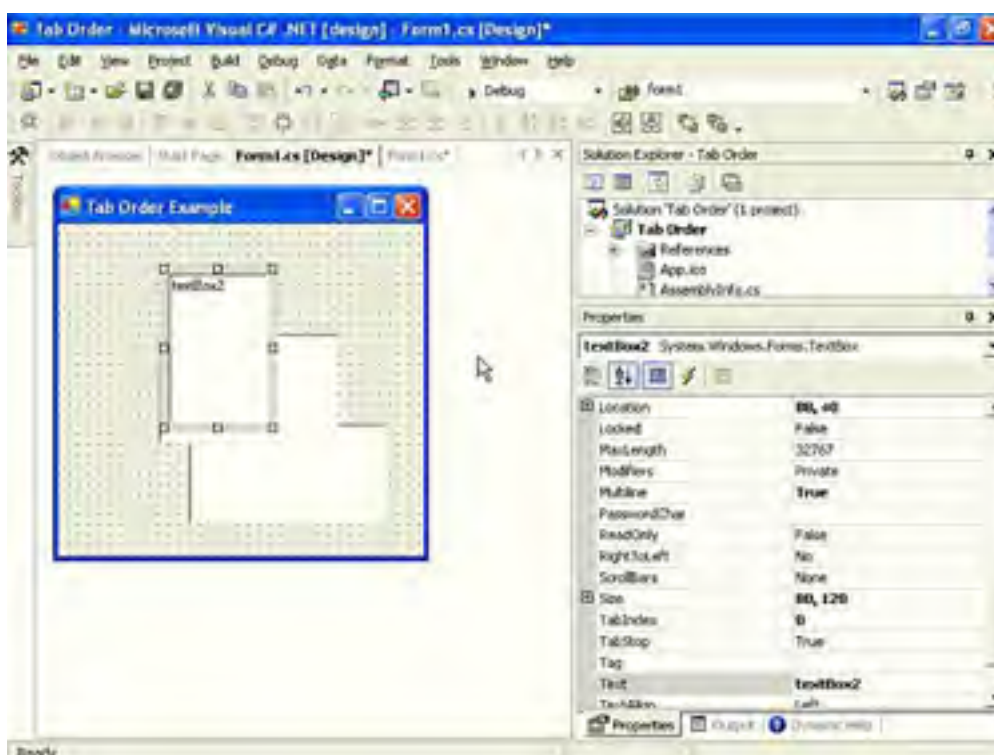
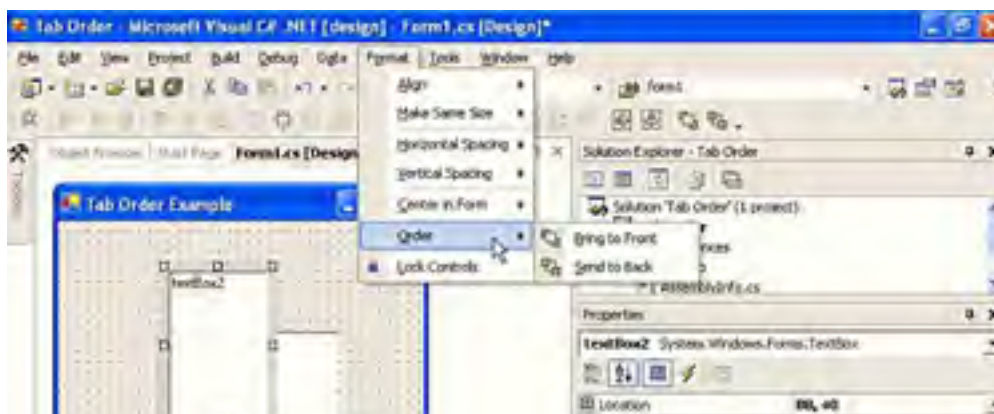
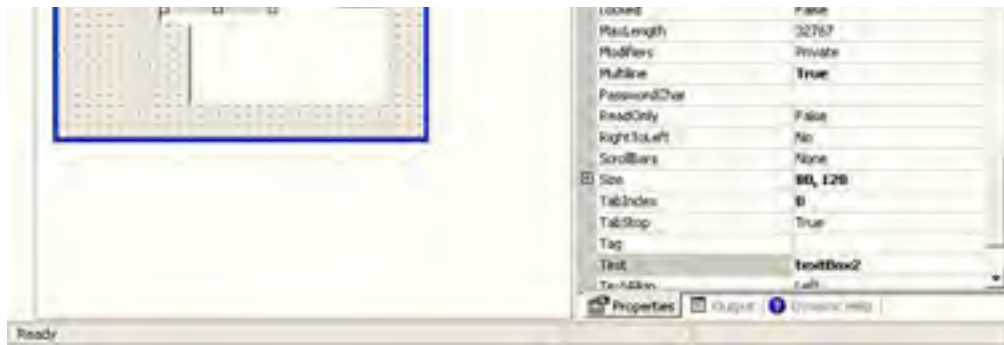


Figure 6.16. The Order menu is used to adjust the layering order of overlapping controls.





To send a control backward in the layering order, click it once to select it and then choose Order, Send to Back (you can also right-click the control to access the layering commands as well). To bring the control forward in the layering order, select the control and choose Order, Bring to Front.

**Did you
Know?**

You can accomplish the same thing in Visual C# .NET code by invoking the BringToFront or SendToBack methods of a control.

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Creating Topmost Windows

As you're probably aware, when you click a window it usually comes to the foreground and all other windows are shown behind it. At times, you may want a window to stay on top of other windows, regardless of whether it's the current window (that is, it has the focus). An example of this is the Find window in Visual C# .NET and other applications such as Word. Regardless of which window has the focus, the Find form always appears floating over all other windows. Such a window is created by setting the form's `TopMost` property to `true`. Not exactly rocket science. However, that's the point: A simple property change or method call is often all it takes to accomplish what might otherwise seem to be a difficult task.

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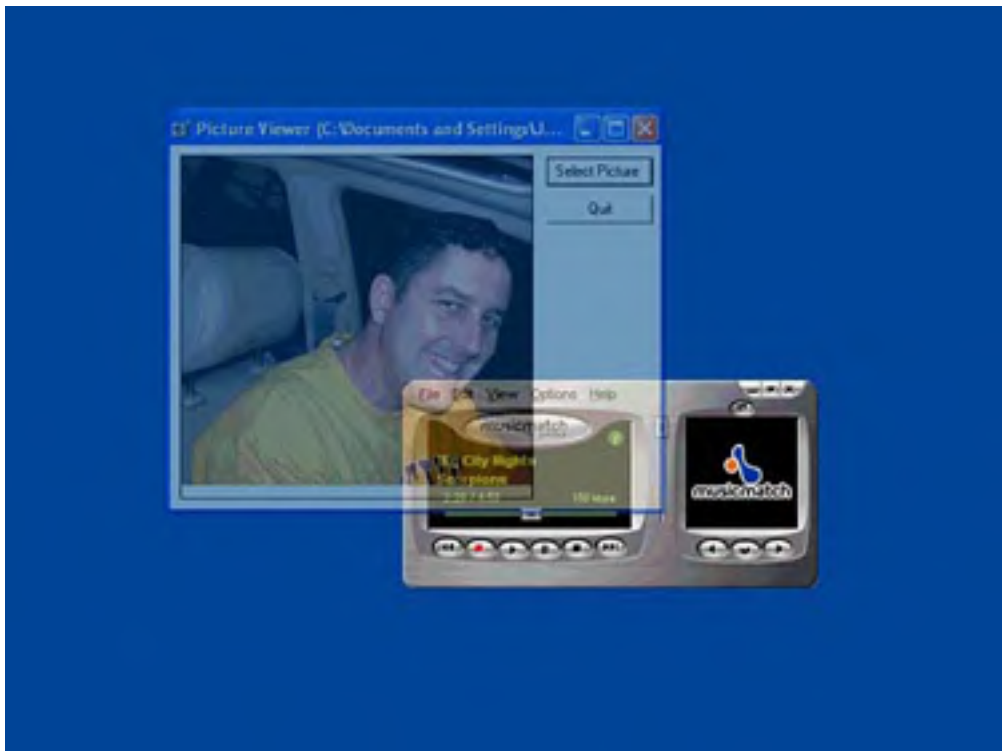
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Creating Transparent Forms

A new property of forms that I think is very cool, although I still can't come up with a reason to use it in a production application, is the Opacity property. This property controls the opaqueness of the form as well as all controls on the form. The default Opacity value of 100% means that the form and its controls are completely opaque (solid), whereas a value of 0% creates a completely transparent form (no real point in that). A value of 50%, then, creates a form that is between solid and invisible (see [Figure 6.17](#)). I suppose you could write a loop that takes the Opaque property from 100% to 0% to fade out the form. Other than that, I don't know where to take advantage of this technique. But ain't it cool?

Figure 6.17. Ghost forms!



Creating Scrollable Forms

A scrollable form is a form that can display scrollbars when its contents are larger than the physical size of the form. Not only is this a cool yet necessary feature, but it's also trivial to implement in your own applications.

The scrolling behavior of a form is determined by the following three properties:

Property	Description
AutoScroll	This property determines whether scrollbars will ever appear on a form.
AutoScrollMinSize	The minimum size of the scroll region (area). If the size of the form is adjusted so that the client area of the form (the area of the form not counting borders and title bar) is smaller than the AutoScrollMinSize , scrollbars will appear.
AutoScrollMargin	This property determines the margin given around controls during scrolling. This essentially determines how far past the edge of the outermost controls you can scroll.

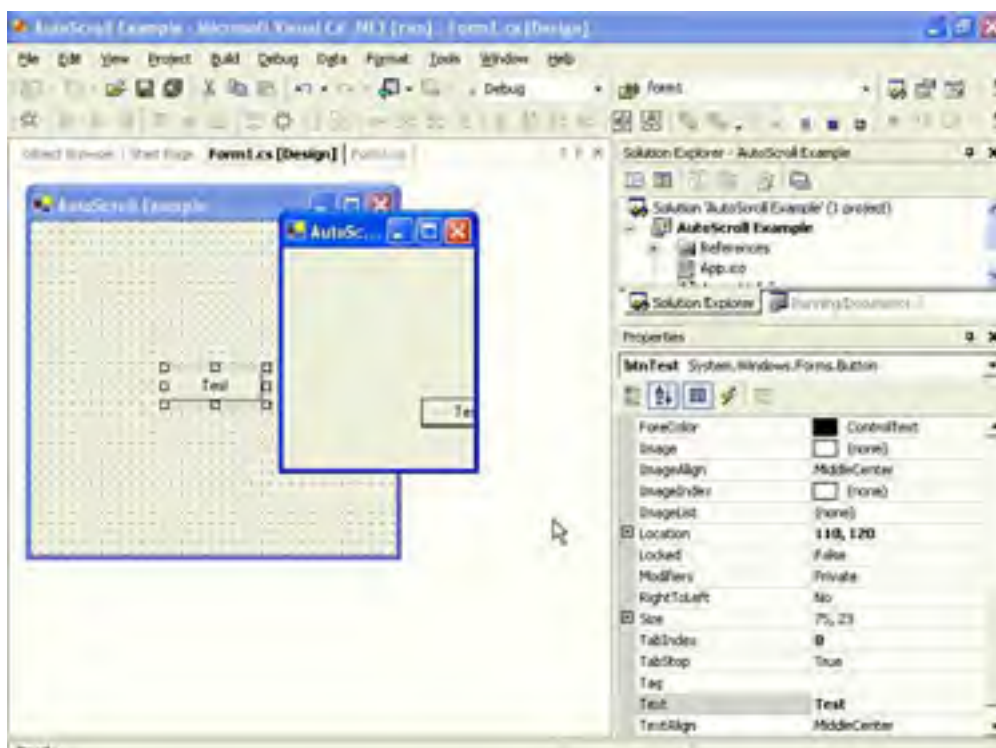
Again, it's easiest to understand this concept by doing it. Create a new Windows Application named **AutoScroll Example**, rename the default form to **fcIsAutoScroll**, set the text of the form to **AutoScroll Example**, and update the entry point in `Main()`.

Add a new Button control to the form by double-clicking the Button tool on the toolbox. Set the button's properties as follows:

Property	Value
Name	<code>btnTest</code>
Location	<code>110,120</code>
Text	<code>Test</code>

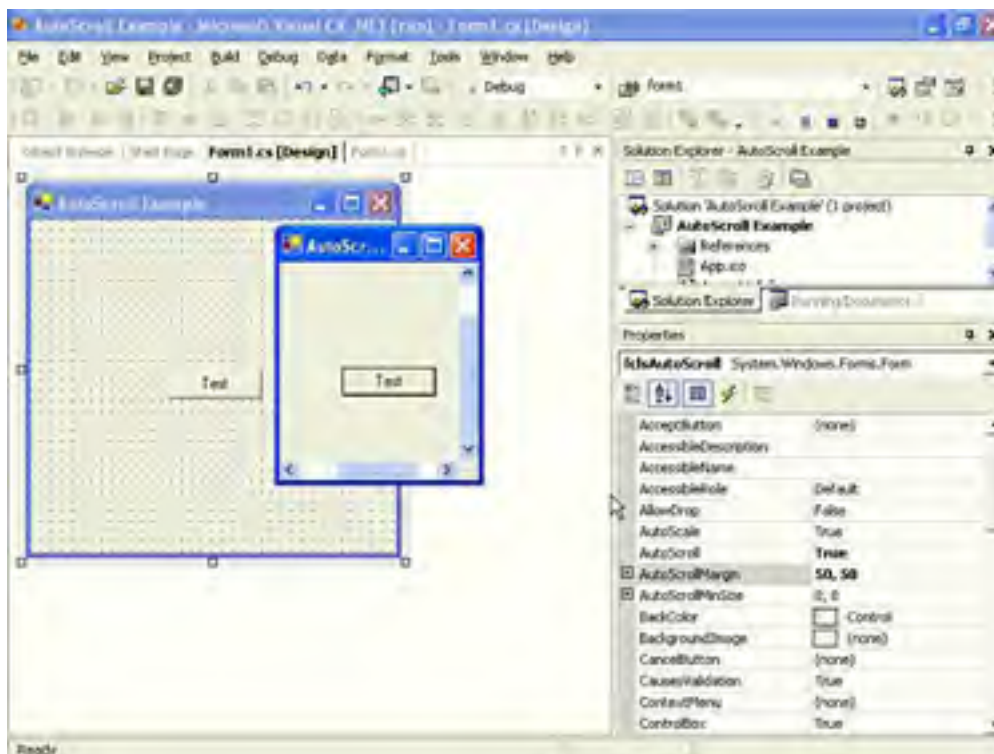
Save the project and press F5 to run it. Drag the borders of the control to make it larger and smaller. Notice that no matter how small you make the form, no scrollbars appear. This makes it possible to have controls on the form that are only partially visible or that can't be seen at all (see [Figure 6.18](#)).

Figure 6.18. Without scrollbars, it's possible to have controls that can't be seen.



Stop the project now by choosing Debug, Stop Debugging or by closing the form. Change the **AutoScroll** property of the form to **true**. At this point you still won't get scrollbars, because you need to adjust at least one of the other scroll properties. Change the **AutoScrollMargin** property to **50,50** and run the project once more. Make the form smaller by dragging a border or a corner, and you'll see scrollbars appear (see [Figure 6.19](#)). The **AutoScrollMargin** property creates a virtual margin (in pixels) around all the outermost controls on the form. If the form is sized to within the margin area of one of these controls, scrollbars automatically appear (*voilà!*).

Figure 6.19. Scrollbars allow the user to view all parts of the form without needing to change the form's size.



The final property that affects scrolling is the **AutoScrollMinSize**. Use the **AutoScrollMinSize** property to create a fixed-size scrolling region. If the form is ever sized such that the visible area of the form is smaller than the scrolling region defined by **AutoScrollMinSize**, scrollbars appear.

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Creating MDI Forms

All the projects you've created so far have been single-document interface (SDI) projects. In SDI programs, every form in the application is a peer of all other forms; no intrinsic hierarchy exists between forms. Visual C# .NET also lets you create multiple-document interface (MDI) programs. An MDI program contains one parent window (also called a container) and one or more child windows. A classic example of an MDI program is Adobe Photoshop. When you run Photoshop, a single parent window appears. Within this parent window, you can open any number of documents, which appear in child windows. In an MDI program, all child windows share the same toolbar and menu bar, which appears on the parent window. One restriction of child windows is that they can exist only within the confines of the parent window. [Figure 6.20](#) shows an example of Photoshop running with a number of child document windows open.

Figure 6.20. Le Collage! MDI applications consist of a single parent window and one or more child windows.



By the way

MDI applications can have any number of normal windows (dialog boxes, for example) in addition to child windows.

You're now going to create a simple MDI project. Create a new Windows Application named **MDI Example**. Change the name of the default form to **fclsMDIParent**, change its Text property to **MDI Parent**, and update the entry point in Main(). Next, change the IsMdiContainer property of the form to **true** (if you don't set the IsMdiContainer property to true, this example won't work). The first thing you'll notice is that Visual C# .NET changed the client area to a dark gray and gave it a sunken appearance. This is the standard appearance for MDI parent windows, and all visible child windows appear in this area.

Create a new form by choosing Add Windows Form from the Project menu. Name the form **fclsChild1.cs** and change its Text property to **Child 1**. Add a third form to the project in the same way. Name it **fclsChild2.cs** and set its Text property to **Child 2**.

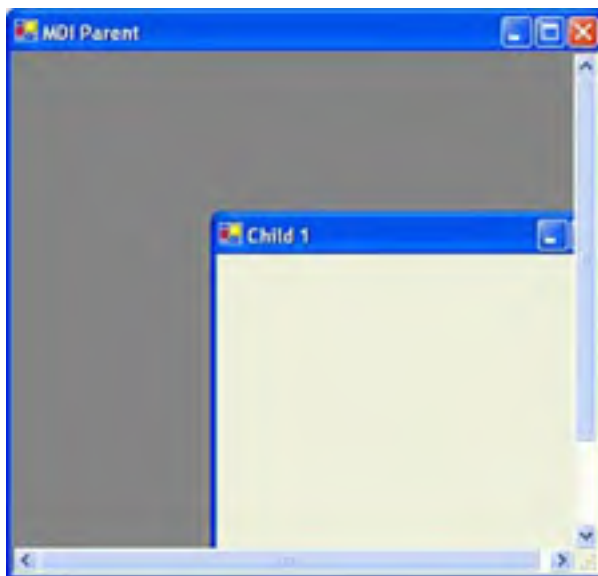
Make sure that the fclsMDIParent parent form is visible in the form designer. If it's not, you can display it by double-clicking it in the Solution Explorer (Form1.cs). Next, double-click the form to access its default event—the Load event. Enter the following code:

```
fclsChild1 objChild = new fclsChild1();  
objChild.MdiParent = this;  
objChild.Show();
```

By now, you should know what this code does. The first statement creates a new object variable of type fclsChild1 and initializes it to hold a new instance of a form. The last statement simply shows the form. What we're interested in here is the middle statement. It sets the MdiParent property of the form to the current form (**this** always references the current object), which is an MDI parent form because its IsMdiContainer property is set to **true**. When the new form is displayed, it's shown as an MDI child.

Save your work and then press F5 to run the project. Notice how the child form appears on the client area of the parent form. If you size the parent form so that one or more child windows can't be fully displayed, scrollbars appear (see [Figure 6.21](#)). If you were to remove the statement that set the MdiParent property, the form would simply appear floating over the parent form and would not be bound by the confines of the parent (it wouldn't be a child window).

Figure 6.21. Child forms appear only within the confines of the parent form.



Stop the project by choosing Debug, Stop Debugging and follow these steps:

1. Display the Solution Explorer and double-click the `fclsChild1` to display the form in the designer. Add a button to the form and set the button's properties as follows:

Property	Value
Name	<code>btnShowChild2</code>
Location	<code>105,100</code>
Size	<code>85,23</code>
Text	<code>Show Child 2</code>

2. Double-click the button to access its Click event, and then add the following code:

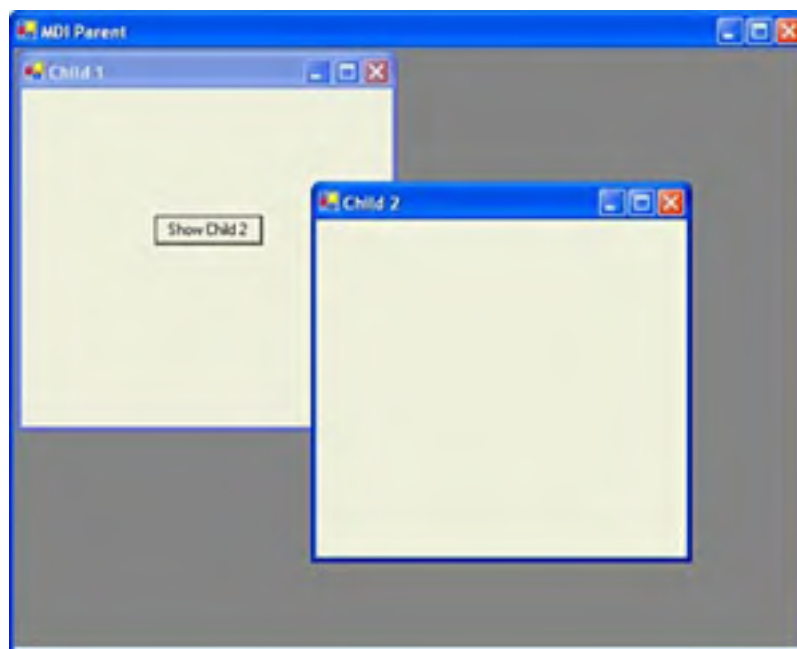
```
fclsChild2 objChild = new fclsChild2();  
objChild.MdiParent = this.MdiParent;  
objChild.Show();
```

This code shows the second child form. Note that two differences exist between this code and the code you entered earlier. First, the `objChild` variable creates a new instance of the `fclsChild2` form rather than the `fclsChild1` form. The second difference is how the parent is set. Because the child form is not a parent form, you can't set the second child's `MdiParent` property to `this`, because `this` doesn't refer to the current form. However, you know that `this.MdiParent` references the parent form because `this` is precisely the property you set to make the form a child in the first place. Therefore, you can simply pass the parent of the first child to the second child, and they'll both be children of the same form.

By the way Any form can be a child form (except, of course, an MDI parent form). To make a form a child form, you set its `MdiParent` property to a form that's defined as an MDI container.

Press F5 to run the project now. You'll see the button on the child form, so go ahead and click it (if you don't see the button, you may have mistakenly added it to the second child form). When you click the button, the second child form appears. Notice how this is also bound by the constraints of the parent form (see [Figure 6.22](#)).

Figure 6.22. Child forms are peers with one another.



By the Way The MDI parent form has an `ActiveMdiChild` property, which you can use to get a reference to the currently active child window.

By the Way To make the parent form larger when the project is first run, you set the `Height` and `Width` properties of the form either at design time or at runtime in the `Load` event of the form.

One thing about forms to keep in mind is that you can create as many instances of a form as you want. For instance, you could change the code in the button to create a new instance of `fclsChild1`. The form that would be created would be the same as the form that created it, complete with a button to create yet another instance. You probably won't apply this technique much now, because you're just getting started with Visual C# .NET. You may find it quite useful in the future, however. For example, if you wanted to create a text editor, you might define the text entry portion as one form but create multiple instances of the form as new text files are opened.

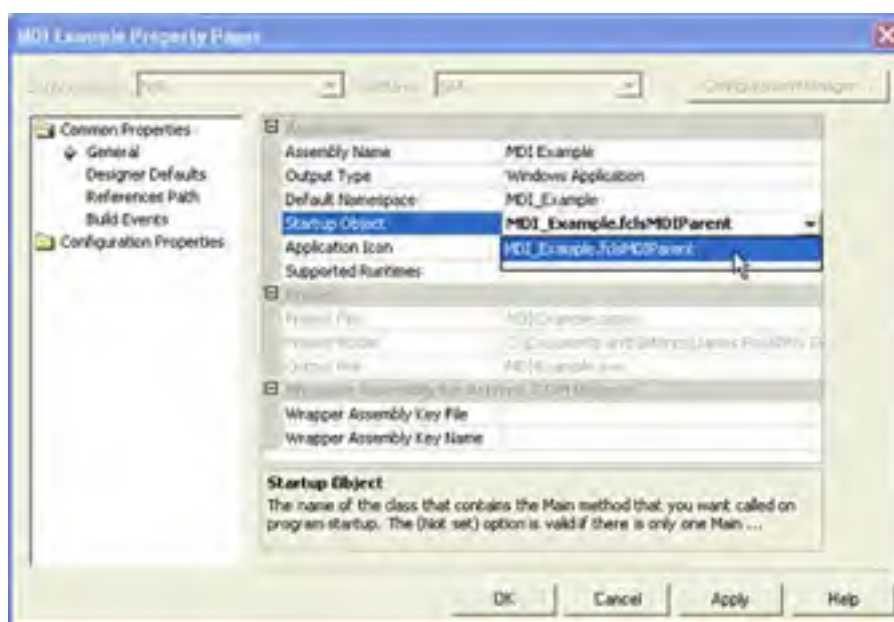
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Setting the Startup Object

The Startup object in Windows Applications is, by default, the first form added to the project. This also happens to be the form that Visual C# .NET creates automatically when you create the new Windows Application project.

The class that contains the Main() method that you want called as the entry point of the application is determined by the Startup Object property. You can change the Startup object by right-clicking the project name in the Solution Explorer and choosing Properties. The Startup Object property appears on the first property page that displays (see [Figure 6.23](#)).

Figure 6.23. The Startup Object property determines the first class that gets initialized and executed.



**By the
Way**

The setting of the Startup Object property isn't required if only one Main() method exists in the project.

Now, if the Startup object property is set to show a child window, you might not get the behavior you expect when the project starts. The designated form would appear, but it wouldn't be a child because no code would execute to set the MdiParent property of the form to a valid MDI parent form.

If MDI forms still confuse you, don't worry. Most of the applications you'll write as a new Visual C# .NET programmer will be SDI programs. As you become more familiar with creating Visual C# .NET projects in general, start experimenting with MDI projects. Remember, you don't have to make a program an MDI program simply because you can; make an MDI program if the requirements of the project dictate that you do so.

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Summary

Understanding forms is critical because forms are the dynamic canvases on which you build your user interface. If you don't know how to work with forms, your entire application will suffer. Many things about working with forms go beyond simply setting properties, especially as you begin to think about the end user. As your experience grows, you'll get into the groove of form design and things will become second nature to you.

In this hour, you learned how to do some interesting things, such as creating transparent forms, as well as some high-end techniques, such as building an MDI application. You also learned how to create scrolling forms (an interface element that shouldn't be overlooked), and you spent a lot of time on working with controls on forms, which is important because the primary function of a form is as a place to host controls. In the next two hours, you'll learn the details of many of Visual C# .NET's powerful controls, which will become important weapons in your vast development arsenal.

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Q&A

Q1: *Do I need to worry about the anchoring and scrolling capabilities of every form I create?*

A1: Absolutely not. The majority of forms in most applications are dialog boxes. A dialog box is a modal form used to gather data from the user. A dialog box is usually a fixed size, which means that its border style is set to a style that can't be sized. With a fixed-size form, you don't need to worry about anchoring or scrolling.

Q2: *How do I know if a project is a candidate for an MDI interface?*

A2: If the program will open many instances of the same type of form, it's a candidate for an MDI interface. For instance, if you're creating an image-editing program and the intent is to allow the user to open many images at once, MDI makes sense. Also, if you'll have many forms that will share a common toolbar and menu, you might want to consider MDI.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** True or False: The first control selected in a series is always made the active control.
- 2:** How many methods are there to add a control to a form from the toolbox?
- 3:** If you double-click a tool in the toolbox, where on the form is it placed?
- 4:** Which property fixes an edge of a control to an edge of a form?
- 5:** Which property do you change to hide the grid on a form?
- 6:** Which menu contains the functions for spacing and aligning controls?
- 7:** Which property do you set to make a form a MDI parent?

Exercises

- 1:** Use your knowledge of the Anchor property and modify the Picture Viewer project you built in [Hour 1](#), "Jumping in with Both Feet: A Visual C# .NET Programming Tour," so that the form can be sized. The buttons should always stay the size that they are and in the relative location in which they're placed, but the picture box should change size to show as much of the picture as possible, given the size of the form.
- 2:** Modify the MDI Example project in this hour so that the first child form shows another instance of itself, rather than showing an instance of the second child form.

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Hour 7. Working with the Traditional Controls

The preceding two hours described how to work with forms in considerable detail. Forms are the foundation of a user interface, but are pretty much useless all by themselves. To create a functional interface, you'll need to use *controls*. Controls are the various widgets and doodads on a form with which a user interacts. Dozens of different types of controls exist, from the simple Label control used to display static text to the rather complicated Tree View control used to present trees of data like that found in Explorer. In this hour, I'll introduce you to the most common (and most simple) controls, which I call traditional controls. In the next hour, you'll learn about the more advanced controls that you can use to create professional-level interfaces.

The highlights of this hour include the following:

- Displaying static text with the Label control
- Allowing users to enter text using a text box
- Creating password fields
- Working with buttons
- Using panels, group boxes, check boxes, and option buttons
- Displaying lists with list boxes and combo boxes

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Displaying Static Text with the Label Control

Label controls are used to display static text to the user. By static, I mean that the user can't change the text directly (but you can change the text with code). Label controls are one of the most common controls used; fortunately, they're also one of the easiest. Labels are most often used to provide descriptive text for other controls, such as text boxes. Labels are also great for providing status-type information to a user, as well as for providing general instructions on a form.

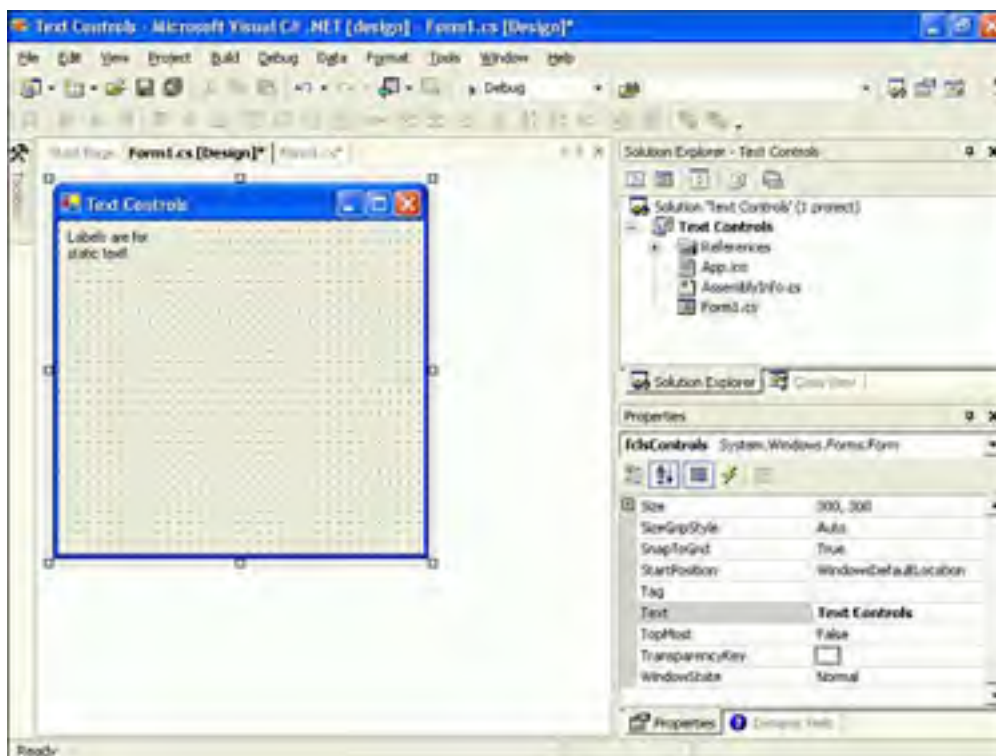
Begin by creating a new Windows Application named **Text Controls**. Change the name of the default form to **fclsControls**, and change its Text property to **Text Controls Example**. Next, change the Main() entry point to use **fclsControls**.

Add a new Label control to the form by double-clicking the Label item in the toolbox. The primary property of the Label control is the Text property, which determines the text displayed to the user. When a Label control is first added to a form, the Text property is set to the name of control—this isn't very useful. Set the properties of the new Label control as follows:

Property	Value
Name	lblMyLabel
Location	5,6
Size	100,25
Text	Labels are for static text!

Notice how the label's text appears on two lines (see [Figure 7.1](#)). This occurs because the text is forced to fit within the size of a new Label control. In most cases, it's best to place label text on a single line. To do this, you could increase the width either by using the Properties window or by dragging the edge of the control, but there is an easier way. Double-click the Label control's AutoSize property now and notice how the label resizes itself automatically to fit the text on a single line. Double-clicking a property that accepts a set number of values cycles the property to the next value. The AutoSize property of new Label controls is **false** by default, so double-clicking this property changed it to **true**.

Figure 7.1. Labels display text that can't be changed by the user.



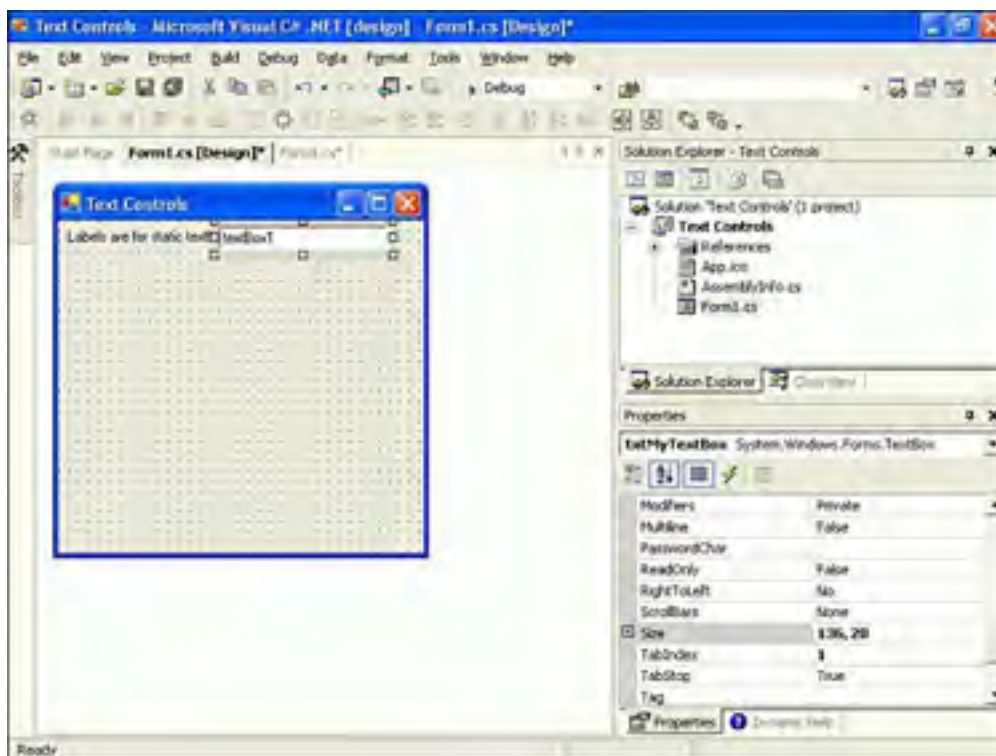
Allowing Users to Enter Text Using a Text Box

A Label control is usually the best control for displaying text a user can't change. However, when you need to let users enter or edit text, the text box is the tool for the job. If you've ever typed information on a form, you've almost certainly used a text box. Add a new text box to your form now by double-clicking the TextBox item in the toolbox. Set the text box's properties as follows:

Property	Value
Name	txtMyTextBox
Location	128,4
Size	136,20

When you first create a new text box, its Text property is set to its default name (see [Figure 7.2](#)). Unfortunately, the Text property isn't automatically changed when you change the name of the text box (which you should always do), so I recommend that you clear out the Text property of new text boxes. Delete the text in the Text property now and notice that the text box appears empty on the form.

Figure 7.2. A new text box has its Text property set to its default name.



Although you'll probably want to clear the Text property of most of your text boxes at design time, understanding certain aspects of the text box is easier when a text box contains text. Set the text box's Text property to **This is sample text**. Remember to press Enter or Tab to commit your property change.

Specifying Text Alignment

Both the TextBox and the Label controls have a TextAlign property (as do many other controls). The TextAlign property determines the alignment of the text within the control—very much like the justification setting in a word processor. You can select from Left, Center, or Right.



Label controls allow you to set the vertical alignment as well, using their TextAlign property. This works best when AutoSize is set to false.

Change the TextAlign property of the text box to Right, and see how the text becomes right-aligned within the text box. Next, change TextAlign to Center to see what center alignment looks like. As you can see, this property is pretty straightforward. Change the TextAlign property back to Left before continuing.

Creating a Multiline Text Box

In the preceding hour, I talked about the sizing handles of a selected control. I mentioned how handles that can be sized are filled with white, and handles that are locked appear with a gray center. Notice how only the left and right edges of the text box have white sizing handles. This means that you can adjust only the left and right edges of the control (you can alter only the width, not the height). This is because the text box is defined as a single-line text box, meaning it will display only one line of text. What would be the point of a really tall text box that showed only a single line of text?

To allow a text box to display multiple lines of text, set its Multiline property to **true**. Set the Multiline property of your text box to **true** now, and notice that all the sizing handles become white.

Change the Text property of the text box to **This is sample text. A multiline text box will wrap its contents as necessary**. Press Enter or Tab to commit the property change. Notice how the text box displays only part of what you entered because the control simply isn't big enough to show all the text (see [Figure 7.3](#)). Change the Size property to **136,60**, and you'll then see the entire content of the text box (see [Figure 7.4](#)).

Figure 7.3. A text box may contain more text than it can display.

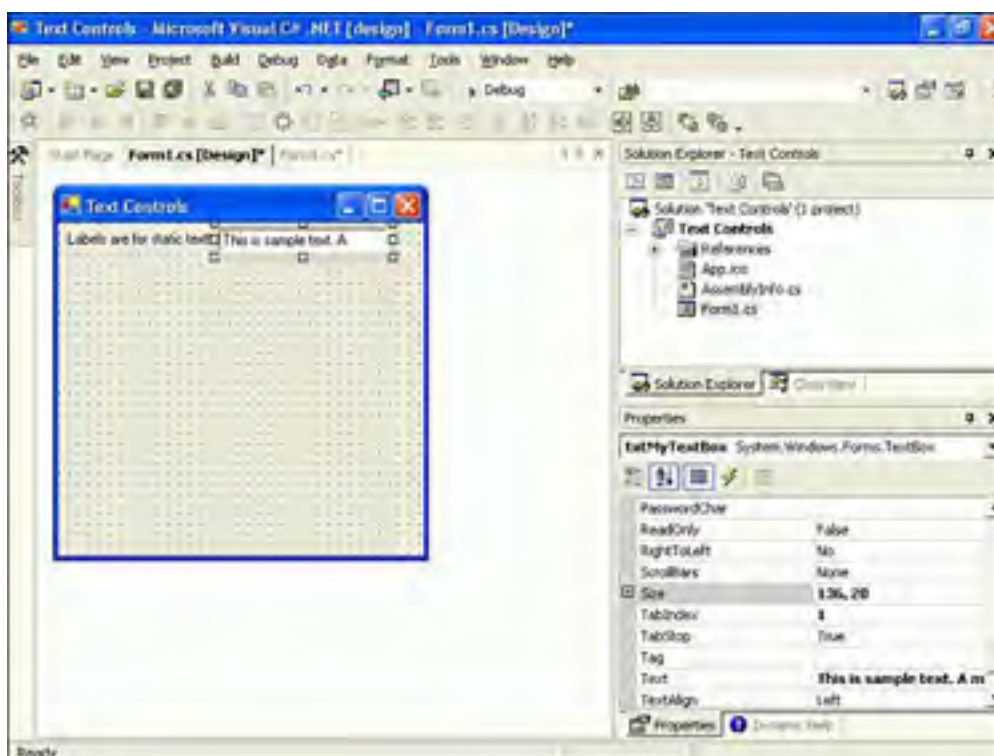
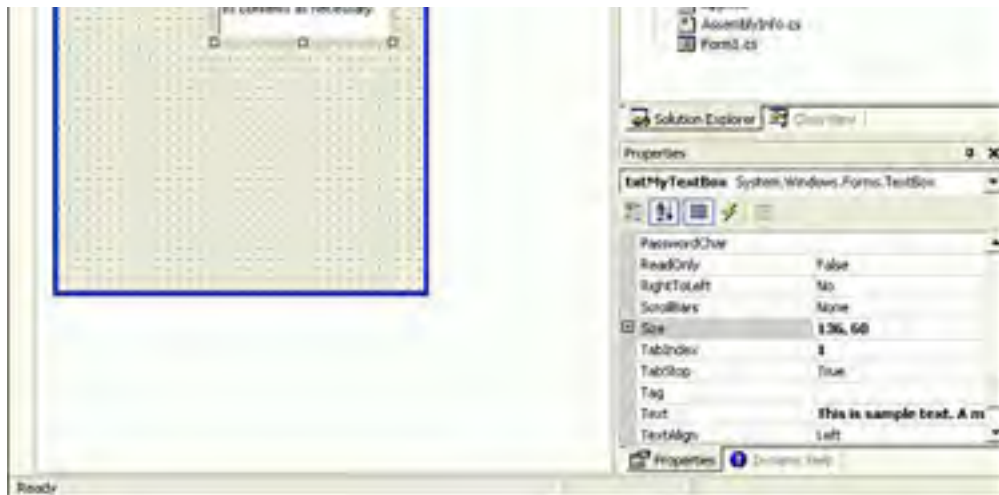


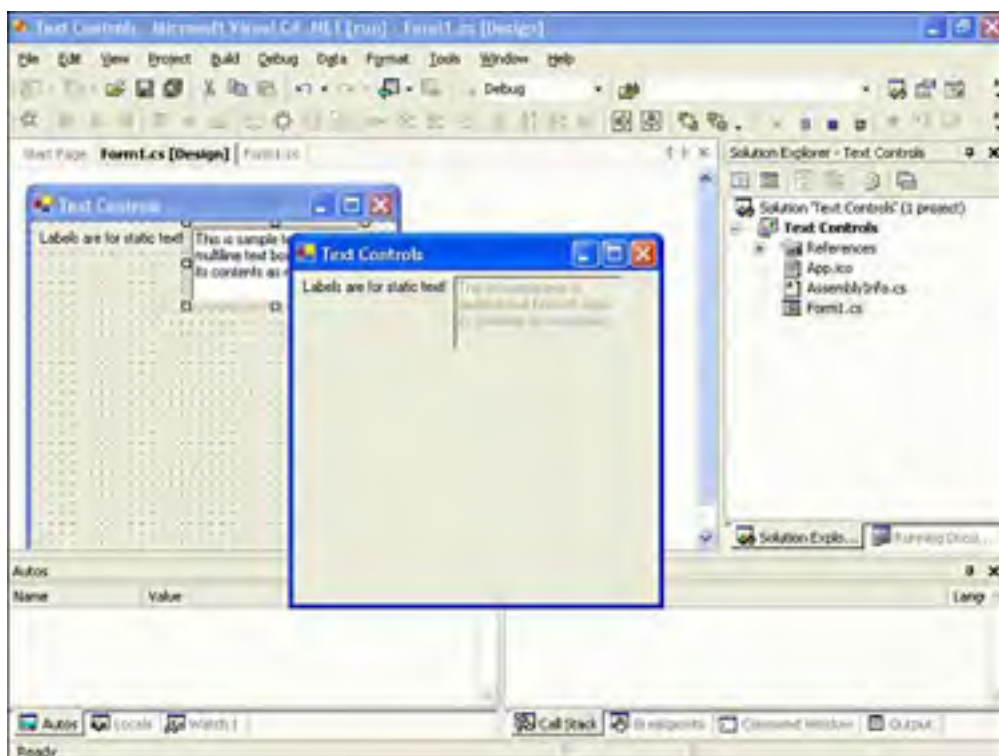
Figure 7.4. A multiline text box can be sized as large as necessary.





Sometimes you won't want a user to be able to interact with a control. For instance, you might implement a security model in an application, and if the user doesn't have the necessary privileges, you may not want the user to be able to alter data. The Enabled property, which almost every control has, determines whether the user can interact with the control. Change the Enabled property of the text box to **false**, and press F5 to run the project. Although no noticeable change occurs in the control in Design view, there is a big change to the control at runtime: the text appears in gray rather than black, and the text box won't accept the focus or allow you to change the text (see [Figure 7.5](#)).

Figure 7.5. You can't interact with a text box whose Enabled property is set to **false**.



Stop the project now by choosing Debug, Stop Debugging, and then change the control's Enabled property back to **true**.

Adding Scrollbars

Even though you can size a multiline text box, there still will be times when the contents of the control are more than can be displayed. If you believe that this is a possibility for a text box you're adding to a form, give the text box scrollbars by changing the ScrollBars property from None to Vertical, Horizontal, or Both.

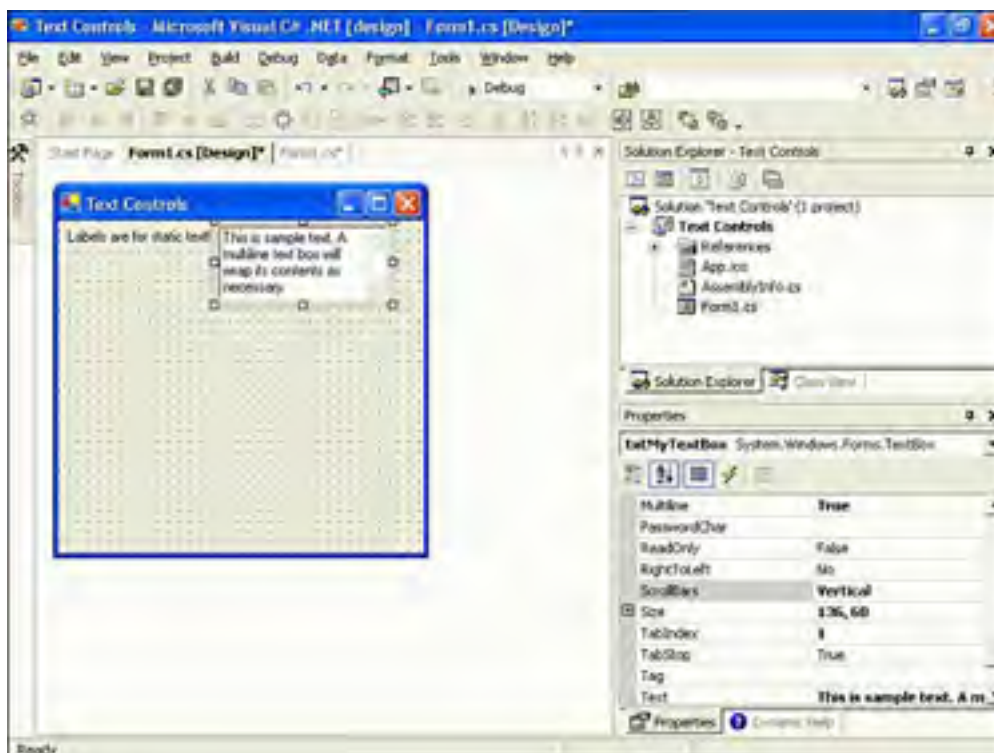


For a text box to display scrollbars, its Multiline property must be set to **true**. Also, if you set the ScrollBars property to Both, the horizontal

scrollbar will not appear unless you also set the WordWrap property to **false**.

Change the ScrollBars property of your text box to Vertical and notice how scrollbars appear in the text box (see [Figure 7.6](#)).

Figure 7.6. If a text box might contain lots of text, give it a scrollbar.



By the Way

If you set a text box's AcceptReturn property to **true**, the user can press Enter to create a new line in the text box. When the AcceptTabs property is set to **true**, the user can press Tab within the control to create columns (rather than moving the focus to the next control).

Limiting the Number of Characters a User Can Enter

You can limit the number of characters a user can type into a text box using the MaxLength property. All new text boxes are given the default value of 32767 for MaxLength, but you can change this as needed (up or down). Add a new text box to the form and set its properties as follows:

Property	Value
Name	txtRestrict
Location	128,80
MaxLength	10
Size	136,20
Text	(make blank)

Run the project by pressing F5 and then enter the following text into the new text box: **So you run and you run.** Be

sure to try to enter more than 10 characters of text—you can't (if you can, you're probably entering the text into the text box with scrollbars, rather than into the new text box). All that you're allowed to enter is **So you run** (10 characters). The text box allows only 10 characters, whether you are entering text using the keyboard or a Paste operation. The MaxLength property is most often used when the text box's content is to be written to a database, in which field sizes are usually restricted. (Using a database is discussed in [Hour 21](#), "Working with a Database.")

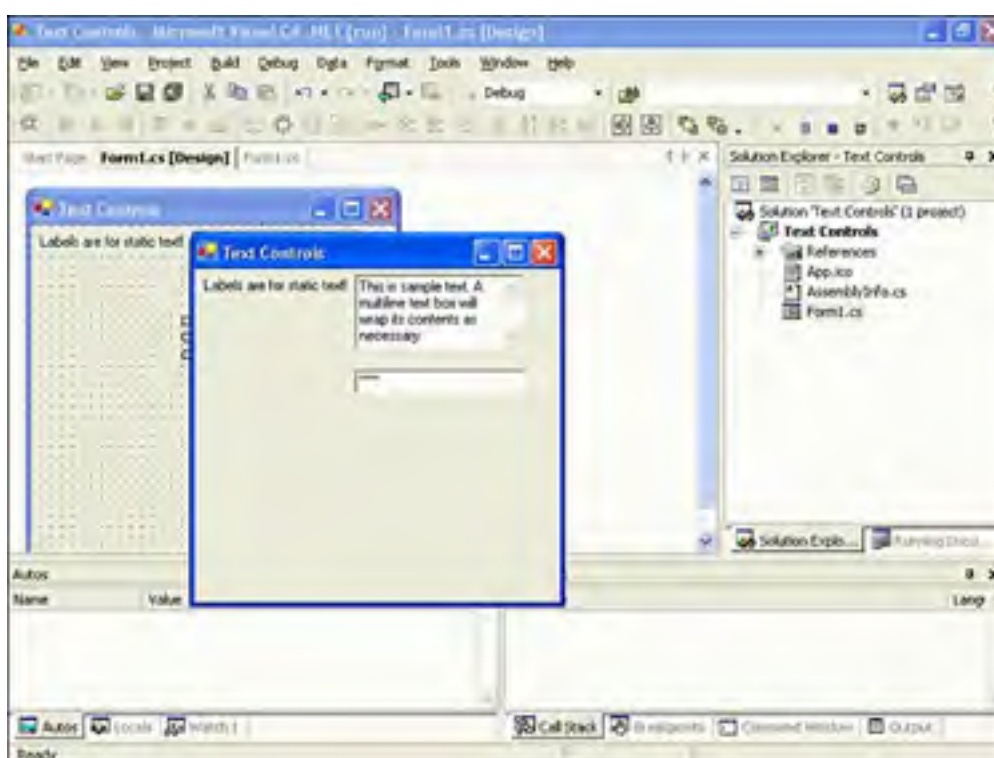
Stop the project by choosing Debug, Stop Debugging and then click Save All on the toolbar.

Creating Password Fields

You've probably used a password field: a text box that displays an asterisk for each character entered. Any text box can be made a password field by assigning a character to its PasswordChar field. Select the PasswordChar property of the second text box now (txtRestrict) and enter an asterisk (*) for the property value.

Run the project once more and enter text into the text box. Now an asterisk is displayed for each character you enter (see [Figure 7.7](#)). Although the user doesn't see the actual text contained in the text box, referencing the Text property in code always returns the true text.

Figure 7.7. A password field displays its password character for all entered text.



A text box will display password characters only if its Multiline property is set to **false**. As you can see, the value of the Multiline property affects a number of other properties.

Stop the project by choosing Debug, Stop Debugging. Delete the asterisk from the PasswordChar field, and then save the project by clicking Save All on the toolbar.

Understanding the Text Box's Common Events

Rarely will you make use of the label's events, but you'll probably use text box events quite a bit. The text box supports many different events; [Table 7.1](#) lists the events you're most likely to use regularly.

Table 7.1. Commonly Used Events of the Text Box Control

Event	Description
-------	-------------

TextChanged	Occurs every time the user presses a key. Use this event to deal with specific key presses (such as capturing specific keys), or when you need to perform an action whenever the content changes.
Click	Occurs when the user clicks the text box. Use this event to capture clicks when you don't care about the coordinates of the mouse pointer.
MouseDown	Occurs when the user first presses down a mouse button over the text box. This event is often used in conjunction with the MouseUp event.
MouseUp	Occurs when the user releases a mouse button over the text box. Use MouseDown and MouseUp when you need more functionality than provided by the Click event.
MouseMove	Occurs when the user moves the mouse over the text box. Use this event to perform actions based on the movement of the cursor.

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Creating Buttons

Every dialog box that Windows displays has at least one button on it. Buttons enable a user to invoke a function with a click of the mouse.

Create a new project named **Button Example**, change the name of the default form to **fcIsButtonExample**, set the form's Text property to **Button Example**, and update the entry point Main() to reference **fcIsButtonExample** instead of Form1. Next, add a new button to the form by double-clicking the Button item in the toolbox. Set the button's properties as follows:

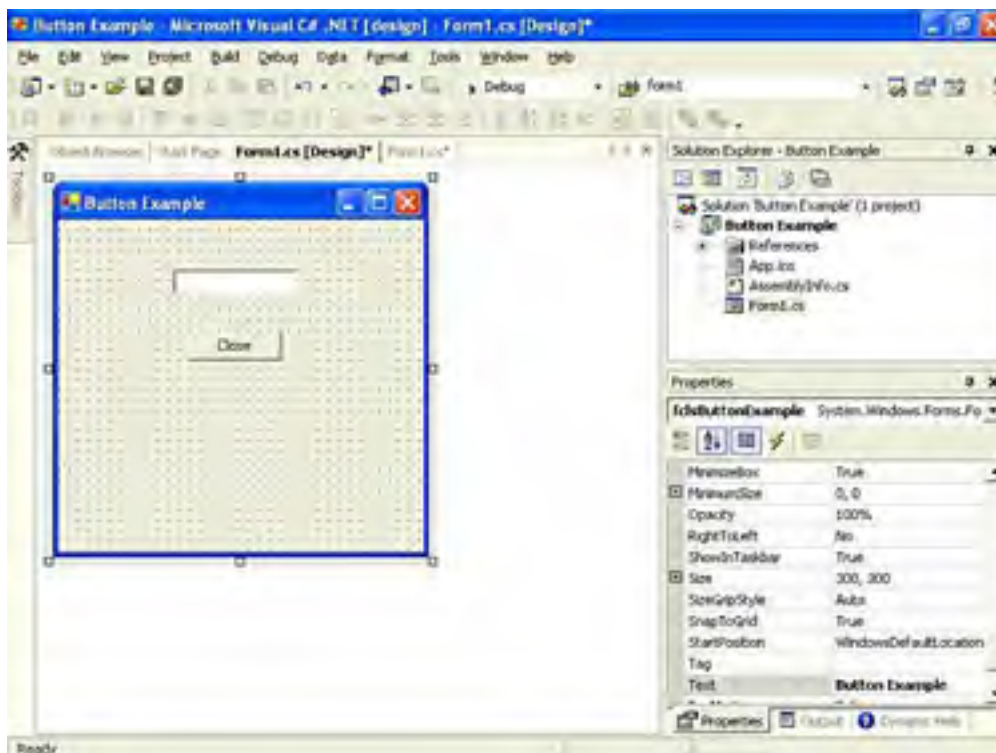
Property	Value
Name	btnClose
Location	104,90
Text	Close

Add a new text box to the form and set its properties as follows:

Property	Value
Name	txtTest
Location	92,40
TabIndex	0
Text	(make blank)

You're probably starting to see a pattern here. Whenever you add a new control to a form, the first thing you should do is give the control a descriptive name. If the control has a Text property, you should change it to something meaningful as well. Your form should now look like [Figure 7.8](#).

Figure 7.8. Users click buttons, such as the Close button, to make things happen.



There's no point in having a button that doesn't do anything, so double-click the button now to access its Click event, and then add the following statement:

```
this.Close();
```

Recall from [Hour 5](#), "Building Forms: The Basics," that this statement closes the current form. Because you'll have only one form in the project, this has the effect of terminating the application. Press F5 to run the project. The cursor appears in the text box, which means that the text box has the focus (it has the lowest `TabIndex` property). Press Enter and note that nothing happens (this will make sense shortly). Next, click the button and the form will close.

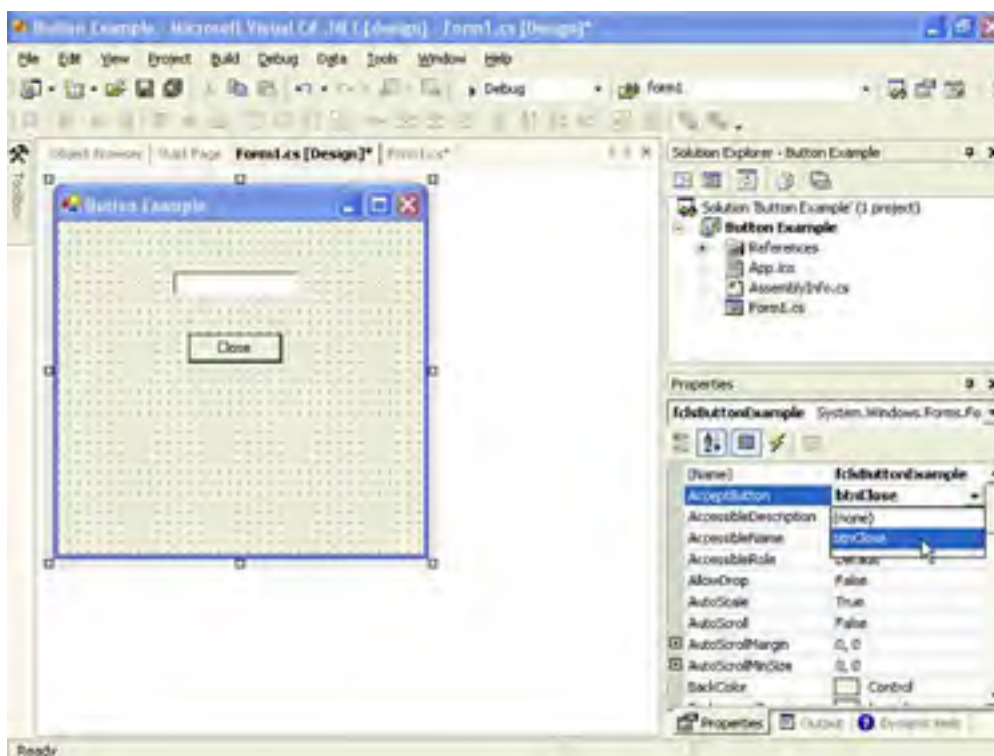
Did you Know? You can programmatically trigger a button's Click event, just as though a user clicked it, by calling the button's `PerformClick` method.

Accept and Cancel Buttons

When you're creating dialog boxes, it's common to assign one button as the default button (called the Accept button). If a form has an Accept button, that button's Click event is fired when the user presses Enter, regardless of which control has the focus. This is great for dialog boxes in which the user enters some text and presses Enter to commit the data and close the form.

To designate a button as an Accept button, show the `AcceptButton` of the form in the Properties window (see [Figure 7.9](#)). Notice that it is currently set to (none)—no button has been designated as the Accept Button. Click in the property and a drop-down arrow appears. Click the arrow and choose the button (`btnClose` in this case) from the list.

Figure 7.9. You can designate only one button as a form's Accept button.



Press F5 to run the project. Again, the text box has the focus. Press Enter, and you'll find that the form closes. Again, pressing Enter on a form that has a designated Accept button causes that button's Click event to fire the same as if the user clicked it with the mouse, regardless of which control has the focus.

The Accept button is a useful concept, and you should take advantage of this functionality when possible. Keep in mind that when you do create an Accept button for a form, you should also create a Cancel button. A Cancel button is a button that fires its Click event when the user presses the Esc key, regardless of which control has the focus. Generally, you place code in a Cancel button to shut down the form without committing any changes made by the user. To designate a button as a Cancel button, choose it as the `CancelButton` property of the form.

Use the following hints when deciding what buttons to assign as the Accept and Cancel buttons of a form:

- If a form has an OK or Close button, chances are good that it should be assigned as the AcceptButton.
- If a form has both an OK and a Cancel button, assign the OK button as the AcceptButton and the Cancel button as the CancelButton (yeah, this is pretty obvious—but often overlooked).
- If a form has a single Close or OK button, assign it to both the AcceptButton and CancelButton properties of the form.
- If the form has a Cancel button, assign it to the CancelButton property of the form.

Adding a Picture to a Button

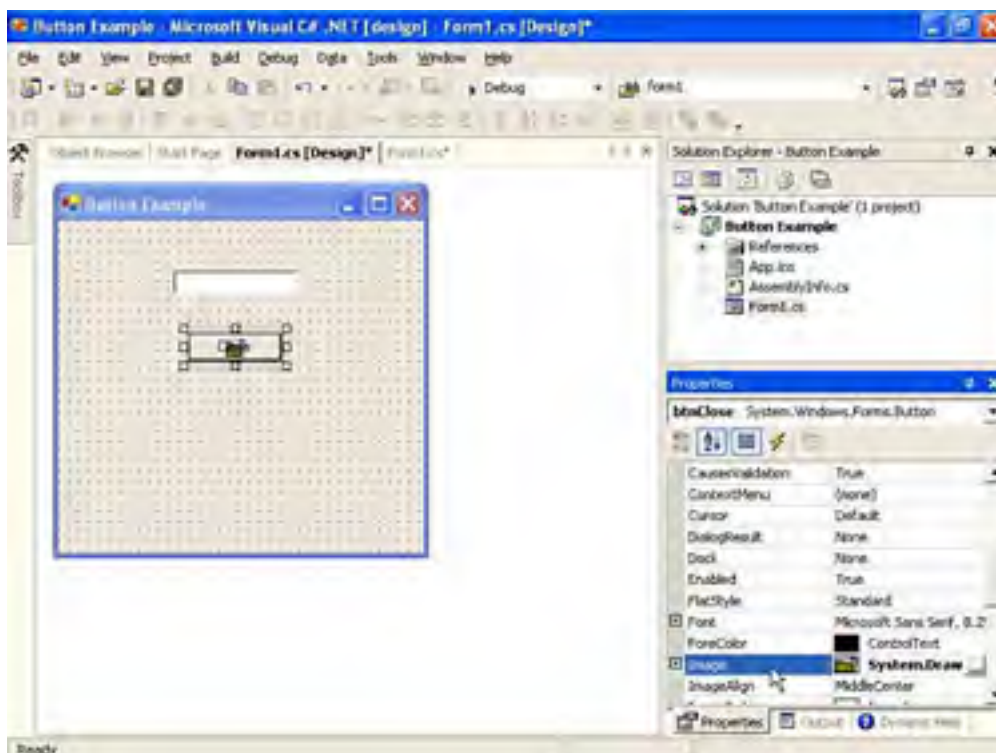
Although it's not standard practice, and you shouldn't overuse the technique because doing so causes clutter and can reduce the usefulness of your interface, it's possible to add a picture to a button. The two primary methods of doing this are to add the picture to the button at design time by loading a picture into the Image property of the control using the Properties window, or to bind the button to an image list. I'll discuss loading a picture using the Properties window here and cover the Image List control in the next hour. (Note: You can load an image at runtime using the technique discussed for the Picture Viewer program in [Hour 1](#), "Jumping In with Both Feet: A Visual C# .NET Programming Tour.")



To perform this operation, you'll need a small bitmap. I've provided one at www.sampublishing.com and at my Web site www.jamesfoxall.com (the file is called Close.bmp). There's also a set of discussion forums at my site, so feel free to drop by with your questions and comments.

Select the button and display its properties in the Properties window. Click the Image property to select it, and then click the button with the three dots that appear. The Open File dialog box appears, allowing you to find and select a bitmap. Use this dialog box to locate and select the Close.bmp bitmap or another small bitmap of your choosing. Click Open to load the image into the button's Image property, and the picture will appear on your button (see [Figure 7.10](#)).

Figure 7.10. The Image property is used to display a picture on a button.



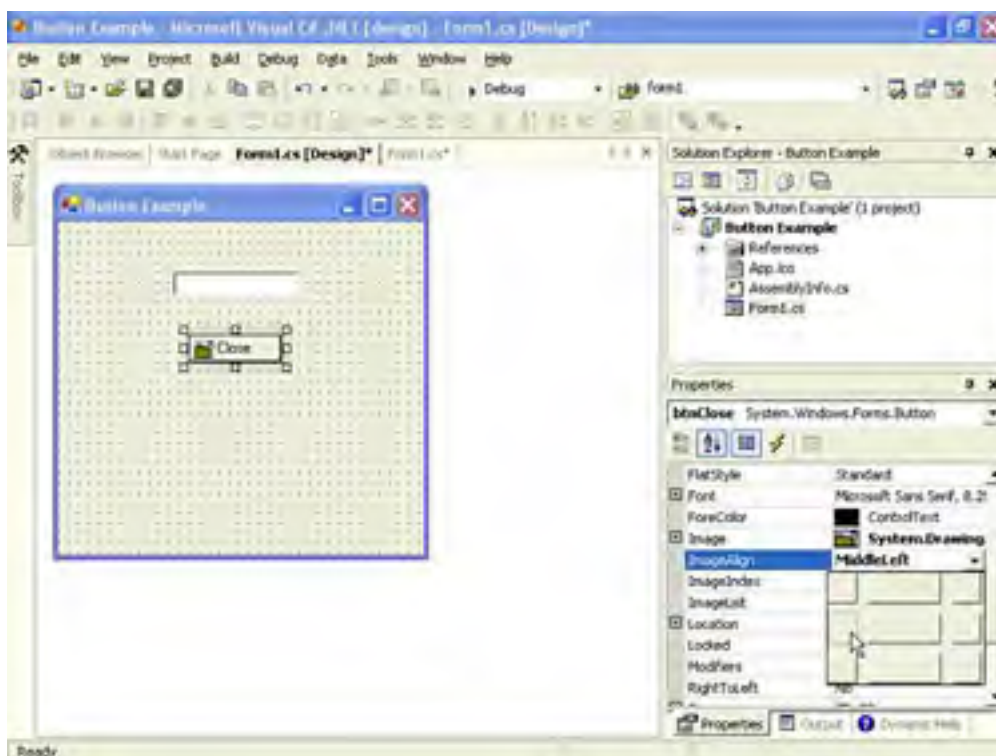


Many controls have an Image property, and for the most part, they all work the same way as the Image property of the Button control.

Notice that there is a problem with how the picture appears on the button—the image overlays the text. This problem is easily corrected.

Although a picture is displayed in the center of a button by default, you can specify the placement using the ImageAlign property. Click the ImageAlign property to display a drop-down arrow, and then click the arrow. The drop-down list contains a special interface for specifying the alignment of the picture (see [Figure 7.11](#)). Each rectangle in the drop-down list corresponds to an alignment (center-left, center-center, center-right, and so on). Click the center-left rectangle now and the image will be moved to the left of the text.

Figure 7.11. Click a rectangle to move the picture to the corresponding alignment.



Creating Containers and Groups of Option Buttons

In this section, you'll learn how to create containers for groups of controls using panels and group boxes. You'll also learn how to use the Check Box and Option Button controls in conjunction with these container controls to present multiple choices to a user.

Begin by creating a new Windows Application titled **Options**. Change the name of the default form to **fclsOptions** and set the form's Text property to **Options**. Next, change the entry point Main() to reference fclsOptions instead of Form1.

Using Panels and Group Boxes

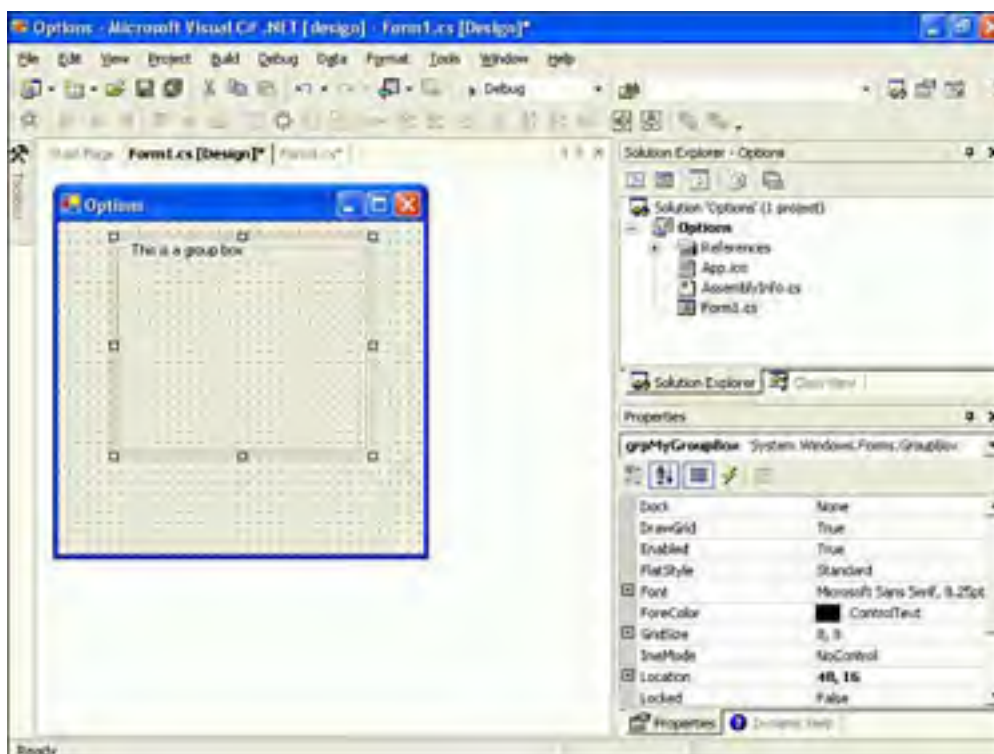
Controls can be placed on a form because the form is a **container** object—an object that can host controls. A form isn't the only type of container, however. Some controls act as containers as well, and a container may host one or more other containers. The Panel and Group Box controls are both container controls that serve a similar purpose, yet each is more suited to a particular application.

By the Way

The Panel control, for the most part, is a slimmed-down version of the Group Box control, so I won't be discussing it in depth. If you need a very basic container control without the additional features offered by the group box (such as a border and a caption), use the Panel control. The primary exception to this is that the panel offers scrolling capabilities just like those found on forms, which group boxes do not support.

The group box is a container control with properties that let you create a border (frame) and caption. Add a new group box to your form now by double-clicking the GroupBox item in the toolbox. When you create a new group box, it has a border by default, and its caption is set to the name of the control (see [Figure 7.12](#)).

Figure 7.12. A group box acts like a form within a form.



Set the properties of the group box as follows:

Property

Value

Name	grpMyGroupBox
Location	48,16
Size	200,168
Text	This is a group box

The group box is a fairly straightforward control. Other than defining a border and displaying a caption, the purpose of a group box is to provide a container for other controls. The next two sections, "[Presenting Yes/No Options Using Check Boxes](#)" and "[Working with Radio Buttons](#)," help demonstrate the benefits of using a group box as a container.

Presenting Yes/No Options Using Check Boxes

The check box is used to display true/false values on a form. You're now going to add a check box to your form—but not in the way you have been adding other controls. As you know by now, double-clicking the CheckBox item in the toolbox will place a new Check Box control on the form. This time, however, you're going to place the check box on the Group Box control.

You can perform any of the following actions to place a control on a group box:

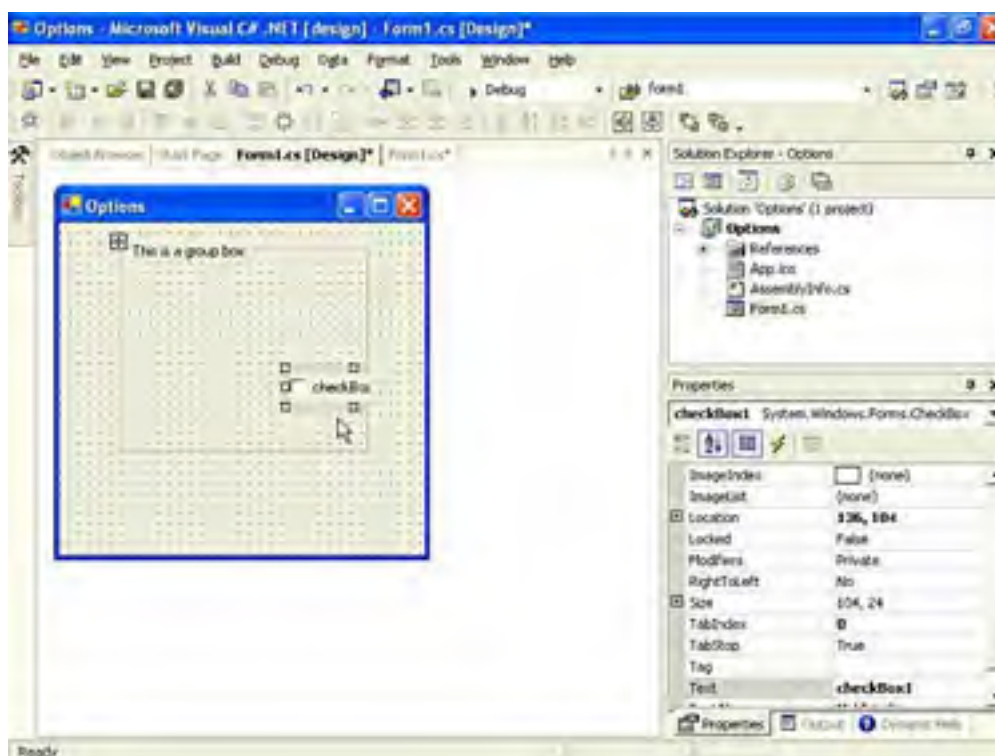
- Add the control to the form, cut the control from the form, select the group box, and paste the control on the group box.
- Draw the control directly on the group box.
- Drop the control on the group box.

You're going to use the third method—dropping a new control directly on the group box. Follow these steps:

1. Click the CheckBox item in the toolbox and drag it to the group box.
2. Release the mouse when you are over the group box.

You should now have a check box on your group box like the one shown in [Figure 7.13](#).

Figure 7.13. Container controls hold other controls.



Move the check box around by clicking and dragging it. You'll notice that you can't move the check box outside the group box's boundaries (refer to [Figure 7.13](#)). This is because the check box is a child of the group box, not of the form.

Set the properties of the check box as follows:

Property	Value
Name	chkMyCheckBox
Location	16,24
Size	120,24
Text	This is a check box

When the user clicks the check box, it changes its visible appearance from checked to unchecked. To see this behavior, press F5 to run the project and click the check box a few times.

When you're done experimenting, stop the running project. To determine the state of the check box in code, use its Checked property. You can also set this property at design time using the Properties window.

Working with Radio Buttons

Check boxes are excellent controls for displaying true/false values. Check boxes work independently of one another, however; if you have five check boxes on a form, each of them could be checked or unchecked. Radio buttons, on the other hand, are mutually exclusive to the container on which they're placed. This means that only one radio button per container may be selected at a time. Selecting one radio button automatically deselects any other radio buttons on the same container. Radio buttons are used to offer a selection of items to a user when the user is allowed to select only one item. To better see how mutual exclusivity works, you're going to create a small group of radio buttons.

Open the toolbox and locate the RadioButton item. Next, drag it to the group box to create a new radio button on the group box control. Set the properties of the radio button as follows:

Property	Value
Name	optOption1
Location	16,56
Size	104,24
Text	This is option 1

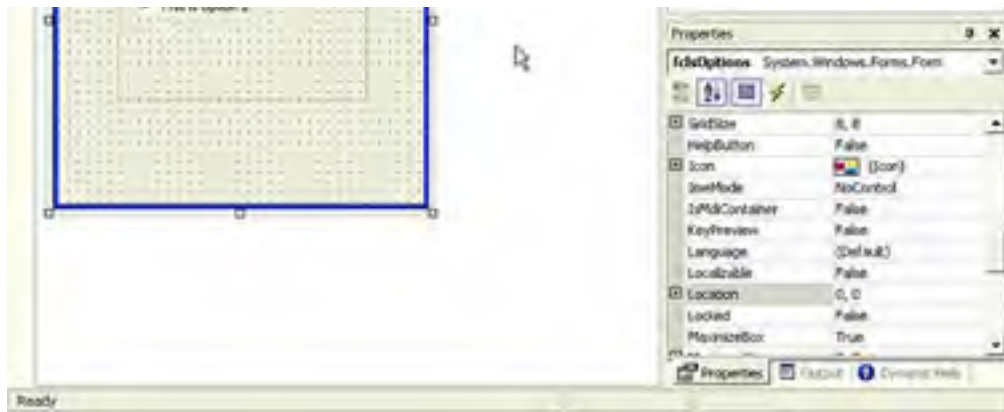
You're going to copy this radio button and paste a copy of the control on the group box. Begin by right-clicking the radio button and choosing Copy from its context menu. Next, click the group box to select it, right-click the group box, and choose Paste from its context menu to create a new radio button. Set the properties of the radio button as follows:

Property	Value
Name	optOption2
Checked	true
Location	16,80
Text	This is option 2

Now that you have your two radio buttons (see [Figure 7.14](#)), run the project by pressing F5.

Figure 7.14. Radio buttons restrict a user to selecting a single item.





Click the first radio button to select it, and notice how the second radio button becomes deselected automatically (its Checked property is set to `false`). Two radio buttons are sufficient to demonstrate the mutual exclusivity, but be aware that you could add as many radio buttons to the group box as you care to and the behavior would be the same. The important thing to remember is that mutual exclusivity is shared only by radio buttons placed on the same container. To create radio buttons that behave independently of one another, you would need to create a second set on another container. You could easily create a new group box (or panel for that matter) and place the second set of radio buttons on the new container. The two sets of radio buttons would behave independently of one another, but mutual exclusivity would still exist among the buttons within each set.

Stop the running project and save your work.

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Displaying a List with the List Box

A list box is used to present a list of items to a user. You can add items to and remove items from the list at any time with very little Visual C# .NET code. In addition, you can set up a list box so that a user can select only a single item or multiple items. When a list box contains more items than it can show because of the size of the control, scrollbars are automatically displayed.



The cousin of the list box is the combo box, which looks like a text box with a down-arrow button at its right side. Clicking a combo box's button causes the control to display a drop-down list box. Working with the list of a combo box is pretty much identical to working with a list box, so I'll discuss the details of list manipulation in this section, and then discuss the features specific to the combo box in the next section.

Create a new project titled **Lists**. Change the name of the default form to **fclsLists** and set its Text property to **Lists Example**. Next, change the entry point `Main()` to reference **fclsLists** instead of `Form1`. Set the form's **Size** property to **300,320**. Add a new list box control to the form by double-clicking the `ListBox` item in the toolbox and then set the properties of the list box as follows:

Property	Value
Name	lstPinkFloydAlbums
Location	72,32
Size	160,121

Every item contained in a list box is a member of the list box's `Items` collection. Working with items, including adding and removing items, is done using the `Items` collection. Most often, you'll manipulate the `Items` collection using code (which I'll show you a little bit later in this hour), but you can also work with the collection at design time using the Properties window.

Manipulating Items at Design Time

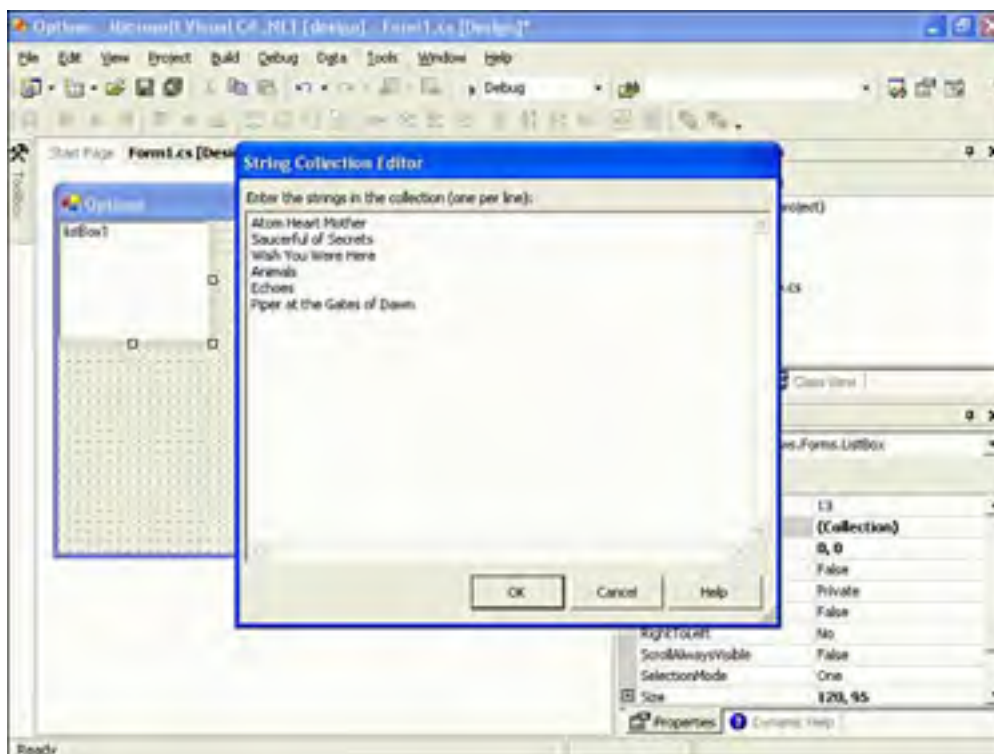
The `Items` collection is available as a property of the list box. Locate the `Items` property in the Properties window and click it to select it. The familiar button with three dots appears, indicating that you can do advanced things with this property. Click the button now to show the String Collection Editor. To add items to the collection, simply enter the items into the text box—one item to a line.

Enter the following items:

- Atom Heart Mother
- Saucerfull of Secrets
- Wish You Were Here
- Animals
- Echoes
- Piper at the Gates of Dawn

When you're finished, your screen should look like that shown in [Figure 7.15](#). Click OK to commit your entries and close the window. Notice that the list box contains the items that you entered.

Figure 7.15. Use this dialog box to manipulate an `Items` collection at design time.



Manipulating Items at Runtime

In [Hour 3](#), "Understanding Objects and Collections," you learned all about objects, properties, methods, and collections. All this knowledge comes into play when manipulating lists at runtime. The `Items` property of a list box (and a combo box) is an object property that returns a collection (collections in many ways are like objects—they have properties and methods). To manipulate list items, you manipulate the `Items` collection.

A list can contain duplicate values, as you'll see in this example. Because of this, Visual C# .NET needs a mechanism other than an item's text to treat each item in a list as a unique item. This is done by assigning each item in an `Items` collection a unique index. The first item in the list has an index of 0, the second an index of 1, and so on. The index is the ordinal position of an item relative to the first item in the `Items` collection, not the top item visible in the list.

Adding Items to a List

New items are added to the `Items` collection using the `Add` method of the collection. You're now going to create a button that adds an album to the list. Close the String Collection Editor now, add a new button to the form, and set its properties as follows:

Property	Value
Name	<code>btnAddItem</code>
Location	<code>104,160</code>
Size	<code>96,23</code>
Text	<code>Add an Item</code>

Double-click the button to access its `Click` event and add the following code:

```
lstPinkFloydAlbums.Items.Add("Dark Side of the Moon");
```

Notice that the `Add` method accepts a string argument—the text to add to the list.



Unlike items added at design time, items added through code aren't preserved when the program ends.

Press F5 to run the project now and click the button. When you do, the new album is added to the bottom of the list. Clicking the button a second time adds another item to the list with the same album name. The list box doesn't care whether the item already exists in the list; each call to the Add method of the Items collection adds a new item to the list.

The Add method of the Items collection can be called as a function, in which case it returns the index (ordinal position of the newly added item in the underlying collection), as in the following:

```
int intIndex;  
intIndex = lstPinkFloydAlbums.Items.Add("Dark Side of the Moon");
```

Stop the running project and save your work before continuing.



To add an item to an Items collection at a specific location in the list, use the Insert method. The Insert method accepts an index in addition to text. To add an item at the top of the list, for example, you could use a statement such as

```
lstPinkFloydAlbums.Items.Insert(0,"Dark Side of the Moon");
```

Remember, the first item in the list has an index of 0.

Removing Items from a List

Removing an individual item from a list is as easy as adding an item and requires only a single method call: a call to the Remove method of the Items collection. The Remove method accepts a string, which is the text of the item to remove. You're now going to create a button that will remove an item from the list. Create a new button and set its properties as follows:

Property	Value
Name	btnRemoveItem
Location	104,192
Size	96,23
Text	Remove an Item

Double-click the new button to access its Click event and enter the following statement:

```
lstPinkFloydAlbums.Items.Remove("Dark Side of the Moon");
```

The Remove method tells Visual C# .NET to search the Items collection, starting at the first item (index = 0), and when an item is found that matches the specified text, to remove that item. As I stated earlier, you can have multiple items with the same text. In this case, the Remove method will remove only the first occurrence; after the text is found and removed, Visual C# .NET stops looking.

Press F5 to run the project now. Click the Add an Item button a few times to add Dark Side of the Moon to the list (see [Figure 7.16](#)). Next, click the Remove an Item button and notice how Visual C# .NET finds and removes one instance of the item.

Figure 7.16. The list box may contain duplicate entries, but each entry is a unique item in the Items collection.



Did you Know?

To remove an item at a specific index, use the `RemoveAt` method. For instance, to remove the first item in the list, you could use a statement such as

```
IstPinkFloydAlbums.Items.RemoveAt(0);
```

Stop the running project and save your work.

Clearing a List

To completely clear the contents of a list box, use the `Clear` method. You are now going to add a button to the form that will clear the list when clicked. Add a new button to the form and set the button's properties as follows:

Property	Value
Name	btnClearList
Location	104,224
Size	96,23
Text	Clear List

Double-click the new button to access its Click event and enter the following statement:

```
IstPinkFloydAlbums.Items.Clear();
```

Press F5 to run the project, and then click the Clear List button. The `Clear` method doesn't care if an item was added at design time or runtime; `Clear()` always removes all items from the list. Stop the project and again save your work.

Did you Know?

Remember, the `Add`, `Insert`, `Remove`, `RemoveAt`, and `Clear` methods are all methods of the `Items` collection, not of the list box itself. If you forget that these are members of the `Items` collection, you might get confused when you don't find them when you enter a period after typing a list box's name in code.

Retrieving Information About the Selected Item in a List

By default, a list box allows only a single item to be selected by the user at a time. Whether a list allows multiple selections is determined by the `SelectionMode` property of the list box. You'll need to understand how to work with the selected item of the most common type of list box—a list box that allows only a single selection.

Two properties provide information about the selected item: `SelectedItem` and `SelectedIndex`. It's important to note that these are properties of the list box itself, not of the `Items` collection of a list box. The `SelectedItem` method returns the text of the currently selected item. If no item is selected, the method returns an empty string. It's desirable at times to know the index of the selected item. This is obtained using the `SelectedIndex` property of the list box. As you know, the first item in a list has the index of 0. If no item is selected, `SelectedIndex` returns a `-1`, which is never a valid index for an item.

You're now going to add a button to the form that, when clicked, displays the selected item's text and index in the Output window. First, change the `Height` property of the form to 320 to accommodate one more button. As you build your interfaces, you'll often have to make small tweaks such as this because it's nearly impossible to anticipate everything ahead of time. Add a new button to the form and set its properties as follows:

Property	Value
Name	<code>btnShowItem</code>
Location	<code>104,256</code>
Size	<code>96,23</code>
Text	<code>Show Selected</code>

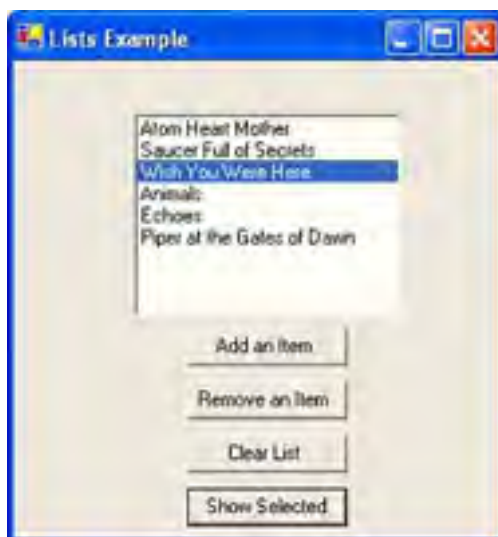
Double-click the new button to access its `Click` event and enter the following statements:

```
System.Diagnostics.Debug.WriteLine(lstPinkFloydAlbums.SelectedItem);  
System.Diagnostics.Debug.WriteLine(lstPinkFloydAlbums.SelectedIndex);
```

`Debug.WriteLine` sends text to the Output window (one of Visual Studio .NET's many development windows). Since there is no Output window in a compiled application, `Debug.WriteLine` statements are ignored during a build.

Press `F5` to run the project and click the `Show Selected` button. Take a look at the Output window (you may have to show it using the `Other Windows` submenu of the `View` menu). You'll see a blank line—the empty string returned by `SelectedItem`, and you'll also see a `-1`, which was returned by `SelectedIndex`. Again, the `-1` denotes that no item is selected. Click an item in the list to select it, and then click `Show Selected` again. This time, you'll see the text of the selected item and its index in the Output window (see [Figure 7.17](#)).

Figure 7.17. The `SelectedItem` and `SelectedIndex` properties make it easy to determine which item is selected in a list.



Stop the running project and save your work.



You can set up a list box to allow multiple items to be selected at once. To do this, you change the `SelectionMode` property of the list box to

MultiSimple (clicking an item toggles its selected state) or MultiExtended (you have to hold Ctrl or Shift to select multiple items). To determine which items are selected in a multiselection list box, you use the list box's SelectedItems collection.

Sorting a List

List boxes and combo boxes have a **Sorted** property. By default, this property is set to **false**. Changing this property value to **true** causes Visual C# .NET to sort the contents of the list alphabetically. When the contents of a list are sorted, the index of each item in the Items collection is changed; therefore, you can't use an index value obtained prior to setting Sorted to **true**.

Sorted is a property, not a method. Realize that you don't have to call Sorted to sort the contents of a list; Visual C# .NET enforces a sort order as long as the Sorted property is set to **true**. This means that all items added using the Add method or the Insert method are automatically inserted into the proper sorted location, in contrast to being inserted at the end of the list or in a specific location.

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Creating Drop-Down Lists Using the Combo Box

List boxes are great, but they have two shortcomings. First, they take up quite a bit of space. Second, users can't enter their own values; they have to select from the items in the list. If you need to conserve space or if you want to allow a user to enter a value that may not exist in the list, use the Combo Box control.

Combo boxes have an Items collection that behaves exactly like that of the List Box control (refer to the preceding section for information on manipulating lists). Here I will show you the basics of how a combo box works.

Add a new combo box to the form by double-clicking the ComboBox item in the toolbox. Set the combo box's properties as follows:

Property	Value
Name	cboColors
Location	72,8
Size	160,21
Text	(make blank)

The first thing you should note is that the combo box has a Text property, whereas the list box doesn't. This works the same as the Text property of a text box. When the user selects an item from the drop-down list, the value of the selected item is placed in the Text property of the text box. The default behavior of a combo box is to allow the user to enter any text in the text box portion of the control—even if the text doesn't exist in the list. I'll show you how to change this behavior shortly.

Select the Items property of the combo box in the Properties window and click the button that appears. Add the following items to the String Collection editor and click OK to commit your entries.

- Black
- Blue
- Gold
- Green
- Red
- Yellow

Press F5 to run the project. Click the arrow at the right side of the combo box and a drop-down list appears (see [Figure 7.18](#)).

Figure 7.18. Combo boxes conserve space.





Next, try typing in the text **Magenta**. Visual C# .NET lets you do this. Indeed, you can type any text that you want. Often, you'll want to restrict a user to entering only values that appear in the list. To do this, you change the DropDownStyle property of the combo box. Close the form to stop the running project and change the DropDownStyle property of the combo box to **DropDownList**. Press F5 to run the project again and try to type text into the combo box. You can't. However, if you enter a character that is the start of a list item, Visual C# .NET will select the closest matching entry.

When set as a DropDownList, a combo box won't allow any text entry; therefore, the user is limited to selecting items from the list. As a matter of fact, clicking in the "text box" portion of the combo box opens the list the same as if you clicked the drop-down arrow.

Stop the running project now and save your work. As you can see, the combo box and list box offer similar functionality. In fact, the coding of their lists is identical. Each one of these controls serves a slightly different purpose, however. Which one is better? That depends entirely on the situation. As you use professional applications, pay attention to their interfaces; you'll start to get a feel for which control is appropriate in a given situation.

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Summary

In this hour you learned how to present text to a user. You learned that the Label control is perfect for displaying static text (text the user can't enter) and that the text box is the control to use for displaying edited text. You can now create text boxes that contain many lines of text, and you know how to add scrollbars when the text is greater than what can be displayed in the control.

I don't think I've ever seen a window without at least one button on it. You've now learned how to add buttons to your forms and how to do some interesting things such as adding a picture to a button. For the most part, working with buttons is a simple matter of adding one to a form, setting its Name and Text properties, and adding some code to its Click event—all of which you now know how to do.

Check boxes and option buttons are used to present true/false and mutually exclusive options, respectively. In this hour, you learned how to use each of these controls and how to use group boxes to logically group sets of related controls.

Last, you learned how to use list boxes and combo boxes to present lists of items to a user. You now know how to add items to a list at design time as well as runtime, and you know how to sort items. The ListBox and ComboBox are powerful controls, and I encourage you to dig deeper into the functionality they possess.

Without controls, users would have nothing to interact with on your forms. In this hour, you learned how to use the standard controls to begin building functional interfaces. Keep in mind that I only scratched the surface of each of these controls and that most do far more than I've hinted at here. Mastering these controls will be easy for you, as you'll be using them a lot.

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Q&A

Q1: *Can I place radio buttons directly on a form?*

A1: Yes. The form is a container, so all radio buttons placed on a form are mutually exclusive to one another. If you wanted to add a second set of mutually exclusive buttons, they'd have to be placed on a container control. In general, I think it's best to place radio buttons on a group box rather than on a form because the group box provides a border and a caption for the radio buttons and makes it much easier to move the set of radio buttons (you simply move the group box) when you're designing the form.

Q2: *I've seen what appears to be list boxes that have a check box next to each item in the list. Is this possible?*

A2: Yes, but this is accomplished using an entirely different control: the checked list box.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** Which control would you use to display text that the user can't edit?
- 2:** What common property is shared by the Label control and text box and whose value determines what the user sees in the control?
- 3:** In order to change the Height of a text box, you must set what property?
- 4:** What is the default event of a Button control?
- 5:** A button whose Click event is triggered when the user presses Enter, regardless of the control that has the focus, is called an ...?
- 6:** Which control would you use to display a yes/no value to a user?
- 7:** How would you create two distinct sets of mutually exclusive option buttons?
- 8:** To manipulate items in a list, you use what collection?
- 9:** What method adds an item to a list in a specific location?

Exercises

- 1:** Create a form with a text box and a combo box. Add a button that, when clicked, adds the contents of the text box to the combo box.
- 2:** Create a form with two list boxes. Add a number of items to one list box at design time using the Properties window. Create a button that, when clicked, removes the selected item in the first list and adds it to the second list.

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Hour 8. Using Advanced Controls

The standard controls presented in the preceding hour enable you to build many types of functional forms. However, to create truly robust and interactive applications, you've got to use the more advanced controls. As a Windows user, you've encountered many of these controls, such as the Tab control, which presents data in tabbed dialog boxes, and the Tree View control, which displays hierarchical lists such as the one in Explorer. In this hour, you'll learn about these advanced controls and learn how to use them to make professional interfaces like those you're accustomed to seeing in commercial products.

The highlights of this hour include the following:

- Creating timers
- Creating tabbed dialog boxes
- Storing pictures in an Image List control
- Building enhanced lists using the List View control
- Creating hierarchical lists with the Tree View control

**By the
Way**

In many of the examples in this hour, I show you how to add items to collections at design time. Keep in mind that almost everything you can do at design time can also be accomplished using Visual C# .NET code at runtime.

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Creating Timers

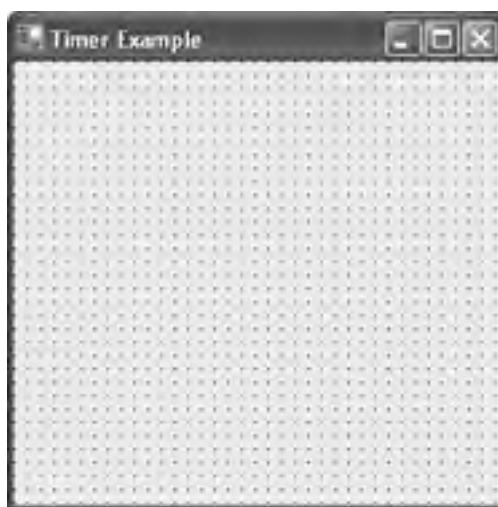
All the controls you used in [Hour 7](#), "Working with the Traditional Controls," had in common the fact that the user can interact with them. Not all controls have this capability—or restriction, depending on how you look at it. Some controls are designed for use only by the developer. One such control is the Open File Dialog control you used in your Picture Viewer application in [Hour 1](#), "Jumping in with Both Feet: A Visual C# .NET Programming Tour." Another control that is invisible at runtime is the Timer control. The Timer control's sole purpose is to trigger an event at a specified interval of time.

Create a new Windows Application titled **Timer Example**. Change the name of the default form to **fclstimerExample** and then set its Text property to **Timer Example**. Next, be sure to set the Main entry point of the project to **fclstimerExample** or the project won't run.

Add a new Timer control to your form by double-clicking the Timer item in the Toolbox. The Timer control is invisible at runtime, so it's added to the gray area at the bottom of the screen rather than placed on the form (see [Figure 8.1](#)). Set the properties of the Timer control as follows:

Property	Value
Name	tmrClock
Enabled	True
Name	tmrClock
Enabled	True
Interval	1000

Figure 8.1. Invisible-at-runtime controls are shown at the bottom of the designer, not on the form.



You probably noticed that there are very few properties for the Timer control compared to the other controls you've worked with. The most important property of the Timer control is the Interval property. The Interval property determines how often the Timer control fires its Tick event (where you'll be placing the code to do something when the designated time elapses). The Interval is specified in milliseconds, so a setting of 1,000 is equal to 1 second.

As with many controls, the best way to understand how the timer works is to use it in a project. Using the Timer control and a Label control, you're now going to create a simple clock. The way the clock will work is that the Timer control will fire its Tick event once every second (because you've set the Interval property to 1,000 milliseconds). Within the Tick event, you'll update the label's Text property to the current system time.

Add a new label to the form and set its properties as follows:

Property	Value
Name	lblClock
BorderStyle	FixedSingle

Location	96,120
Size	100,23
Text	(make blank)
TextAlign	MiddleCenter

Next, double-click the Timer control to access its Tick event. When a timer is first enabled, it starts counting (in milliseconds) from 0. When the amount of time specified in the Interval property passes, the Tick event fires and the timer starts counting from 0 once again. This cycle continues until the timer is disabled (the Enabled property is set to False). Because you've set the Enabled property of the timer to True at design time, it will start counting as soon as the form on which it's placed is loaded. Enter the following statement in the Tick event:

```
lblClock.Text = DateTime.Now.ToLongTimeString();
```

The .NET Framework provides date/time functionality in the System namespace. The Now property of the DateTime class returns the current time. Using the ToLongTimeString method returns the time as a string with a format of hh:mm:ss. This code causes the Text property of the label to show the current time of day, updated once a second. Press F5 to run the project now, and you'll see the Label control acting as a clock, updating the time every second (see [Figure 8.2](#)).

Figure 8.2. Timers make it easy to execute your code at specified intervals.



Stop the running project now and save your work.

Timers are powerful, but you must take care not to overuse them. For a timer to work, Windows must be aware of the timer and must constantly compare the current internal clock to the interval of the timer. It does all this so that it can notify the timer at the appropriate time to execute its Tick event. In other words, timers take system resources. This isn't a problem for an application that uses a few timers, but I wouldn't overload an application with a dozen timers unless I had no other choice (and there's almost always another choice).

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Creating Tabbed Dialog Boxes

Windows 95 was the first version of Windows to introduce a tabbed interface. Since then, tabs have been widely adopted as a primary interface element. Tabs provide two major benefits: the logical grouping of controls and the reduction of required screen space. Although tabs might look complicated, they are actually easy to build and use.

Create a new Windows Application named **Tabs Example**. Change the name of the default form to **fclsTabs**, set its Text property to **Tabs Example**, and modify the Main entry point to **fclsTabs**. Next, add a new Tab control to your form by double-clicking the TabControl item in the toolbox. At first, the new control looks more like a panel than a set of tabs because it doesn't actually have any tabs. Set the Tab control's properties as follows:

Property	Value
Name	tabMyTabs
Location	8,16
Size	272,208

The tabs that appear on a Tab control are determined by the control's TabPages collection. Click the TabPages property of the Tab control in the Properties window and then click the small button that appears. Visual C# .NET then shows the TabPage Collection Editor. As you can see, your Tab control has no tabs. Click Add now to create a new tab (see [Figure 8.3](#)).

Figure 8.3. New Tab controls have no tabs; you must create them.



Each tab in the collection is called a *page*. Visual C# .NET names each new page TabPageX, where X is a unique number. Although you don't have to change the name of a page, it's often easier to work with a Tab control if you give each tab a meaningful name, such as pgeGeneralPage, pgePreferencesPage, and so forth. Set the Name property of your new page to pgeContacts now.

Each page has a number of properties, but the property you'll be concerned with most is the Text property because the value of the Text property determines the text the user will see on the tab. Change the Text property of your new tab page to **Contacts**. Next, click Add to create a second page. Change the Name of the new tab to **pgeAppointments**, set the Text property to **Appointments**, and then click OK to close the dialog box. Your Tab control now has two tabs (pages).



The properties on the editor are always in categorized mode, regardless of the way you choose to view properties in the Properties window.

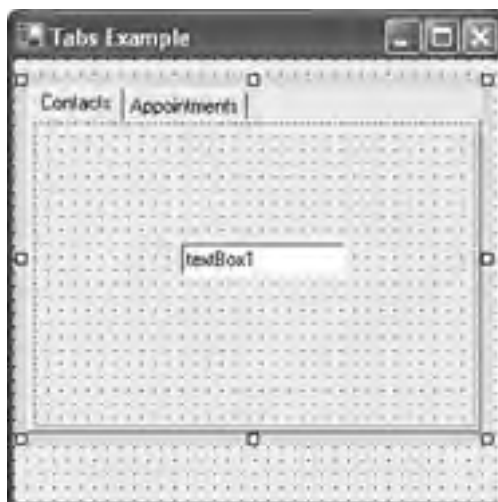
**Did you
Know?**

A quick way to add or remove a tab is to use the shortcuts provided in the description pane at the bottom of the Properties window.

Each page on a Tab control acts as a container, much like a Panel or Group Box control. This is why you can't drag the Tab control by clicking in the middle of it. To drag a container control, you have to click and drag the dotted border around the control.

Add a text box to the first tab now by dragging the TextBox item from the toolbox and dropping it on the tab page. After it's on the page, drag it to approximately the center of the page. Next, click the Appointments tab, just as if you were a user switching tabs. (You may have to click it twice—once to select the tab control and a second time to switch tabs. If so, click slowly to avoid double-clicking the tab control and showing its default event.) As you can see, the Appointments tab comes to the front, and the text box is no longer visible. Visual C# .NET has hidden the first page and shown you the second. Drag a check box from the toolbox and drop it on the Appointments page, and then click Contacts once more. Again, Visual C# .NET handles the details of showing and hiding the tab pages; you no longer see the check box, but you do see the text box (see [Figure 8.4](#)).

Figure 8.4. The Tab control makes it easy to create a tabbed interface.



By understanding two simple programming elements, you'll be able to do 99% of what you need to with the Tab control. The first element is that you'll need to know which tab is selected at runtime. The SelectedIndex property of the control (not the TabIndex property) sets and returns the index of the currently selected tab: 0 for the first tab, 1 for the second, and so forth. The second thing to know is how to tell when the user switches tabs. The Tab control has a SelectedIndexChanged event, which fires whenever the selected tab is changed. In this event, you can check the value of SelectedIndex to determine the tab that has been selected.

Perhaps the trickiest issue with the Tab control is that each tab page has its own set of events. If you double-click the tabs themselves, you'll get a set of global events for the Tab control (this is where you'll find the SelectedIndexChanged event). If you double-click a page on the tabs, you'll get a unique set of events for that page; each page has its own set of events.

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Storing Pictures in an Image List

Many of the controls discussed in this hour have the capability to attach pictures to different types of items. The Tree View control, which is used in Explorer for navigating folders, for example, displays images next to each folder node. Not all of these pictures are the same; the control uses specific pictures to denote information about each node. It would have been possible for Microsoft to make each control store its images internally, but that would be highly inefficient because it wouldn't allow controls to share the same pictures—you'd have to store the pictures in each control that needed them. This would also cause a maintenance headache. For example, suppose you have 10 Tree View controls and each displays a folder image for folder nodes. Now, it's time to update your application and you want to update the folder image to something a bit nicer. If the image were stored in each Tree View control, you'd have to update all 10 of them (and risk missing one). Instead, Microsoft created a control dedicated to storing pictures and serving them to other controls: the Image List. When you put images in an Image List control, it's easy to share them among other types of controls.

Follow these steps:

1. Create a new Windows Application named **Lists and Trees**.
2. Change the name of the default form to **fclsListsAndTrees**, set its Text property to **Lists and Trees Example**.
3. Set the entry point of the project to **fclsListsAndTrees**.
4. Add a new Image List control by double-clicking the ImageList item in the toolbox. Like the Timer control, the Image List is an invisible-at-runtime control, so it appears below the form, not on it. Change the name of the Image List to **imgMyImages**.

The sole purpose of an Image List control is to store pictures and make them available to other controls. The pictures are stored in the Images collection of the Image List control. Click the Images property of the control in the Properties window and then click the small button that appears. Visual C# .NET then displays the Image Collection Editor. Notice that this editor is similar to other editors you've used in this hour. Click Add to display the Open dialog box and use this dialog box to locate and select a 16x16 pixel bitmap. If you don't have a 16x16 pixel bitmap, you can create one using Microsoft Paint, or you can download samples I've provided at http://www.sampublishing.com/detail_sams.cfm?item=??? or at <http://www.jamesfoxall.com>. After you've added an image, click OK to close the Image Collection Editor.

Take a look at the ImageSize property of the Image control. It should be 16,16. If it isn't, the bitmap you selected isn't 16x16 pixels; this property is set to the dimensions of the first picture added to the Image List.

You can't always rely on the background where a picture will be displayed to be white—or any other color for that matter. Because of this, the Image List control has a TransparentColor property. By default, the TransparentColor property is set to Transparent. This isn't an intuitive setting, because in effect it means no color is treated as transparent (unless the image is an icon that has a transparent area). If you designate a specific color for the TransparentColor property, when a picture is served from the Image List to another control, all occurrences of the specified color will appear transparent—the background will show through. This gives you the power to create pictures that can be served to controls without concern about the color on which the picture will appear.

That's all there is to adding images to an Image List control. The power of the Image List resides in its capability to be linked to by other controls, so that they can access the pictures the Image List stores.

Building Enhanced Lists Using the List View

The List View control is like a list box on steroids—and then some. The List View can be used to create simple lists, multicolumn grids, and icon trays. The right pane in Explorer is a List View. (You can change the appearance of the List View in Explorer by right-clicking it and using the View submenu of the context menu that appears.) The primary display options available for Explorer's List Views are Large Icons, Small Icons, List, and Details. These correspond exactly to the display options available for a List View by way of its View property. You're now going to create a List View with a few items on it and experiment with the different views—including showing a picture for the items.

Did you Know?

I can only scratch the surface of this great control here. After you've learned the basics in this hour, I highly recommend that you spend some time with the List View control, the Help text, and whatever additional material you can find. I use the List View all the time, and it's a very powerful tool to have in your arsenal—displaying lists is *very* common.

Add a List View control to your form now by double-clicking the ListView item in the toolbox. Set the properties of the List View as follows:

Property	Value
Name	IstMyListView
Location	8,8
Size	275,97
SmallImageList	imgMyImages
View	Details

As you can see, you can attach an Image List to a control via the Properties window (and with code as well, of course). Not all controls support the Image List, but those that do make it as simple as setting a property to link to an Image List control. The List View actually allows linking to two Image Lists: one for large icons (32x32 pixels) and one for small images. In this example, you're going to use only small pictures. If you wanted to use the large format, you could hook up a second Image List containing larger images to the List View's LargeImageList property.

Creating Columns

When you changed the View property to Details, an empty header was placed at the top of the control. The contents of this header are determined by the columns defined in the Columns collection.

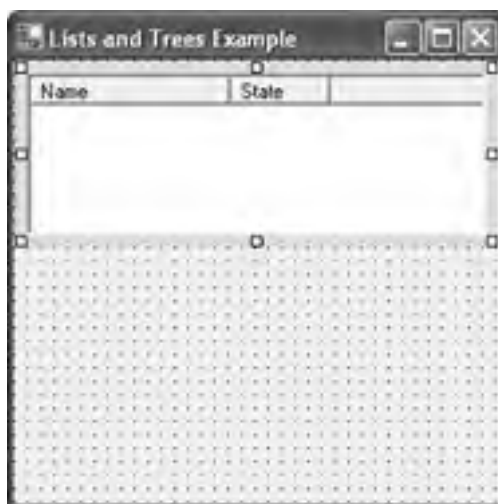
Select the Columns property on the Properties window and click the small button that appears. Visual C# .NET then displays the ColumnHeader Collection Editor window. Click Add to create a new header and change its Text property to **Name** and its Width property to **120**. Click Add once more to create a second column, and change its Text property to **State**.

By the way

I haven't told you to change the names of the columns in this example because you're not going to be referencing them by name.

Click OK to save your column settings and close the window. Your list view should now have two named columns (see [Figure 8.5](#)).

Figure 8.5. Use List Views to present multicolumn lists.

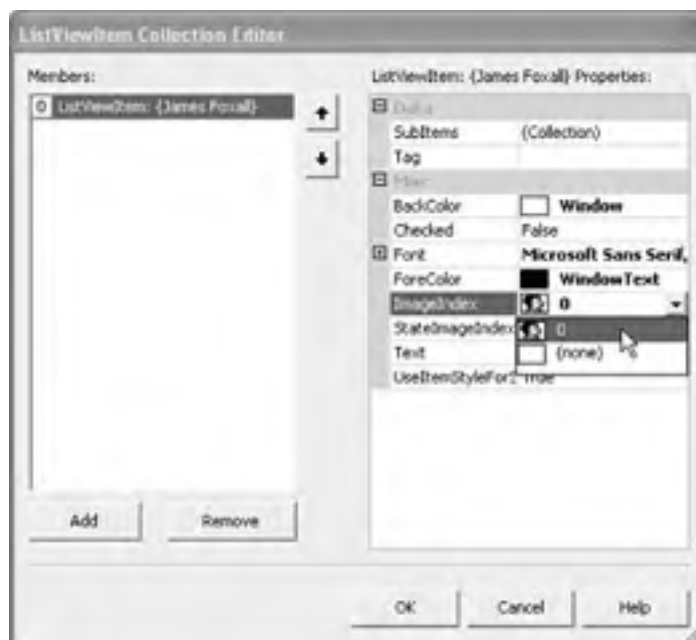


Adding List Items

Complete the following steps to add two items to the list view:

1. Click the Items property in the Properties window and then click the small button that appears, which displays the ListViewItem Collection Editor dialog box.
2. Click Add to create a new item, and change the item's Text property to **James Foxall**.
3. Next, open the drop-down list for the ImageIndex property. Notice how the list contains the picture in the linked Image List control (see [Figure 8.6](#)). Select the image.

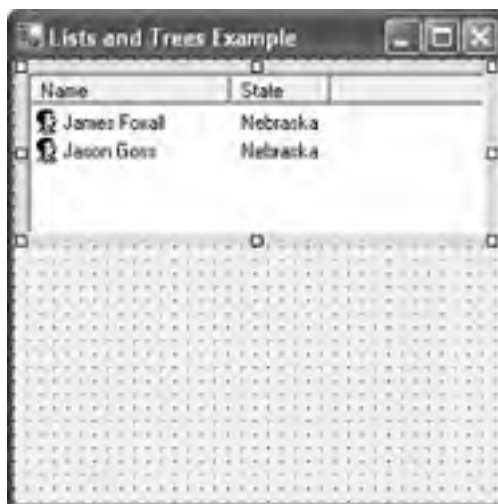
Figure 8.6. Pictures from a linked Image List are readily available to the control.



4. The Text property of an item determines the text displayed for the item in the List View. If the View property is set to Details and multiple columns have been defined, the value of the Text property appears in the first column. Subsequent column values are determined by the SubItems collection.
5. Click the SubItems property and then click the small button that appears, which displays the ListViewSubItem Collection Editor. The item that appears in the list refers to the text of the item itself, which you don't want to change.
6. Click Add to create a new subitem and change its text to **Nebraska**.

7. Click OK to return to the ListViewItem Collection Editor.
8. Click the Add button to create another item. This time, change the Text property to your name and use the techniques you just learned to add a subitem. For the Text property of the subitem, enter your state of residence. Go ahead and give it an image just as you did for my name.
9. When you're finished, click OK to close the ListViewItem Collection Editor. Your List View should now contain two list items (see [Figure 8.7](#)).

Figure 8.7. List views offer much more functionality than a standard list box.



10. Next, experiment with the View property of the List View control to see how the various settings affect the appearance of the control. The Large Icons setting doesn't display an icon, because you didn't link an Image List control to the LargeImageList property of the List View. Be sure to set the View property back to Details before continuing.
11. Press F5 to run the project and try selecting your name by clicking your state. You can't. The default behavior of the List View is to consider only the clicking of the first column as selecting an item.
12. Stop the project and change the FullRowSelect property to True; then run the project once more.
13. Click your state again, and this time your name becomes selected (actually, the entire row becomes selected). Personally, I prefer to set up all my List Views with FullRowSelect set to True, but this is just a personal preference. Stop the project now and save your work.

Manipulating a List View Using Code

You've just learned the basics of working with a List View control. Even though you performed all the steps for this example in Design view, you'll probably manipulate your list items using code because you won't necessarily know ahead of time what to display in the list. Next, you'll learn how to work with the List View in code.

Adding List Items Using Code

Adding an item using code is very simple—if the item you're adding is simple. To add an item to your list view, you use the Add method of the Items collection, like this:

```
lstMyListView.Items.Add("Bob Benzel");
```

If the item is to have a picture, you can specify the index of the picture as a second parameter, like this:

```
lstMyListView.Items.Add("Jim White",0);
```

If the item has subitems, things get more complicated. The Add method enables you to specify only the text and image index. To access the additional properties of a list item, you need to get a reference to the item in code. Remember that new items have only one subitem by default; you have to create additional items. The Add method of the Items collection returns a reference to the newly added item. Knowing this, you can create a new variable to hold a reference to the item, create the item, and manipulate anything you choose to about the item using the variable (see [Hour 11](#),

"Using Constants, Data Types, Variables, and Arrays," for information about using variables). The following code creates a new item and appends a subitem to its SubItems collection:

```
ListViewItem objListItem;  
objListItem = lstMyListView.Items.Add("Yvette Webster", 0);  
objListItem.SubItems.Add("Tennessee");
```

Determining the Selected Item in Code

The List View control has a collection that contains a reference to each selected item in the control: the SelectedItems collection. If the MultiSelect property of the List View is set to True (as it is by default), the user can select multiple items by holding down the Ctrl or Shift keys when clicking items. This is why the List View supports a SelectedItems collection rather than a SelectedItem property. To gather information about a selected item, you refer to it by its index. For example, to print the text of the first selected item (or the only selected item if just one is selected), you could use code like this:

```
if (lstMyListView.SelectedItems.Count > 0)  
System.Diagnostics.Debug.WriteLine(lstMyListView.SelectedItems[0].Text);
```

The reason you check the Count property of the SelectedItems collection is that if no items are selected, a runtime exception would occur if you attempted to reference element 0 in the SelectedItems collection.

Removing List Items Using Code

To remove a list item, use the Remove method of the Items collection. The Remove Item method accepts and expects a reference to a list item. To remove the currently selected item, for example, you could use a statement such as

```
lstMyListView.Items.Remove(lstMyListView.SelectedItems[0]);
```

or

```
lstMyListView.Items.RemoveAt (0);
```

Again, you'd want to make sure that an item is actually selected before using this statement.

Removing All List Items

If you're filling a List View using code, you'll probably want to clear the contents of the List View first. That way, if the code to fill the List View is called a second time, duplicate entries won't be created. To clear the contents of a List View, use the Clear method of the Items collection, like this:

```
lstMyListView.Items.Clear ();
```

The List View control is an amazingly versatile tool. As a matter of fact, I rarely use the standard ListBox now; I prefer to use the List View because of its added functionality—such as displaying an image for an item. I've barely scratched the surface here, but you now know enough to begin using this awesome tool in your own development.

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Creating Hierarchical Lists with the Tree View

The Tree View control is used to present hierarchical data. Perhaps the most commonly used Tree View control is found in Explorer, where you can use the Tree View to navigate the folders and drives on your computer. The Tree View is perfect for displaying hierarchical data, such as a departmental display of employees. In this section, I'll teach you the basics of the Tree View control so that you can use this powerful interface element in your applications.

The Tree View's items are contained in a Nodes collection, in much the same way that items in a List View are stored in an Items collection. To add items to the tree, you append them to the Nodes collection. As you can probably see by now, after you understand the basics of objects and collections, you can apply that knowledge to almost everything in C#. For instance, the skills you learned in working with the Items collection of the List View control are similar to the skills needed for working with the Nodes collection of the Tree View control. In fact, these concepts are very similar to working with list boxes and combo boxes.

Add a Tree View control to your form now by double-clicking the TreeView item in the toolbox. Set the Tree View control's properties as follows:

Property	Value
Name	twvLanguages
ImageList	imgMyImages
Location	8,128
Size	275,97

Adding Nodes to a Tree View

Working with nodes at design time is very similar to working with a List View's Items collection. So, I'll show you how to work with nodes in code. To add a node, you call the Add method of the Nodes collection (which you'll do in this example). Follow these steps to programmatically add a node:

1. Add a new button to your form and set its properties as follows:

Property	Value
Name	btnAddNode
Location	8,240
Size	75,23
Text	Add Node

2. Double-click the button to access its Click event, and enter the following code:

```
twvLanguages.Nodes.Add("Monte Sothman");  
twvLanguages.Nodes.Add("Visual C# .NET");
```

3. Press F5 to run the project, and then click the button. Two nodes will appear in the tree, one for each Add method call (see [Figure 8.8](#)).

Figure 8.8. Nodes are the items that appear in a tree.





Notice how both nodes appear at the same level in the hierarchy; neither node is a parent or child of the other. If all your nodes are going to be at the same level in the hierarchy, you should consider using a List View control instead because what you're creating is simply a list.

Stop the project and return to the button's **Click** event. Any given node can be both a parent to other nodes and a child of a single node (the parent node of any given node can be referenced via the **Parent** property of a node). For this to work, each node has its own **Nodes** collection. This can be confusing, but if you realize that child nodes belong to the parent node, it starts to make sense (it can still be confusing in practice, though).

You're now going to create a new button that adds the same two nodes as before but makes the second node a child of the first. Return to the design view of the form and then create a new button and set its properties as shown:

Property	Value
Name	btnCreateChild
Location	96,240
Size	80,23
Text	Create Child

Double-click the new button to access its **Click** event and add the following code:

```
TreeNode objNode;  
objNode = tvwLanguages.Nodes.Add("Monte Sothman");  
objNode.Nodes.Add("Visual C# .NET");
```

This code is similar to what you created in the List View example. The **Add** method of the **Nodes** collection returns a reference to the newly created node. Thus, this code creates a variable of type **TreeNode** (variables are discussed in detail in [Hour 11](#)), creates a new node whose reference is placed in the variable, and then adds a new node to the **Nodes** collection of the first node.

To see the effect that this has, press **F5** to run the project and click the new button. You'll see a single item in the list, with a plus sign to the left of it. This plus sign indicates that child nodes exist. Click the plus sign, and the node is expanded to show its children (see [Figure 8.9](#)).

Figure 8.9. You can create as deep a hierarchy as you need using the Tree View control.



This example is a simple one—a single parent node having a single child node. However, the principles used here are the same as those used to build complex trees with dozens or hundreds of nodes.

Removing Nodes

To remove a node, you call the Remove method of the Nodes collection. The Remove method accepts and expects a valid node, so you must know which node to remove. Again, the Nodes collection works very much like the Items collection in the List View control, so the same ideas apply. For example, the currently selected node is returned in the SelectedNode property of the Tree View control. So, to remove the currently selected node, you could use this statement:

```
twLanguages.Nodes.Remove(twLanguages.SelectedNode);
```

If this statement were called when no node is selected, an error would occur. In [Hour 11](#), you'll learn all about data types and equalities, but here's a preview: If an object variable doesn't reference an object, it's equivalent to the C# keyword null. Knowing this, you could validate whether an item is selected with a little bit of logic using code like the following (note that the two equal signs, rather than the intuitive one equal sign, are used to compare equalities):

```
if (!(twLanguages.SelectedNode == null))  
twLanguages.Nodes.Remove(twLanguages.SelectedNode);
```



Removing a parent node causes all its children to be removed as well.

Clearing All Nodes

To clear all nodes in a Tree View, invoke the Clear method of the Nodes collection, like this:

```
twLanguages.Nodes.Clear();
```

As with the List View, I've only scratched the surface of the Tree View. Spend some time becoming familiar with the basics of the Tree View, as I've shown here, and then dig a bit deeper to discover the not-so-obvious power and flexibility of this control.

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Summary

Visual C# .NET includes a number of controls that go beyond the standard functionality of the traditional controls discussed in [Hour 7](#). In this hour, I discussed the most commonly used advanced controls. You learned how to use the Timer control to trigger events at predetermined intervals. You also learned how to use the Tab control to create the tabbed dialog boxes with which you're so familiar.

Also in this hour, you learned how to add pictures to an Image List control so that other controls can use them. The Image List makes it easy to share pictures among many controls, making it a very useful tool. Finally, you learned the basics of the List View and Tree View controls—two controls you can use to build high-end interfaces that present structured data. The more time you spend with all these controls, the better you'll become at creating great interfaces.

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Q&A

Q1: *What if I need a lot of timers, but I'm concerned about system resources?*

A1: When possible, use a single timer for multiple duties. This is extremely easy when two events occur at the same interval—why bother creating a second timer? When two events occur at different intervals, you can use some decision skills along with static variables (discussed in [Hour 11](#)) to share Timer events.

Q2: *What else can I do with an Image List control?*

A2: You can assign a unique picture to a node in a Tree View control when the node is selected. You can also display an image in the tab of a tab page in a Tab control. There are a lot of uses, and as you learn more about advanced controls, you'll see additional opportunities for using images from an Image List.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** What increment of time is applied to the Interval property of the Timer control?
- 2:** What collection is used to add new tabs to a Tab control?
- 3:** What property returns the index of the currently selected tab?
- 4:** True or False: You should use different Image List controls for storing images of different sizes.
- 5:** To see columns in a List View control, the View property must be set to what?
- 6:** The additional columns of data that can be attached to an item in a list view are stored in what collection?
- 7:** What property of what object would you use to determine how many items are in a List View?
- 8:** Each item in a Tree View is called what?
- 9:** How do you make a node the child of another node?

Exercises

- 1:** Add a second Image List control to your project with the List View. Place an icon (32x32 pixels) in this Image List, and link the Image List to the LargeImageList property of the List View control. Change the View property to Large Icons. Does the icon appear next to a list item? If not, is there a property of an item you can set so that it does?
- 2:** Create a new project and add a List View, a button, and a text box to the default form. Create a new item in the List View control using the text entered into the text box when the button is clicked.

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Hour 9. Adding Menus and Toolbars to Forms

The use of a Graphical User Interface (GUI) for interacting with and navigating programs is one of the greatest features of Windows. Despite this, a fair number of Windows users still rely primarily on the keyboard, preferring to use a mouse only when absolutely necessary. Data-entry people in particular never take their hands off the keyboard. Many software companies receive support calls from angry customers because a commonly used function is accessible only by using a mouse. Menus are the easiest way to navigate your program for a user who relies on the keyboard, and Visual Studio and Visual C# .NET make it easier than ever to create menus for your applications. In this hour, you'll learn how to build, manipulate, and program menus on a form. In addition, I'll teach you how to use the Toolbar control to create attractive and functional toolbars. Finally, you'll learn how to "finish off" a form with a status bar.

The highlights of this hour include the following:

- Adding, moving, and deleting menu items
- Creating checked menu items
- Programming menus
- Implementing context menus
- Assigning shortcut keys
- Creating toolbar items
- Defining toggle buttons and separators
- Creating a status bar

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Building Menus

When I said that Visual C# .NET makes building menus easier than ever, I wasn't kidding. Building menus is now an immediately gratifying process. I can't stress enough how important it is to have good menus, and now that it's so easy to do, there is no excuse for not putting menus in an application.

Did you Know?

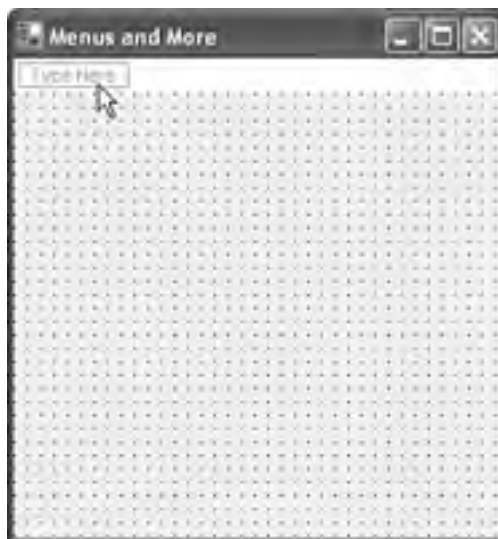
When running an application for the first time, users will often scan the menus before opening a manual. (Most users never open the manual!) When you provide comprehensive menus, you make your program easier to learn and use.

Adding Menu Items

Adding menus to a form is accomplished by way of a control: the Main Menu control. The Main Menu control is a bit odd in that it's the only control I know of (besides the context menu control discussed later in this hour) that sits at the bottom of the form in the space reserved for controls without an interface (like a Timer control), yet actually has a visible interface on the form. Start by creating a new Windows Application project named **Menus and More**, and then follow these steps:

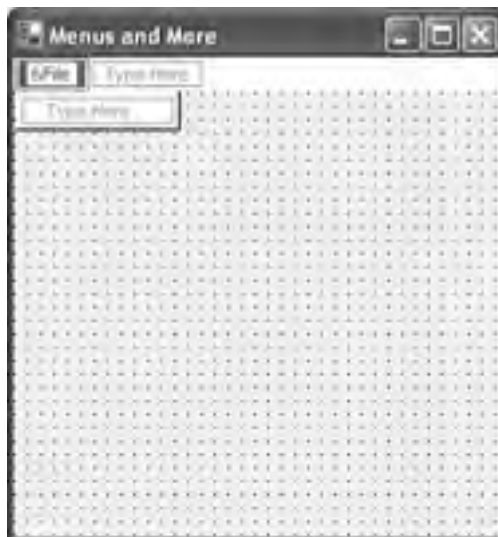
1. Change the name of the default form to **fclsMenusAndMore**, and set its Text property to **Menus and More**.
2. Change the Main entry point of the project to reference **fclsMenusAndMore** instead of Form1.
3. Next, add a new Main Menu control to your form by double-clicking the MainMenu item in the toolbox. (Don't worry about changing its name at this time because you won't be referencing it in code.) As you can see, the control is added to the pane at the bottom of the form designer. Take a look at the top of the form—you'll see the text Type Here (see [Figure 9.1](#)).

Figure 9.1. A menu has no items when first added to a form.



4. Click this text and type **&File**. As you begin typing, Visual C# .NET displays two new boxes that say Type Here (see [Figure 9.2](#)).

Figure 9.2. Creating a menu item automatically prepares the control for more items.



Take a look at the Properties window (if it's not visible, press F4 to show it). The text you just entered created a new menu item. Each menu item is an object; therefore, the item has properties. (You may have to press Tab to commit your entry and then click the text you typed once more to see its properties.) MenuItem1 isn't very descriptive, so change the name of the item to **mnuFileMenu**. Notice that you're naming the File item you just created, not changing the name of the Main Menu control.

By the Way

You might be wondering why I had you enter the ampersand (&) in front of the word "File." Take a look at your menu now, and you'll see that Visual C# .NET doesn't display the ampersand; instead, it displays the text with the F underlined, as in File. The ampersand, when used in the Text property of a menu item, tells Visual C# .NET to underline the character immediately following it. For top-level menu items, such as the File item you just created, this underlined character is known as an *accelerator key*. Holding down Alt and pressing an accelerator key opens the menu as if the user had clicked it. You should avoid assigning the same accelerator key to more than one top-level menu item on a given menu. When the menu item appears on a drop-down menu (as opposed to being a top-level item), the underlined character is called a *hotkey*. When a menu is visible (open), the user can press a hotkey to trigger the corresponding menu item the same as if it were clicked. Again, don't use the same hotkey for more than one item on the same menu.

5. Click the Type Here text that appears to the immediate right of the File item and enter the text **&Help**. Visual C# .NET gives you two more Type Here items—the same as when you entered the File item. Adding new menu items is a matter of clicking a Type Here box and entering the text for an item.
6. Press Tab to commit your entry and then click the text you typed once more to select it. Change the name of your new menu item in the Properties window to **mnuHelpMenu**.

By the Way

If you click a Type Here box *below* an existing menu item, you'll add a new item to the same menu as the item above the box. If you click the Type Here box to the right of a menu item, you'll create a submenu using the menu to the left of the box as the entry point for the submenu. As you've already seen, clicking the Type Here box along the top of the menu bar creates a top-level menu.

7. Click once more on the File item to display a Type Here box below it. Click this Type Here box and enter the text **&Quit**.
8. Press Tab to commit your entry and then click the new item once more to select it. Change the name of the new item to **mnuQuit**. Now is a good time to save your work, so click Save All on the toolbar.

Moving and Deleting Menu Items

Deleting and moving menu items are even easier processes than adding new items. To delete a menu item, you would right-click it and choose Delete from the context menu that appears. To move an item, you would drag it from its current location and drop it in the location in which you want it placed.

Creating Checked Menu Items

A menu item that isn't used to open a submenu can display a check mark next to its text. Check marks are used to create menu items that have state—the item is either selected or it isn't. You're now going to create a checked menu item. Click the Type Here box below the Quit menu item and enter **Ask Before Closing**. Then change the name of this new item (remember to press Tab to commit your entry and then click the item again to select it) to **mnuAskBeforeClosing**. Next, change the Checked property of the new item to true. Notice that the menu item now has a check mark next to it (see [Figure 9.3](#)).

Figure 9.3. Menu items can be used to indicate state.



Press F5 to run the project. The menu will appear on your form, just as you designed it (see [Figure 9.4](#)). Click the File menu to open it and then click Quit; nothing happens. In fact, the checked state of your menu item doesn't even change. In the next section, I'll show you how to add code to menu items to make them actually do something (as well as change their checked state). Stop the project before continuing.

Figure 9.4. What you see (at design time) is what you get (at runtime).



Programming Menus

As I've said before, every menu item is a unique object—that's why you were able to change the name for each item you created. Although individual menu items aren't controls as such, adding code behind them is very similar to adding code behind a control. You're now going to add code to the Quit and Ask Before Closing menu items.

Follow these steps to create the exit code:

1. Click the File menu now to open it.
2. Double-click the Quit menu item. Just as when you double-click a control, Visual C# .NET displays the code editor with the default event for the menu item you've clicked. For menu items, this is the Click event.
3. Enter the following code:

```
this.Close();
```

As you know by now, this code closes the current form. This has the effect of stopping the project because this is the only form and it's designated as the Main entry point object.

4. Switch back to the form designer (click the Form1.cs [Design] tab).

You're now going to create the code for the Ask Before Closing menu item. This code will invert the Checked property of the menu item; if `Checked = True`, it will be set to false and vice versa.

1. Double-click the Ask Before Closing item to access its Click event, and enter the following code:

```
mnuAskBeforeClosing.Checked = (!mnuAskBeforeClosing.Checked);
```

The logical negation operator (!) is used to perform a negation of a Boolean (true or false) value. Don't worry; I discuss this in detail in [Hour 12](#), "Performing Arithmetic, String Manipulation, and Date/Time Adjustments." For now, realize that if the current value of the Checked property is true, (!Checked) returns false. If Checked is currently false, (!Checked) returns true. Therefore, the checked value will toggle between true and false each time the menu item is clicked.

2. Press F5 to run the project. Open the File menu by pressing Alt+F (remember, the F is the accelerator key).
3. Next, click the Ask Before Closing button—it becomes unchecked. Click the menu item once more and it becomes checked again.
4. Click it a third time to remove the check mark, and then click Quit to close the form.

Did you notice that you weren't asked whether you really wanted to quit? That's because the quit code hasn't been written to consider the checked state of the Ask Before Closing button.

Follow these steps to ensure the user gets prompted accordingly:

1. Return to the Click event of the Quit button and change its code to look like this:

```
if (mnuAskBeforeClosing.Checked)
{
    if (MessageBox.Show("Do you really wish to exit?",
        "Quit Verification", MessageBoxButtons.YesNo) == DialogResult.No)
        return;
}
this.Close();
```

Now when the user selects the Quit button, Visual C# .NET considers the checked state of the Ask Before Closing menu item. If the item is checked, Visual C# .NET asks users whether they really want to exit. If a user chooses No, the procedure quits and the form doesn't unload. This code may be a bit foreign to you now, but you'll learn the ins and outs of making decisions (executing code based on conditions) and message boxes in later hours.

2. Press F5 to run the project. Open the File menu, click the Ask Before Closing item to toggle its state. Make sure it's selected when you're done, and then click Quit.
3. This time, Visual C# .NET asks you to confirm your intentions rather than immediately closing the form. Go ahead and close the form, and then click Save All on the toolbar to save your work.

Did you Know?

When designing your menus, look at some of the many popular Windows applications available and consider the similarities and differences between their menus and yours. Although your application may be quite unique and therefore may have very different menus from other applications, similarities probably exist as well. When possible, make menu items in your application follow the same structure and design as similar items in the popular programs. This will shorten the learning curve of your application, reduce user frustration, and save you time.

Implementing Context Menus

Context menus are the pop-up menus that appear when you right-click an object on a form. Context menus get their name from the fact that they display context-sensitive choices—menu items that relate directly to the object that's right-clicked. Most Visual C# .NET controls have a default context menu (also called a *shortcut menu*), but you can assign custom context menus if you want. Add a new text box to the form and set its properties as follows:

Property	Value
Name	txtMyTextbox
Location	96,122
Size	100,20
Text	(make blank)

Press F5 to run the project, and then right-click the text box to display its context menu (see [Figure 9.5](#)). This menu is the default context menu for the **Text Box** control; it's functional but limited. Stop the project now and return to Design view.

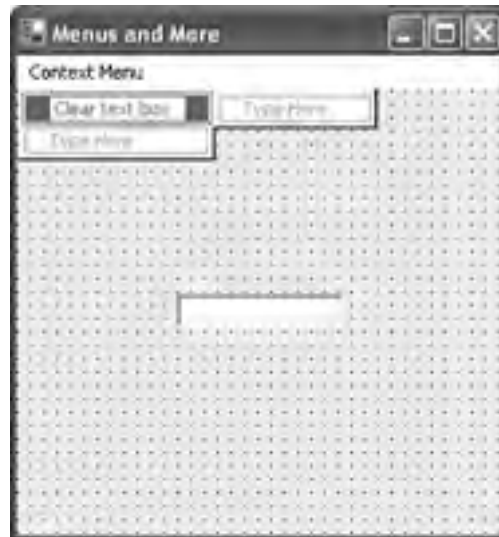
Figure 9.5. Most items have a default context menu.



Creating context menus is very much like creating regular menus. Context menus, however, are created using a different control: the Context Menu control. Follow these steps to implement a custom context menu in your project:

1. Add a new context menu to the form by double-clicking the ContextMenu item in the toolbox. Like the Main Menu control, the Context Menu control is placed in the pane below the form designer. When the control is selected, a Context Menu item appears at the top of the form. Change its name to **mnuContext**.
2. Clicking the Context Menu box at the top of the form opens the context menu itself, which is empty by default. Click the Type Here box and enter the text **Clear text box** (see [Figure 9.6](#)). You've just created a context menu with a single menu item.

Figure 9.6. Context menus are edited much like regular menus.



3. Change the name of the new menu item to **mnuClearTextbox**, and then double-click the item to access its Click event.

Enter the following code:

```
txtMyTextbox.Text = "";
```

4. Linking a control to a context menu is accomplished by setting a property. Display the form designer once more, and then click the Text Box control to select it and display its properties in the Properties window.
5. Change the ContextMenu property of the text box to **mnuContextMenu**; the context menu is now linked to the text box. Press F5 to run the project.
6. Enter some text into the text box and then right-click the text box; your custom context menu appears in place of the default context menu.
7. Choose Clear Text Box from the context menu, and the contents of the text box will clear. Stop the project and save your work.

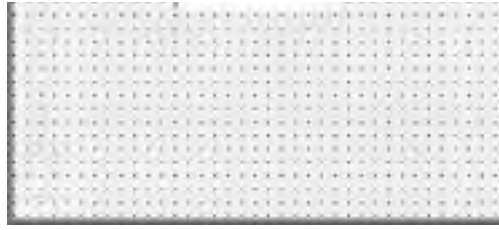
Assigning Shortcut Keys

If you've spent any time learning a Microsoft application, you've probably learned some keyboard shortcuts. For instance, pressing Ctrl+P in any application that prints has the same effect as opening the File menu and choosing Print. You can add the same type of shortcuts to your menus by following these steps:

1. Click the Main Menu control at the bottom of the form designer, click File on its menu, and then click Quit to select the Quit menu item.
2. Next, click the Shortcut property in the Properties window and then click the down arrow that appears. This list contains all the shortcut keys that can be assigned to a menu item.
3. Locate and select Ctrl+Q (for Quit) in the list (see [Figure 9.7](#)).

Figure 9.7. A shortcut key is assigned using the Shortcut property of a menu item.





4. Press F5 to run the project once more. Next, press Ctrl+Q, and the application will behave just as though you opened the File menu and clicked the Quit item.

**Did you
Know?**

Although it's not always possible, try to assign logical shortcut key combinations. The meaning of F6 is hardly intuitive, for example. But, when assigning modifiers such as Ctrl with another character, you have some flexibility. For instance, the key combination of Ctrl+Q might be a more intuitive shortcut key for Quit than Ctrl+T.

Using the Toolbar Control

Generally speaking, when a program has a menu (as most programs should), it should also have a toolbar. Toolbars are one of the easiest ways for a user to access program functions. Unlike menu items, toolbar items are always visible and therefore are immediately available. In addition, toolbar items have ToolTips, which enable a user to discover a toolbar button's purpose simply by hovering the pointer over the button.

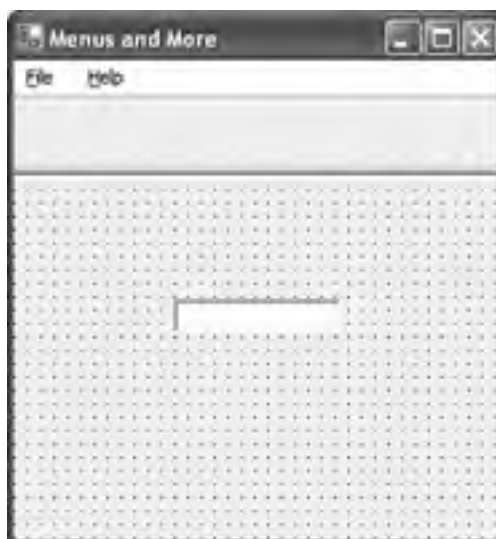
Toolbar items are really shortcuts for menu items; every item on a toolbar should have a corresponding menu item. Remember that some users prefer to use the keyboard, in which case they need to have keyboard access to functions via menus.

The actual items you place on a toolbar depend on the features supported by the application. However, the mechanics of creating toolbars and toolbar items are the same, regardless of the buttons you choose to use. Toolbars are created using the Toolbar control.

Follow these steps to create a toolbar on your form:

1. Add a new Toolbar control to your form now by double-clicking the ToolBar item in the toolbox. A new toolbar is then added to the top of your form (see [Figure 9.8](#)). Change the name of the toolbar to **tbrMainToolbar**.

Figure 9.8. New toolbars default to the top of the form and have no buttons.



Every toolbar you've used displays pictures on buttons. The Toolbar control gets the pictures for its buttons from an Image List control.

2. Go ahead and add an Image List control to the form now and change its name to **imgMyPictures**.
3. Add a new 16x16 pixel bitmap to the Images collection of the Image List control. You can use a picture you created or use one from the samples I've made available on the Web site.
4. When you're finished adding the new button, close the Image Collection Editor and select the Toolbar control on the form.
5. Set the ImageList property of the toolbar to use the image list you've just created.

Adding Toolbar Buttons Using the Buttons Collection

Like many other controls you've already learned about, the Toolbar control supports a special collection: the Buttons collection. The Buttons collection contains the buttons that appear on the toolbar (ooh, tricky). Click the Buttons property in the Properties window and then click the small button that appears; the ToolbarButton Collection Editor displays. The list of button members is empty because new toolbars have no buttons. Click Add to create a new button, and set its properties as follows:

Property	Value
Name	tbbQuit

ImageIndex	0
Text	Quit
ToolTipText	Quit this application

Click OK to close the ToolbarButton Collection Editor. Your new button is now visible on the toolbar. As you can see, text appears below the picture in the button, but this is *not* how most toolbars appear. Not a problem—access the Buttons collection once more and clear the Text property of the button.

Programming Toolbars

Unlike menus, where each menu item receives its own Click event, the Toolbar control has one common Click event that fires when the user clicks any button on the toolbar. Double-click the Toolbar control on the form to access the toolbar's ButtonClick event (close the button editor first if it's open). Enter the following code:

```
if (e.Button == tbbQuit)
    this.Close();
```



In a nontrivial program, the ideal way to set this up would be to create a method that is called both by the Click event of the menu item and by clicking the equivalent toolbar button. This reduces duplication of code and eliminates bugs (the Quit button doesn't honor the Ask Before Closing option in this example, even though the menu item does).

The Button property of the `e` object is an object property that holds a reference to the button that's clicked. (The `e` object is discussed in detail in [Hour 10](#), "Creating and Calling Methods.") This code uses an `if` statement to determine whether the clicked button is the Quit button. If the Quit button was clicked, the form closes. (Decision-making constructs such as `if` and `switch` statements are discussed in [Hour 13](#), "Making Decisions in Visual C# Code.")

Go ahead and press F5 and run your project. Clicking the Close button should then close your application.

Creating Toggle Buttons

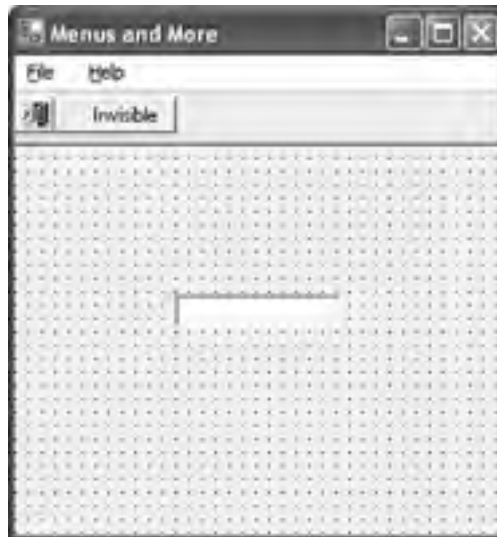
The button that you've created for your toolbar is a standard pushbutton. When the user clicks it with the mouse, the button will appear to be pressed while the user holds down the mouse button and will return to a normal state when the user releases the mouse button. Although this is the style you'll use for most of your toolbar buttons, the Toolbar control supports other styles as well. One such style is the toggle button. A toggle button, much like the check mark of a menu item, is used to denote state. When a toggle button is clicked, it appears in a pressed state and stays that way until clicked again, in which case it returns to its normal appearance. Microsoft Word has a number of such buttons. The paragraph alignment buttons, for example, are all toggle buttons—the button that corresponds to the current paragraph's alignment appears pressed.

Add a new button to your toolbar now and set its properties as follows:

Property	Value
Name	tbbInvisible
Text	Invisible
Style	ToggleButton

Next, click OK to close the editor and the new button will appear on the toolbar. Take note that you didn't have to designate a picture for the toolbar item (but you usually should). Because you don't want the toolbar's height to be larger than necessary, change the TextAlign property of the Toolbar control to Right. Your toolbar should now look like the one in [Figure 9.9](#).

Figure 9.9. Toolbar items can display a picture, text, or a combination of both.



Again, double-click the toolbar to access its `ButtonClick` event. Now that there are two buttons, the simple `if` statement is no longer suited to determining the button pushed. Change the code in your procedure to match the following:

```
if (e.Button == tbbQuit)
    this.Close();
else if (e.Button == tbbInvisible)
    txtMyTextbox.Visible = !(tbbInvisible.Pushed);
```

This code is a bit more complex than the previous code. The `else if` statement is evaluated if the first `if` statement is false, in this case, only if `e.Button` is not the *Quit* button. The new statement that you're interested in at the moment is the one in which the `Visible` property of the text box is set. Remember, the logical negation operator (`!`) negates a value. Therefore, this statement sets the `Visible` property of the text box to the negation of the pushed state of the `tbbInvisible` button. In other words, when the button is pushed, the text box is hidden, and when the button is not pushed (depressed), the text box is visible.

Follow these steps to test the project:

1. Press F5 to run the project now and notice that the text box is visible.
2. Click the Invisible button on the toolbar and note that its appearance changes to a pushed state and the text box becomes hidden (see [Figure 9.10](#)).

Figure 9.10. Toggle-style buttons appear "pressed" when clicked.



3. Click the button again to return the button's state to normal, and the text box reappears.

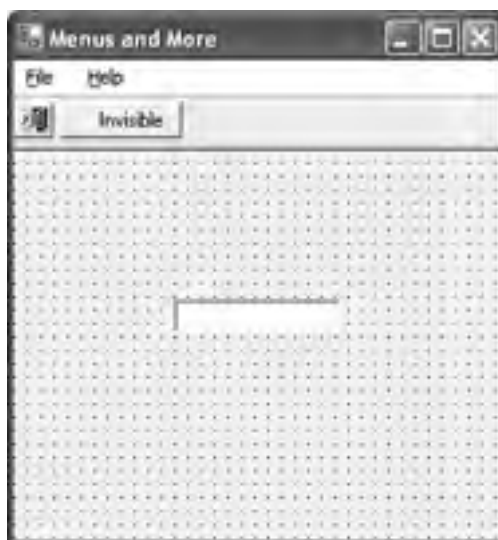
When you're finished, stop the project and save your work.

Creating Separators

As you add more and more buttons to a toolbar, it becomes evident that you need a way to logically group them. Placing related buttons next to one another is a great start toward building a good toolbar. However, a toolbar may be a bit difficult to use even if its buttons are placed in a logical order, unless the buttons are separated into groups. Placing a space between sets of related buttons creates button groups. You're now going to add a separator space to your toolbar.

Add a new button to your toolbar using the Buttons collection in the Properties window. Change its name to **tbbSeparator1** and change its Style to **Separator**. When you change the Style property of the button to Separator, it disappears from the toolbar (or at least it seems to). When a button is designated as a separator, it's simply an empty placeholder used to create a space between two buttons. Because this separator is at the end row of buttons, you can't see it. Move it to the second position by selecting it in the ToolBarButton Collection Editor and clicking the up arrow that appears to the right of the Members list; this arrow and the one below it are used to move a button up or down in the list. Click OK to save your changes and your toolbar will now have a space between the two buttons (see [Figure 9.11](#)).

Figure 9.11. Separators are used to create spaces between groups of buttons.



Creating Drop-Down Menus for Toolbar Buttons

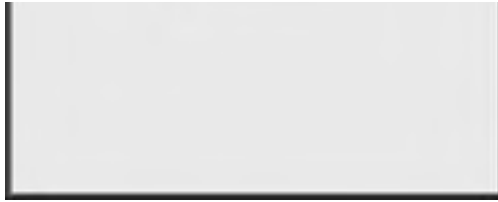
You need to be familiar with one last type of toolbar button. Follow these steps:

1. Create a new button using the Buttons collection in the Properties window and set its name to **tbbDropdown**.
2. Set the button's Style property to **DropDownButton**.
3. Finally, set the DropDownMenu property to **mnuContext** and click OK to commit your changes.

Notice how the button has a drop-down arrow on it. Press F5 to run the project and click the drop-down arrow; the menu that you designated in the DropDownMenu property appears (see [Figure 9.12](#)). As you can see, the DropDownMenu property makes it easy to integrate drop-down menus with your toolbars.

Figure 9.12. Toolbar buttons can be used to display drop-down menus.





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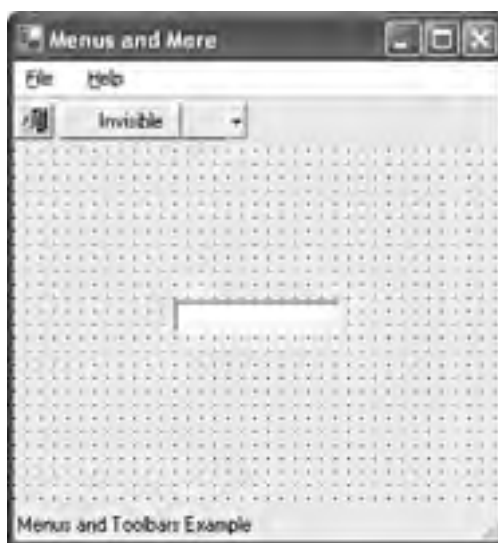
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Creating a Status Bar

The last control I'm going to show you is the Status Bar control. The status bar isn't nearly as fancy, or even as useful, as other controls, such as the Toolbar or the Main Menu (but it's also not as difficult to work with). Nevertheless, a status bar adds value to an application in that it makes available information, and users have come to expect it. In its simplest form, a status bar displays a text caption and sizing grip—the three diagonal lines to the right of the control that the user can drag with the mouse to change the size of the form.

Add a new status bar to the form now by double-clicking the StatusBar item in the toolbox. Change the name of the status bar to **sbrMyStatusBar**. The Text property determines the text displayed in the left side of the status bar. Notice that the Text is set to the default name of the control. Change the Text property to **Menus and Toolbars Example**, and notice how the text in the status bar changes (see [Figure 9.13](#)).

Figure 9.13. Status bars dress up a form.



If a form's border is sizable, the user can click and drag the sizing grip at the right side of the status bar to change the size of the form. The status bar isn't smart enough to realize when a form's border can't be resized; you'll have to change the SizingGrip property of the status bar to False to hide the grip.

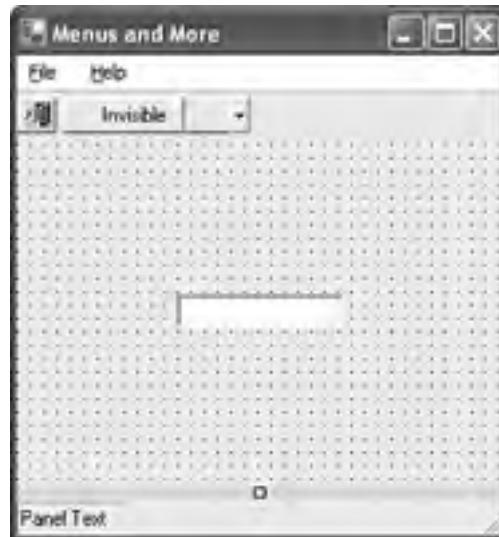
The default behavior of the status bar is quite simple, consisting of text and a sizing grip. However, you can create more complex status bars using this control.

The Status Bar control contains a Panels collection. To see how a panel works, follow these steps:

1. Select the Panels property in the Properties window and click the small button that appears.
2. On the StatusBarPanel Collection Editor, click Add to create a new panel and set the Text of the panel to **Panel Text**.
3. Set the AutoSize property to **Contents**, and click OK to save your changes.

Nothing looks different, right? This is because one last thing is required to display the status bar panels. Change the ShowPanels property of the status bar to True now, and the status bar will display its panel (see [Figure 9.14](#)). You can add multiple panels to a Status Bar control and even tailor the appearance of each panel by changing the border style or displaying an image from a linked Image List control.

Figure 9.14. Status bars can display custom panels.



The Status Bar is such a simple control that you might overlook using it. However, I encourage you to use it when appropriate.

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Summary

Menus, toolbars, and status bars add tremendous value to an application by greatly enhancing its usability. In this hour, you learned how to use the Main Menu control to build comprehensive menus for your applications. You learned how to add, move, and delete menu items and how to define accelerator and shortcut keys to facilitate better navigation via the keyboard. You also saw how toolbars provide shortcuts for accessing common menu items. You learned how to use the Toolbar control to create functional toolbars complete with bitmaps, drop-downs, and logical groupings. Finally, you discovered how to use a status bar to "dress up" the application. Implementing these items is an important part of the interface design process for an application, and you now have the skills necessary to start putting them into your own programs.

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Q&A

Q1: *I have a number of forms with nearly identical menus. Do I really need to take the time to create menus for all these forms?*

A1: Not as much as you think. Create a Main Menu control that has the common items on it, and then copy and paste the control to other forms. You can then build on this menu structure, saving you a lot of time.

Q2: *I've seen applications that allow the end user to customize the menus and toolbars. Can I do that with the Visual C# .NET menus and toolbars?*

A2: No. To accomplish this behavior, you'll have to purchase a third-party component.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** True or False: Form menu bars are created using the Context Menu control.
- 2:** To create an accelerator or hotkey, preface the character with a(n):
- 3:** If you've designed a menu using a Main Menu control, but that menu isn't visible on the form designer, how do you make it appear?
- 4:** To place a check mark next to a menu item, you set what property of the item?
- 5:** How do you add code to a menu item?
- 6:** Toolbar items are part of what collection?
- 7:** To create a separator on a toolbar, you create a new button and set what property?
- 8:** True or False: Every button on a toolbar has its own Click event.
- 9:** What must you do to have panels appear on a status bar?

Exercises

- 1:** Modify the code you created for the toolbar that closes the form to take into consideration the checked status of the Ask Before Closing menu item.
- 2:** Implement a toggle button that works just like the Ask Before Closing menu item.

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Hour 10. Creating and Calling Methods

If you've been reading this book from the beginning, you've now spent about nine hours building the basic skills necessary to navigate Visual C# .NET and to create an application interface. Creating a good interface is extremely important, but it's only one step toward creating a Windows program. After you've created the basic interface of an application, you need to enable the program to do something. The program may perform an action all on its own, or it may perform actions based on a user interacting with the interface—either way, you write Visual C# .NET code to make your application perform tasks. In this hour, you'll learn how to create sets of code (called classes), and how to create and call isolated code routines (called methods).

The highlights of this hour include the following:

- Creating static class members
- Creating methods
- Calling methods
- Exiting methods
- Passing parameters
- Avoiding recursive methods
- Working with tasks

Creating Class Members

A *class* is a place to store the code you write. Before you can begin writing Visual C# .NET code, you must start with a class. As mentioned in previous hours, a class is used as a template to create an object (which may have properties and/or methods). Properties and methods of classes can be either instance members or static members. *Instance members* are associated with an instance of a class—an object created from a class using the keyword `new`. On the other hand, *static members* belong to the class as a whole, not to a specific instance of a class. You've already worked with one class using instance members to create a form (refer to [Hour 5](#), "Building Forms: The Basics," for more information). When you double-click an object on a form, you access events that reside in the form's class module.

Other languages, such as Visual Basic, differentiate between class methods and public methods that are globally available outside of a class. Visual C# .NET requires all methods to exist in the context of a class, but a globally available method can be achieved by defining *static* methods in your class. Static methods are always available regardless of whether an instance of the class exists. In fact, you can't access a static member through an instance of a class, and attempting to do so results in an exception (error).

By the Way

Classes are used as templates for the instantiation of objects. I discuss the specifics of creating objects in [Hour 16](#), "Designing Objects Using Classes." Most of the techniques discussed in this hour apply to class modules with instance members (methods that are part of an instantiated object), but I'm going to focus this discussion on static members because they're easier to use (you can create and use static methods without getting into the complications of creating objects).

Although you could place all your program's code into a single class module, it's best to create different modules to group related sets of code. In addition, it's best not to place code that isn't specifically related to a form within a form's class module; place such code in the logical class or, preferably, in a specialized class module.

By the Way

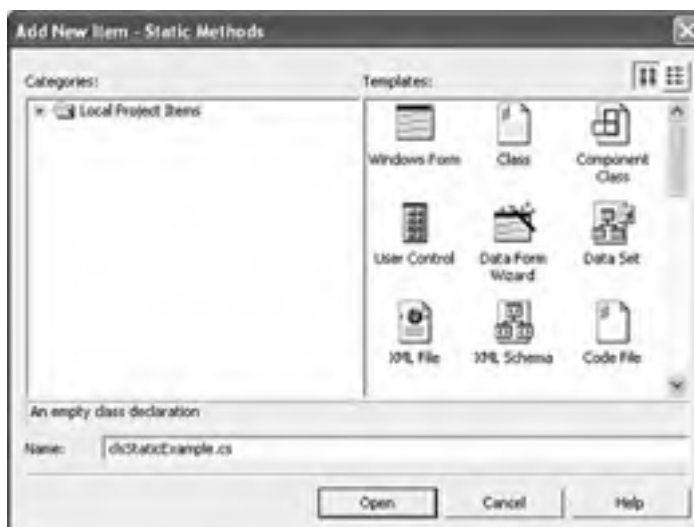
The current development trend centers on object-oriented programming, which revolves around class modules. I'll give you a primer on object-oriented programming in [Hour 16](#), but this is a very advanced topic so I won't be covering it in detail. I highly recommend that you read a book dedicated to the topic of object-oriented programming, such as *Sams Teach Yourself Object-Oriented Programming in 21 Days*, after you are comfortable with the material in this book.

One general rule for using static members is that you should create classes to group related sets of code. This is not to say you should create dozens of classes. Rather, group related methods into a reasonably sized set of classes. For instance, you might want to create one class that contains all your printing routines and another that holds your data-access routines. In addition, I like to create a general-purpose class in which to place all the various routines that don't necessarily fit into a more specialized class.

Start Visual C# .NET now, create a new Windows Application project named **Static Methods**, and then follow these steps:

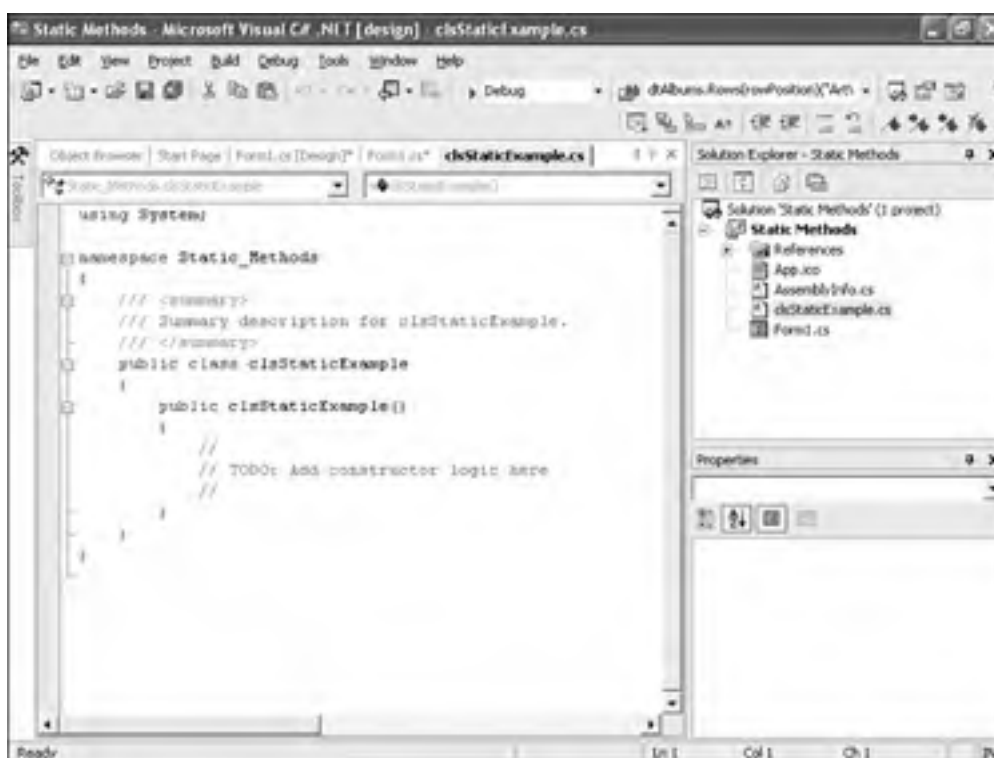
1. Change the name of the default form to **fcIsExample**, set its Text property to **Method Example**.
2. Set the Main() entry point of the project to reference **fcIsExample** instead of Form1.
3. Change the Size property of the form to **371, 300**.
4. Add a new class to the project by choosing Project, Add Class. Visual C# .NET then displays the Add New Item dialog box, as shown in [Figure 10.1](#).

Figure 10.1. All new project items are added using this dialog box.



Note that this is the same dialog box used to add new forms. Change the name of the class to **clsStaticExample.cs** and click Open. Visual C# .NET then creates the new class and positions you in the code window—ready to enter code (see [Figure 10.2](#)).

Figure 10.2. Classes have no graphical interface, so you always work with them in the code editor.



Save your project now by clicking Save All on the toolbar.

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Defining and Writing Methods

After you've created the class(es) in which to store your code, you can begin writing methods. A **method** is a discrete set of code that can be executed. Methods are much like events, but rather than being executed by a user interacting with a form or control, methods are executed when called by a code statement.

The first thing to keep in mind is that every method should perform a specific function, and it should do it very well; you should avoid creating methods that perform many tasks. As an example of the use of methods, consider that you want to create a set of code that, when called, draws an ellipse on a form. So, you create a method that clears the surface and draws the ellipse. Now, say you need to draw an ellipse on a surface that already has things drawn on it. If you called your method, it would clear the existing drawing before drawing the ellipse. If you put the clearing and the drawing into separate methods, you'd be able to use the drawing method in more places without fear of clearing something that shouldn't be cleared. By placing these routines in a class rather than attaching them to a specific form, you also make the methods available to any form that may need them.

There are two types of methods in Visual C# .NET, including

- Methods that return a value
- Methods that do not return a value (void)

There are many reasons to create a method that returns a value. For example, a method can return **true** or **false**, depending on whether it was successful in completing its task. You could also write a method that accepts certain *parameters* (data passed to the method, in contrast to data returned by the method) and returns a value based on those parameters. For example, you could write a method that lets you pass it a sentence, and in return it passes back the number of characters in the sentence. The possibilities are limited only by your imagination. Just keep in mind that a method doesn't have to return a value.

Declaring Methods That Don't Return Values

Because you've already created a class, you're ready to create methods (to create a method, you first declare it within a class).

Position the cursor to the right of the closed brace (}) that signifies the end of the public clsStaticExample block, and press Enter to create a new line. Enter the following three statements:

```
public static void DrawEllipse(System.Windows.Forms.Form frm)
{
}
```

Next, position your cursor to the right of the open brace ({) and press Enter to create a new line between the two braces. This is where you'll place the code for the method.

The declaration of a method (the statement used to define a method) has a number of parts. The first word, **public**, is a keyword (a word with a special meaning in Visual C# .NET). The keyword **public** defines the scope of this method, designating that the method can be called from code contained in modules other than the one containing the defined method (scope is discussed in detail in the next hour). You can use the keyword **private** in place of **public** to restrict access of the method to code that resides only in the module in which the method resides.

The word **static** is another Visual C# .NET keyword. As mentioned earlier, **static** members belong to a class as a whole, not to a specific instance of a class. This will allow the `DrawEllipse()` method to be accessed from other classes without having to instantiate a `clsStaticExample` object.

The word **void** is another Visual C# .NET keyword. The **void** keyword is used to declare a method that doesn't return a value. Later in this hour, you will learn how to create methods that do return values.

The third word, `DrawEllipse`, is the name of the method and can be any string of text you want it to be. Note, however, that you can't assign a name that is a keyword, nor can you use spaces within a name. In this example, the method is going to draw an ellipse on the form, so you use the name `DrawEllipse`. You should always give method names that reflect their purpose. You can have two methods with the same name only if they have different scope (discussed in the next hour).

Did you Know?

Some programmers prefer the readability of spaces in names, but in many instances, such as when naming a method, spaces can't be used. A common technique is to use an underscore (_) in place of a space, such as in `Draw_Ellipse`; but I recommend that you just use mixed case, as you have in this example.

Immediately following the name of the method is a set of parentheses surrounding some text. Within these parentheses you can define parameters—data to be passed to the method by the calling program. In this example, you've created a parameter that accepts a reference to a form. The routine will draw an ellipse on whatever form is passed to the parameter.



Parentheses must always be supplied, even when a procedure doesn't accept any parameters (in which case nothing is placed between the parentheses). In fact, the required parentheses help you determine whether a statement is a property or a method.

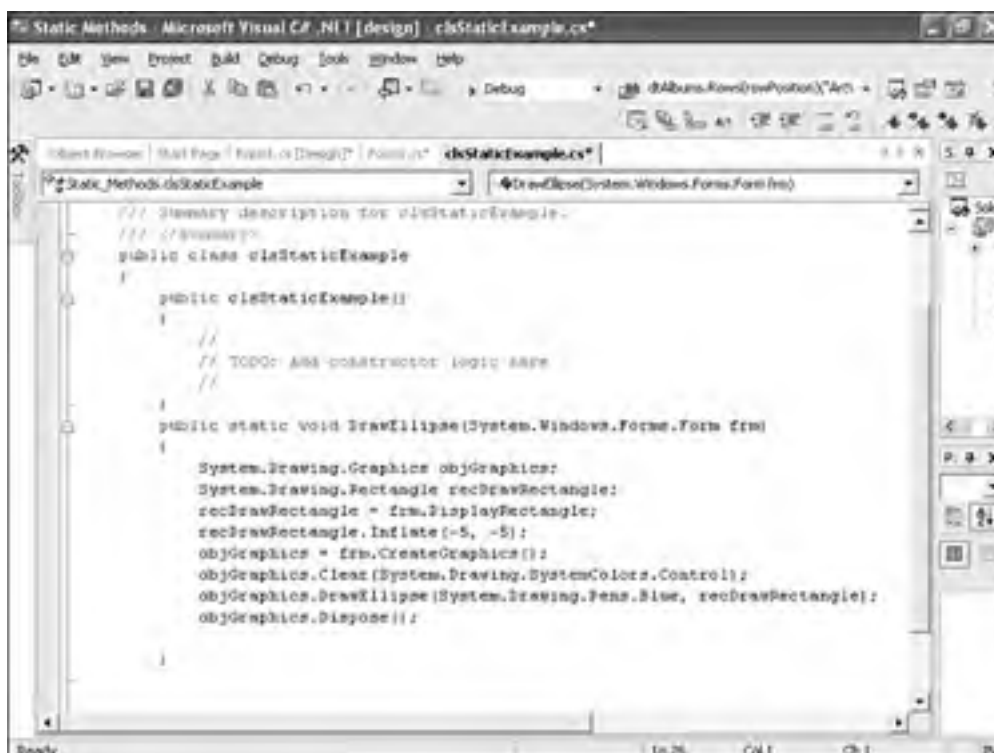
Add the following code to your DrawEllipse method:

```
System.Drawing.Graphics objGraphics;  
System.Drawing.Rectangle recDrawRectangle;  
recDrawRectangle = frm.DisplayRectangle;  
recDrawRectangle.Inflate(-5, -5);  
objGraphics = frm.CreateGraphics();  
objGraphics.Clear(System.Drawing.SystemColors.Control);  
objGraphics.DrawEllipse(System.Drawing.Pens.Blue, recDrawRectangle);  
objGraphics.Dispose();
```

Much of this code is similar to a code example discussed in [Hour 3](#), "Understanding Objects and Collections," so I'm not going to go over it in detail here. Basically, this routine creates a rectangle with the same dimensions as the client rectangle of the supplied form. Then, the Inflate method is used to reduce the size of the rectangle by five pixels in each dimension. Finally, a graphics object is created and set to reference the client area of the supplied form, and a rectangle is drawn within the boundaries of the rectangle. In [Hour 18](#), "Working with Graphics," you'll learn the details of code you're entering here.

When you've finished entering your code, it should look like that in [Figure 10.3](#).

Figure 10.3. All code for a method must reside between the open and close braces of the method.



Now you're going to create a procedure that erases the ellipse from a form. Place the caret (cursor) at the end of the closing brace (}) for the DrawEllipse() method and press Enter to create a new line. Enter the following three statements:

```
public static void ClearEllipse(System.Windows.Forms.Form frm)
{
}
```

Add the following line of code to the ClearEllipse() method on a new line between the opening and closing braces:

```
frm.Refresh();
```

This single line of code forces the designated form to refresh itself. Because the ellipse that was drawn by the first procedure isn't part of the form (it was simply drawn onto the form), the ellipse is effectively erased.

Declaring Methods That Return Values

The two methods you've created so far don't return values. You're now going to declare a method that returns a value. Here's the general syntax for the method you will create:

```
[modifiers] datatype MethodName(parameters)
```

You'll notice one key difference between declaring a method that doesn't return a value and declaring one that does: You have to define the data type of the value returned. Previously, you used the keyword void to declare that no value was being returned. Data types are discussed in detail in the next hour, so it's not important that you fully understand them now. It is important, however, that you understand what is happening.

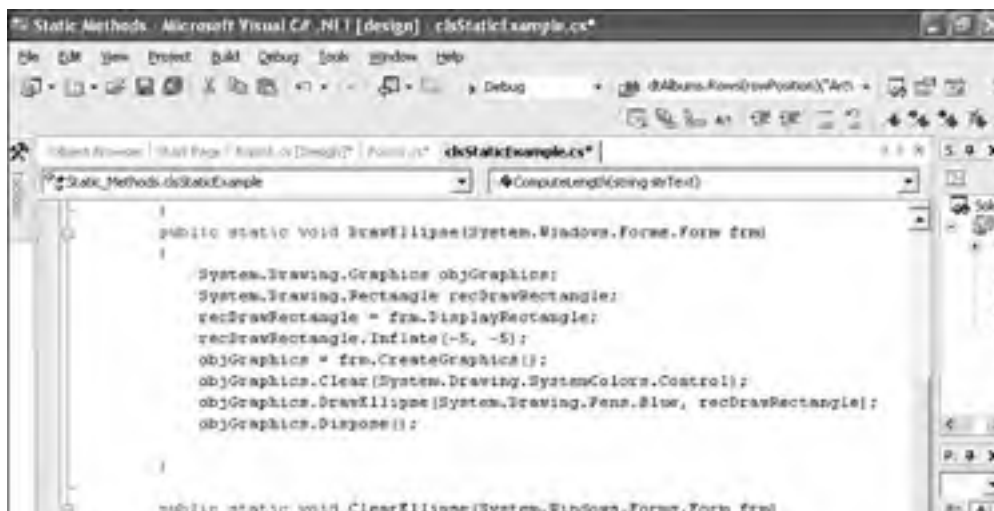
The data type entered before the method name denotes the type of data returned by the method. The method that you're about to enter returns a numeric value of type integer. If the method were to return a string of text, it would be declared as string. It is very important that you declare the proper data type for your functions.

Position the cursor to the right of the closing brace for the ClearEllipse() method, press Enter to create a new line, and enter the following statements:

```
public static int ComputeLength(string strText)
{
    return strText.Length;
}
```

When you create a method that returns a value, you use the Visual C# .NET keyword *return* to return whatever value you want the method to return. In this example, you're using the built-in Length() method of the string class to determine the number of characters within the string that are passed to the method. This value is returned as the value of the method. (You could avoid writing the function altogether and just use the String.Length() method in the calling code, but this makes a good example.) Your methods should now look like the one in [Figure 10.4](#).

Figure 10.4. Classes often contain many methods.



```
frm.Refresh();  
  
public static int ComputeLength(ref string strText)  
{  
    return strText.Length;  
}
```

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Creating the User Interface of Your Project

Now that you've written all of the procedures for this example, you need to create the interface for the project. Click the Form1.cs [Design] tab in the IDE to display the form designer for the default form.

You'll need three buttons on this form—one to call each of your methods. Add the first button to the form by double-clicking the Button icon in the toolbox, and then set its properties as follows:

Property	Value
Name	btnDrawEllipse
Location	0,0
Size	80,23
Text	Draw Ellipse

Add a second button to the form and set its properties as follows:

Property	Value
Name	btnClearEllipse
Location	283,0
Size	80,23
Text	Clear Ellipse

Finally, add the third button to the form and set its properties as follows:

Property	Value
Name	btnComputeLength
Location	0,240
Size	100,23
Text	Compute Length

The last control you need to add to your form is a text box. When the user clicks the Compute Length button, the button's Click event will call the ComputeLength function, passing it the text entered into the text box. It will then display the length of the text in the Output window (this works only when running in the IDE, not when compiled as an application).



The Output window is a Visual Studio .NET design window to which you can print text. I use the Output window a lot in examples throughout the remaining hours. You display the Output window by choosing View, Other Windows and then selecting Output. Be aware that the Output window is not available to a compiled component.

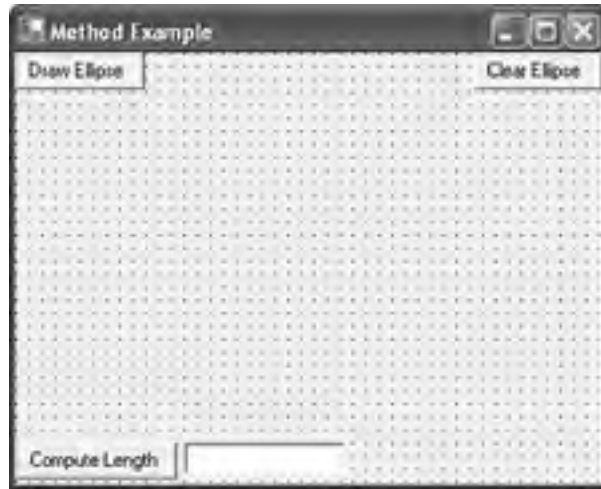
Add a text box to the form by double-clicking the Textbox icon in the toolbox. Set the new text box's properties as follows:

Property	Value
Name	txtInputForLength
Location	104,240
Text	(make blank)

Your form should now look like the one shown in [Figure 10.5](#). You're now ready to write the Visual C# .NET code to call

your methods.

Figure 10.5. This form is not all that attractive, but it's functional enough for our purposes.



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Calling Methods

Calling a method is fairly simple. However, just as methods that return values are declared differently from methods that don't, calling these two types of methods differs as well. You're first going to write code to call the two methods you declared as (methods that don't return values). Double-click the Draw Ellipse button to access its Click event and take a look at the event declaration:

```
private void btnDrawEllipse_Click(object sender, System.EventArgs e)
{
}
```

As you might have noticed, event handlers are methods. The only real difference is that event methods are called automatically in response to the user doing something, rather than being called by code you write. In this case, the `btnDrawEllipse_Click()` is called when the user clicks the `btnDrawEllipse` button. This method is declared as private, so only methods within this module can call this method (yes, you can call event methods). Add the following statement to this Click event:

```
clsStaticExample.DrawEllipse(this);
```

To call the `DrawEllipse` method, you must precede it with the name of the class in which it is defined. The method name and parentheses always come next. If the method expects one or more parameters, place them within the parentheses. In this `DrawEllipse()` procedure expects a reference to a form. By specifying the keyword `this`, you're passing a reference to the current form.

Did you Know?

When you type in the class name `clsStaticExample` followed by a period, Visual C# .NET displays the methods defined for the `clsStaticExample` class. Also, notice that when you type in the left parenthesis for the `DrawEllipse()` method, Visual C# .NET displays a ToolTip showing the parameters expected by the method (see [Figure 10.6](#)). It can be difficult to remember the parameters expected by all methods (not to mention the proper order in which to pass them), this little feature will save you a great deal of time and frustration.

Figure 10.6. Visual C# .NET displays the parameters expected of method.



You're now going to place a call to the `ClearEllipse()` method in the Click event of the Clear Ellipse button. Display the form view again and double-click the Clear Ellipse button to access its Click event. Add the following statement:

```
clsStaticExample.ClearEllipse(this);
```

All that's left to do is add code that computes the length of the string entered by the user. Do so by following these steps:

1. Display the form in Design view.
2. Double-click the Compute Length button to access its Click event and enter the following statements. (Recall from "Working with the Traditional Controls," that `System.Diagnostics.Debug.WriteLine()` sends text to the Output window.)

```
int intLength;  
intLength = clsStaticExample.ComputeLength(txtInputForLength.Text);  
System.Diagnostics.Debug.WriteLine("length = " + intLength);
```

The first line creates a new variable to hold the return value of the `ComputeLength()` method. The second statement calls `ComputeLength()` method. When calling a method that returns a value, think of the method in terms of the value it returns. For example, when you set a form's `Height` property, you set it with code like this:

```
MyForm.Height = 200;
```

This statement sets a form's height to 200. Suppose you had a method that returned a value that you wanted to use to set the form's `Height` property. Thinking of the method in terms of the value it returns, you could replace the literal value with a method call, as in the following:

```
MyForm.Height = MyClass.MyMethod();
```

Try to look at the statement you just entered using this way of thinking. When you do, you see that the statement in this example really says, "Set the variable `intLength` equal to the value returned by the method `ComputeLength()`." If `ComputeLength()` returns the value 20, for example, the line of code would behave as though it were written like this:

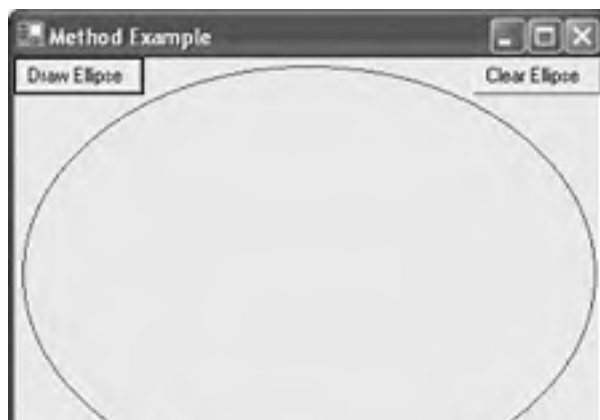
```
intLength = 20;
```

When calling methods, you must treat the method call the same as you would treat the literal value returned by the method. This often means placing a method call on the right side of an equal sign.

The last line of code you entered sends the result of the method call to the Output window in the IDE. The text "`length =`" and the value of `intLength` are concatenated (joined together), to produce one string of text that gets displayed. You'll learn about concatenation in [Hour 12](#), "Performing Arithmetic, String Manipulation, and Date/Time Adjustments."

The project is now complete. Click `Save All` on the toolbar to save your work, and then press `F5` to run the project. Click the `Clear Ellipse` button and an ellipse is drawn on the form (see [Figure 10.7](#)).

Figure 10.7. Clicking the button calls the method that draws the ellipse in the house Jack built.





Here's what is happening when you click the Draw Ellipse button:

1. The Draw Ellipse button's Click event is triggered.
2. The method call statement within the Click event is executed.
3. Code execution jumps to the DrawEllipse() method.
4. All code within the DrawEllipse() method gets executed.
5. Execution returns to the Click event.

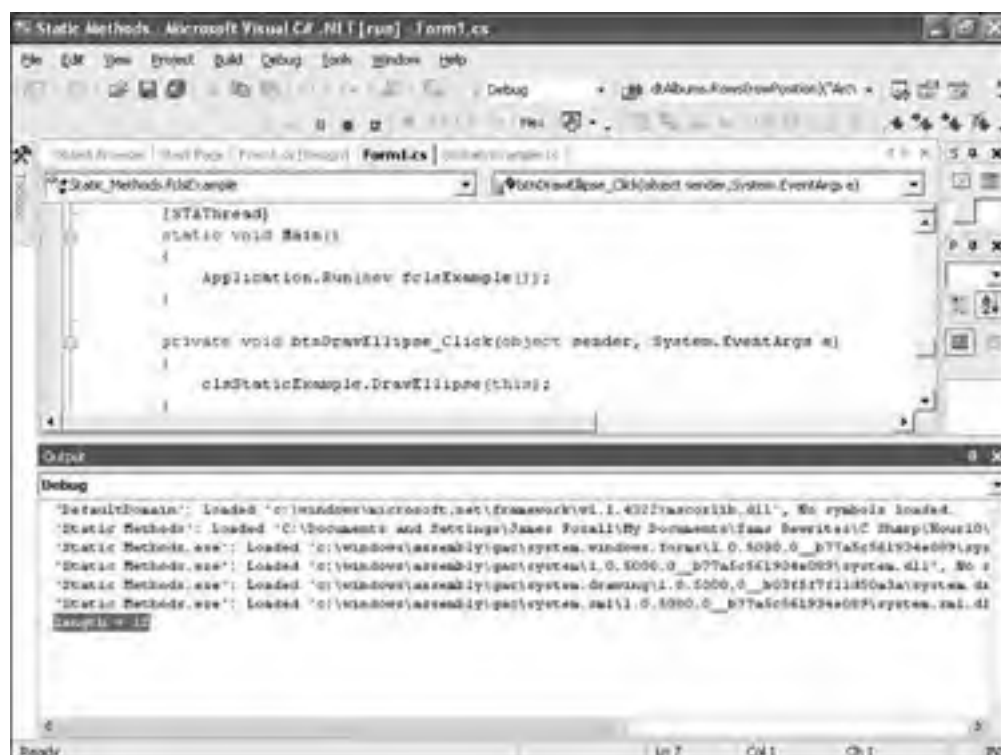
Click the Clear Ellipse button now to clear the form. When you click this button, the following occurs:

1. The Clear Ellipse button's Click event is triggered.
2. The method call statement within the Click event is executed.
3. Code execution jumps to the ClearEllipse() method.
4. All code within the ClearEllipse() method gets executed.
5. Execution returns to the Click event.

Finally, enter some text into the text box and click the Compute Length button. Here's what happens:

1. The Compute Length button's Click event is triggered.
2. The reference to the ComputeLength method causes code execution to jump to that method.
3. The ComputeLength() method determines the length of the string. This value is passed back as the result of the method.
4. Execution returns to the Click event.
5. The result of the method is placed in the variable intLength.
6. The rest of the code within the Click event executes. The final result is the length of the string, which is printed in the Output window (see [Figure 10.8](#)).

Figure 10.8. System.Diagnostics.Debug.WriteLine sends text to the Output window



Passing Parameters

Parameters are used within a method to allow the calling code to pass data into the method. You've already seen how parameters work—parameters are created within the parentheses of a method declaration. A parameter definition consists of the data type and a name for the parameter, as shown here:

```
public static void MyMethod(string strMyStringParameter)
```



After you've read about variables in [Hour 11](#), "Using Constants, Data Types, Variables, and Arrays," this structure will make a lot more sense. Here, I just want you to get the general idea of how to define and use parameters.

You can define multiple parameters for a method by separating them with a comma, like this:

```
public static void MyMethod(string strMyStringParameter,  
int intMyIntegerParameter)
```

A calling method passes data to the parameters by way of arguments. This is mostly a semantic issue; when defined in the declaration of a method, the item is called a **parameter**. When the item is part of the statement that calls the method, it's called an *argument*. Arguments are passed within parentheses—the same way in which parameters are defined. If a procedure has arguments, you separate them with commas. For example, you could pass values to the method just defined using a statement like this:

```
MyClass.MyProcedure("This is a string", 11);
```

The parameter acts like an ordinary variable within the method. Remember, variables are storage entities whose values can be changed. In the call statement shown previously, I sent literal values to the procedure. I could have also sent the values of variables like this:

```
MyClass.MyProcedure(strAString, intAnInteger);
```

An important thing to note about passing variables in Visual C# .NET is that parameters are passed by **value** rather than by **reference**. When passed by value, the method receives a copy of the data; changes to the parameter don't affect the value of the original variable. When passed by reference, the parameter actually references the original variable itself. Changes made to the parameter within the method propagate to the original variable. To pass a parameter by reference, you preface the parameter definition with the keyword `ref` as shown here:

```
public static void MyMethod(ref string strMyStringParameter,  
int intMyIntegerParameter)
```

Parameters defined without `ref` are passed by value; this is the default behavior of parameters in Visual C# .NET. Therefore, in the previous declaration, the first parameter is passed by reference, whereas the second parameter is passed by value.

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Exiting Methods

Ordinarily, code within a method executes from beginning to end—literally. However, when a return statement is reached, execution immediately returns to the statement that made the method call; you can force execution to leave the method at any time by using a return statement. If Visual C# .NET encounters a return statement, the method terminates immediately, and code returns to the statement that called the method.

Avoiding Infinite Recursion

It's possible to call methods in such a way that a continuous loop occurs. Consider the following procedures:

```
public static void DoSomething()  
{  
    DoSomethingElse();  
}  
public static void DoSomethingElse()  
{  
    DoSomething();  
}
```

Calling either of these methods produces an infinite loop of methods calls and results in the error shown in [Figure 10.9](#).

Figure 10.9. Infinite recursion results in a Stack Overflow Exception (error).



This endless loop is known as a **recursive** loop. Without getting too technical, Visual C# .NET allocates some memory for each method call in an area known as the stack. Only a finite amount of space is on the stack, so infinite recursion eventually uses all the available stack space and an exception occurs. This is a serious error, and steps should be taken to avoid such recursion.

Legitimate uses exist for recursion, most notably in the use of algorithms such as those used in calculus. Deliberate recursion techniques don't create infinite recursion, however; there is always a point where the recursion stops (hopefully, before the stack is consumed).



If you have an interest in such algorithms, you should consider reading a book dedicated to the subject.

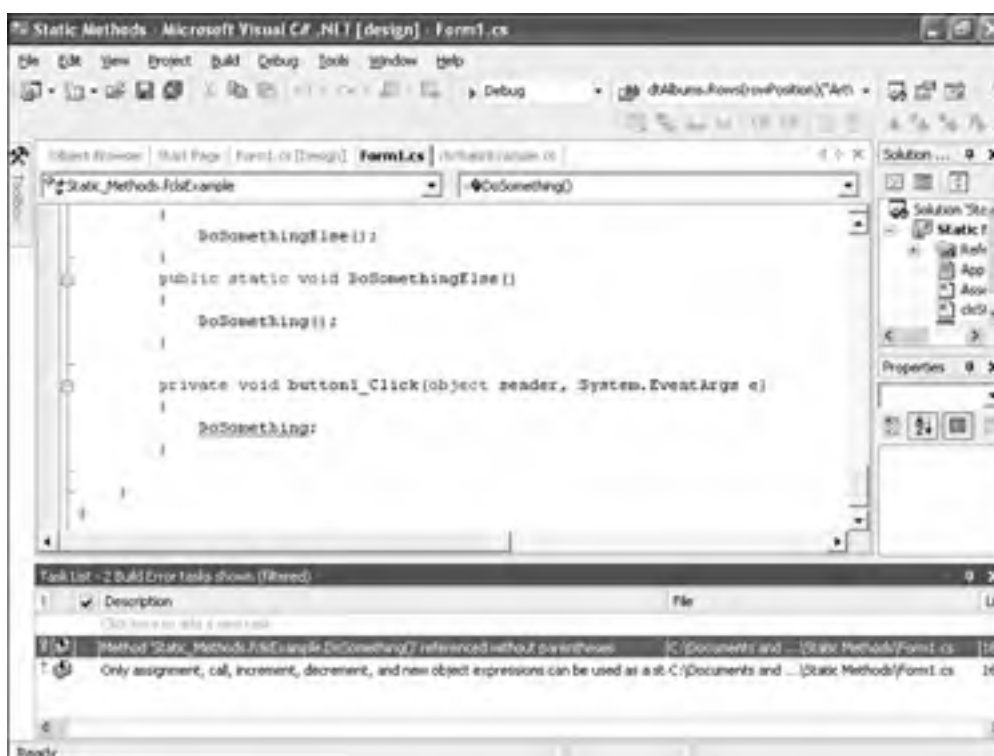
As you build your applications, you'll find that the number of methods and classes expands rather quickly. At times, you'll realize that a method isn't finished or that you had to use a "hack" (a less desirable solution) to solve a problem. You'll need an easy way to keep these things straight so that you can revisit the code as needed. You'll learn a powerful way to do this in the next section.

Working with Tasks

One of the most exciting IDE enhancements from previous versions of Visual Studio, in my opinion, is the new Task List. Tasks are really all about managing code. If your Task List window isn't displayed, show it now by choosing View, Show Tasks and then choosing All. Tasks are used to keep track of critical spots in code or things that need to be done. Visual C# .NET automatically creates some tasks for you, and you can create your own as needed.

One instance in which Visual C# .NET creates tasks is when your code has compile (build) errors. Because Visual C# .NET knows the exact error and the offending statement, it creates an appropriate task. [Figure 10.10](#) shows the Task List containing a build error. Notice how the task's description tells you the exact problem. Double-clicking a system-generated task takes you directly to the related statement (double-clicking a task that you created has a different effect, as discussed shortly). If the task exists in a class that isn't loaded, Visual C# .NET loads the class and then takes you to the statement. This greatly simplifies the process of addressing compile errors in code; you can simply work through the list of tasks rather than compile, fix an error, try compiling again, fix the next error, and so on.

Figure 10.10. Tasks help you keep track of critical spots in code.



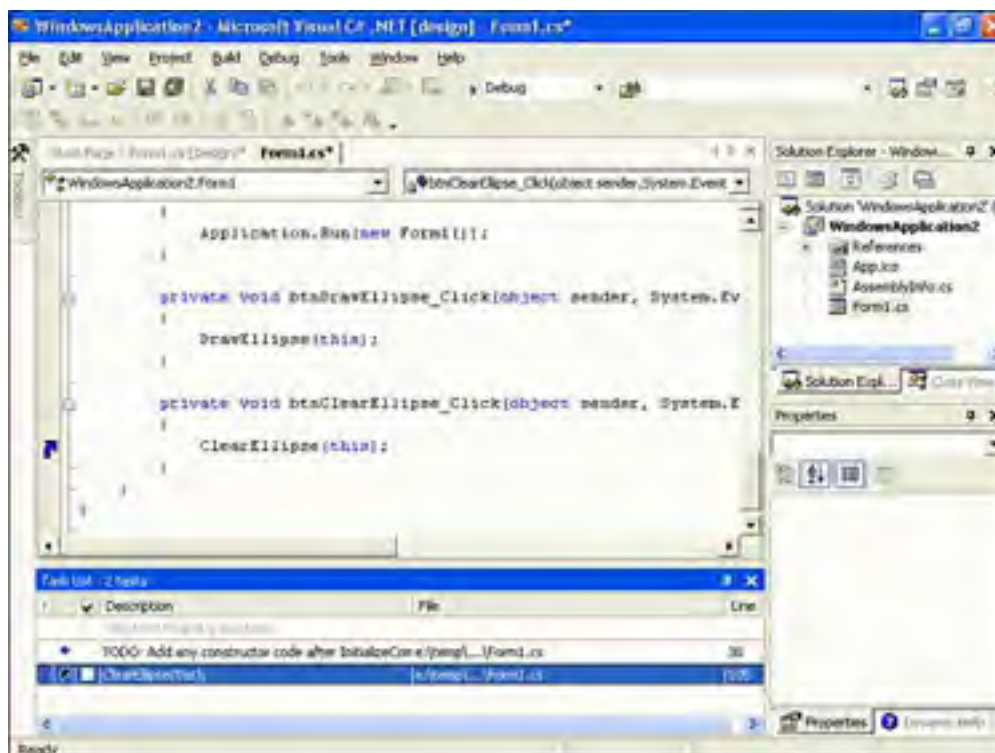
In addition to system-generated tasks, you can create your own tasks as often and wherever needed. In the past, it was common to place certain comments such as "TODO" in code as a reminder where you needed to come back and address something. When you wanted to address the issues, you had to perform a text search in your code. This was a highly inefficient process. Unfortunately, these comments were often missed or just plain forgotten.

Now you can create a task wherever you need to. Creating a task is easy. Ironically, the menu item used to create tasks has changed since the first edition of Visual C# .NET (it was easier to get to before). Now, to create a task for a specific code statement you follow these steps:

1. Click anywhere on the code statement so the insertion point is on the code line.
2. Open the Edit menu, and then open the Bookmarks submenu.
3. Choose Add Task List Shortcut from the Bookmarks submenu.

Visual C# .NET creates a task shortcut at the statement (as indicated by a blue arrow in the left margin of the code window) and adds the task to the Task List window. The default description for the next task is the actual code statement you flagged (see [Figure 10.11](#)). If you wanted to change this text, you could click the description in the Task List to put it in Edit mode and then change the text. If you wanted to go directly to the statement to which a task is attached, you would double-click the shortcut arrow next to the task in the Task List (the arrow is the same one that appears in the left margin of the code window).

Figure 10.11. Tasks make it easy to track issues that need to be addressed.



By the way

Another way to create a task is to insert a comment that literally starts with TODO:—Visual C# .NET will then automatically create a task using the comment.

You don't have to attach a task to a code statement. To create a task that isn't attached to code, click the first row of the Task List. The default text [Click here to add a new task](#) goes away, and you're free to enter the description for your new task.

To delete a task you created, click once on the task in the Task List to select it, and then right-click the task and choose Delete from the context menu. You can't delete a task that was created by Visual C# .NET as a result of a build error—you must correct the error to make the task go away.

Tasks are an incredibly simple, yet useful, tool. I highly encourage you to use them in your development.

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Summary

In this hour, you learned that a method is a discrete set of code designed to perform a task or related set of tasks. Methods are code structures you write Visual C# .NET code in. Some methods may be as short as a single line of code, whereas others will be pages in length. You learned how to define methods and how to call them; creating and calling methods is critical to your success in programming with Visual C# .NET. Because you use methods so often, they'll become second nature to you in no time. Be sure to avoid creating recursive methods, though!

Classes are used to group related methods. In this hour, I focused on the class module (which is little more than a container for methods) and static methods. Remember to group related methods in the same class and to give each class a descriptive name. In [Hour 16](#), you'll build on your experience with classes and methods and work with instance classes, which demand good segregation of discrete classes.

Finally, you learned about Visual Studio's new Task List feature. You now know that Visual C# .NET creates some tasks for you but that you are free to create tasks as you see fit. You learned how to easily jump to a statement that's related to a task and how to create tasks that aren't related to a specific code statement. The Task List is a powerful weapon to have in your development arsenal, and I encourage you to use it.

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Q&A

Q1: *Do I need to pay much attention to scope when defining my methods?*

A1: It may be tempting to create all your methods as public static, but this is bad coding practice for a number of reasons. For one thing, you will find that in larger projects, you'll have methods with the same name that do slightly different things. Usually, these routines are relevant only within a small scope. If the method isn't needed at the public level, don't define it for public access.

Q2: *What is a "reasonable" number of classes?*

A2: This is hard to say. There really is no right answer. Instead of worrying about an exact count, you should strive to make sure that your classes are logical and that they contain only appropriate methods and properties.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** What are the entities that are used to house methods called?
- 2:** True or False: To access methods in a class module, you must first create an object.
- 3:** Data that has been passed into a method by a calling statement is called a?
- 4:** To pass multiple arguments to a method, separate them with a?
- 5:** The situation in which a method or set of methods continue to call each other in a looping fashion is called?
- 6:** How do you attach a task to a code statement?

Exercises

- 1:** Create a method as part of a form that accepts one string and outputs a different string. Add code to the TextChanged event of a text box to call the procedure, passing the contents of the text box as the argument.
- 2:** Create a single method that calls itself. Call this method from the Click event of a button and observe the resulting error.

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Part III: Making Things Happen—Programming

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HOUR 12 [Performing Arithmetic, String Manipulation, and Date/Time Adjustments](#)

HOUR 13 [Making Decisions in Visual C# Code](#)

HOUR 14 [Looping for Efficiency](#)

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Hour 11. Using Constants, Data Types, Variables, and Arrays

As you write your Visual C# .NET methods, you'll regularly need to store and retrieve various pieces of information. In fact, I can't think of a single application I've written that didn't need to store and retrieve data in code. For example, you might want to keep track of how many times a method has been called, or you may want to store a property value and use it at a later time. Such data can be stored as **constants**, **variables**, or **arrays**. Constants are named values that you define once at design time and cannot be changed after that, but can be referenced as often as needed. Variables, on the other hand, are like storage bins; you can retrieve or replace the data in a variable as often as you need to. Arrays act like grouped variables, enabling you to store many values in a single array variable.

Whenever you define one of these storage entities, you have to decide the type of data it will contain. For example, is a new variable going to hold a string value (text) or perhaps a number? If it will hold a number, is the number a whole number, an integer, or something else entirely? After you determine the type of data to store, you must choose the level of visibility that the data has to other methods within the project (this visibility is known as **scope**). In this hour, you'll learn the ins and outs of Visual C# .NET's data types, how to create and use these "storage" mechanisms, and how to minimize problems in your code by reducing scope.

The highlights of this hour include the following:

- Understanding data types
- Determining data type
- Converting data to different data types
- Defining and using constants
- Dimensioning and referencing variables
- Working with arrays
- Determining scope
- Using a naming convention

By the Way

I cover a lot of important material in this hour, but you'll notice a lack of hands-on examples. You're going to use variables throughout the rest of this book, and you've already used them in earlier hours. I've used the space in this hour to teach you the meat of the subject; you'll get experience with the material in other hours.

Understanding Data Types

In any programming language, the compiler, the part of the Visual Studio .NET Framework that interprets the code you write into a language the computer can understand, must fully understand the type of data you're manipulating in code. For example, if you asked the compiler to add the following values, it would get confused:

```
659 / "Dog"
```

When the compiler gets confused, it either refuses to compile the code (which is the preferred situation because you can address the problem before your users run the application), or it halts execution and displays an exception (error) when it reaches the confusing line of code. (These two types of errors are discussed in detail in [Hour 15](#), "Debugging Your Code.") Obviously, you can't divide 659 by the word "Dog"; these two values are different types of data. In Visual C# .NET, these two values are said to have two different *data types*. In Visual C# .NET, constants, variables, and arrays must always be defined to hold a specific type of information.

Determining Data Type

Data typing—the act of defining a constant, a variable, or an array's data type—can be confusing. To Visual C# .NET, a number is not a number. A number that contains a decimal value is different from a number that doesn't. Visual C# .NET can perform arithmetic on numbers of different data types, but you can't store data of one type in a variable with an incompatible type. Because of this limitation, you must give careful consideration to the type of data you plan to store in a constant, a variable, or an array at the time you define it. Visual C# .NET supports two categories of data types: value types and reference types. The main difference between these two types is how their values are stored in memory. As you continue to create more complex applications, this difference may have an impact on your programming. For this book, however, this distinction is minimal. [Table 11.1](#) lists the Visual C# .NET data types and the range of values each one can contain.

Table 11.1. The Visual C# .NET Data Types

Data Type —Value	Value Range
bool	True or False
byte	0 to 255
char	A single character
decimal	+/-79,228,162,514,264,337,593,543,950, 335 with no decimal point; +- 7.9228162514264337593543950335 with 28 places to the right of the decimal; use this data type for currency values
double	-1.79769313486232E308 to -4.94065645841247E-324 for negative values; 4.94065645841247E-324 to 1.79769313486232E308 for positive values
float	-3.402823E38 to -1.401298E-45 for negative values; 1.401298E-45 to 3.402823E38 for positive values
int	-2,147,483,648 to 2,147,483,647
long	-9,223,372,036,854,775,808 to 9,223,372,036,854,775,807
sbyte	-128 to 127
short	-32,768 to 32,767
uint	Integers in the range from 0 to 4,294,967,295
ulong	Integers in the range from 0 to 10 ²⁰
ushort	Integers in the range from 0 to 65,535
Data Type — Reference	Value Range
string	0 to approximately 2 billion characters
object	Any type can be stored in a variable type Object

Visual C# .NET supports unsigned data types for short, int, and long (the types prefaced with u, such as uint). Because negative numbers are excluded (there is no sign), this has the effect of doubling the positive values for a short, an int, or a long. Signed data types are preferable and should be used unless you have a very good reason for doing otherwise (such as declaring a variable that will never hold a negative value).

Tips for Determining Data Type

The list of data types may seem daunting at first, but you can follow some general guidelines for choosing among them. As you become more familiar with the different types, you'll be able to fine-tune your data type selection.

Following are some helpful guidelines for using data types:

- If you want to store text, use the string data type. The string data type can be used to store any valid keyboard character, including numbers and nonalphabetic characters.
- To store only the values True or False, use the bool data type.
- If you want to store a number that contains no decimal places and is greater than -32,768 and smaller than 32,767, use the short data type.
- To store numbers with no decimal places but with values larger or smaller than short allows, use the int or long data types.
- If you need to store numbers that contain decimal places, use the float data type. The float data type should work for almost all your values containing decimals, unless you're writing incredibly complex mathematical applications or need to store very large numbers; in that case, use a double.
- If you need to store currency amounts, use the decimal data type.
- To store a single character, use the char data type.
- If you need to store a date and/or a time value, use the Date data type. When you use the Date data type, Visual C# .NET recognizes common date and time formats. For example, if you store the value 7/22/2001, Visual C# .NET doesn't treat it as a simple text string; it knows that the text represents July 22, 2001.

Casting Data from One Data Type to Another

Under some circumstances, Visual C# .NET won't allow you to move data of one type into a variable of another type. The process of changing a value's data type is known as **casting**. Visual C# .NET supports two types of casting: implicit and explicit. **Implicit** conversions are done automatically by the compiler. These conversions guarantee that no data is lost in the conversion. For instance, you can set the value of a variable declared as double to the value of a variable declared as float without an explicit cast because there is no risk of losing data; the double data type holds a more precise value than does a float, and this type of cast is called a *widening cast*.

Explicit casting is required when a potential exists for data loss or when converting a larger data type into a smaller data type (a narrowing cast). If you tried to place a value in a variable when the value was higher than the variable's supported data type, some data would be lost. Therefore, Visual C# .NET requires that these types of conversions be explicitly written using the cast operator. For instance, you can set the value of a variable declared as short to the value of a variable declared as integer using the following syntax:

```
short MyShortInteger;  
int MyInteger = 1000;  
MyShortInteger = (short) MyInteger;
```

Notice here that 1000 would fit in a short, so data wouldn't actually be lost if no explicit cast were performed. However, Visual C# .NET doesn't care; it's the *potential* for data loss that causes Visual C# .NET to require explicit casts.

[Table 11.2](#) lists some of the type conversions that can be done implicitly with no loss of information.

Table 11.2. Safe Conversions

Type	Can Be Safely Converted To
byte	char, short, int, long, float, double, decimal
short	int, long, float, double, decimal
int	long, float, double, decimal
long	float, double, decimal
float	double, decimal
double	decimal

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Defining and Using Constants

When you hard-code numbers in your code (such as in `intVotingAge = 19;`), a myriad of things can go wrong. Hard-coded numbers are generally referred to as "magic numbers" because they're often shrouded in mystery; the meaning of such a number is obscure because the digits themselves give no indication of what the number represents. Constants are used to eliminate the problems of magic numbers.

You define a constant as having a specific value at design time, and that value never changes throughout the life of your program. Constants offer the following benefits:

- **Elimination or reduction of data entry problems** It is much easier, for example, to remember to use a constant named `c_pi` than it is to enter 3.14159265358979 everywhere `pi` is needed. The compiler will catch misspelled or undeclared constants, but it doesn't care one bit what you enter as a literal value. (Incidentally, you can retrieve the value of `pi` using `System.Math.PI`, so you don't have to worry about creating your own constant!)
- **Code is easier to update** If you hard-coded a mortgage interest rate at 6.785, and rates were changed to 7.00, you would have to change every occurrence of 6.785 in code. In addition to the possibility of data entry problems, you'd run the risk of changing a value of 6.785 that had nothing to do with the interest rate—perhaps a value that represented a savings bond yield. With a constant, you change the value once at the constant declaration, and all code uses the new value.
- **Code is easier to read** Magic numbers are often anything but intuitive. Well-named constants, on the other hand, add clarity to code. For example, which of the following statements makes the most sense to you?

```
decInterestAmount = ((decLoanAmount * 0.075) * 12);
```

or

```
decInterestAmount = ((decLoanAmount * cfltInterestRate) * _  
c_intMonthsInTerm);
```

Constant definitions have the following syntax:

```
const datatype name = value;
```

To define a constant to hold the value of `pi`, for example, you could use a statement such as this:

```
const float c_pi = 3.14159265358979;
```

Note how I prefix the constant name with `c_`. I do this so that it's easier to determine what's a variable and what's a constant when reading code. See the section "[Naming Conventions](#)" later in this hour for more information.

After a constant is defined, you can use the constant's name in code in place of the constant's value. For example, to output the result of two times the value of `pi`, you could use a statement like this (the `*` character is used for multiplication and is covered in the next hour):

```
Debug.WriteLine(c_pi * 2);
```

Using the constant is much easier and less prone to error than typing this:

```
Debug.WriteLine(3.14159265358979 * 2);
```

Constants can be referenced only in the scope in which they are defined. I discuss scope in the section "[Determining Constant and Variable Scope](#)."

Declaring and Referencing Variables

Variables are similar to constants in that when you reference a variable's name in code, Visual C# .NET substitutes the variable's value in place of the variable name when the code executes. This doesn't happen at compile time, though. Instead, it happens at runtime—the moment the variable is referenced. This is because variables, unlike constants, can have their values changed at any time.

Declaring Variables

The act of defining a variable is called **declaring**. (Variables with scope other than local are dimensioned in a slightly different way, as discussed in the section on scope.) You've already defined variables in previous hours, so a declaration statement should look familiar to you:

```
datatype variablename = initialvalue;
```

You don't have to specify an initial value for a variable, although being able to do so in the declaration statement is very cool and useful. To create a new string variable and initialize it with a value, for example, you could use two statements, such as the following:

```
string strName;  
strName = "Matt Perry";
```

However, if you know the initial value of the variable at design time, you can include it on the declaration statement, like this:

```
string strName = "Matt Perry";
```

Note, however, that supplying an initial value doesn't make this a constant; it's still a variable, and the value of the variable can be changed at any time. This method of creating an initial value eliminates a code statement and makes the code a bit easier to read because you don't have to go looking to see where the variable is initialized.

It's important to note that Visual C# .NET is a strongly typed language; therefore, you must always declare the data type of a variable. In addition, Visual C# .NET requires that all variables be initialized before they're used.



Visual Basic programmers should note that Visual C# .NET will *not* default numeric variables to 0 or strings to empty strings.

For example, the following statements would result in a compiler error in Visual C# .NET: **Type or namespace "single" could not be found.**

```
float fltMyValue;  
System.Diagnostics.Debug.WriteLine (fltMyValue + 2);
```



You cannot use a reserved word to name a constant or a variable. For example, you couldn't use `public` or `private` as variable names.

Passing Literal Values to a Variable

The syntax of assigning a *literal* value (a hard-coded value such as 6 or "test") to a variable depends on the data type of the variable.

For strings, you must pass the value in quotes, like this:


```
strFirstName = "James Tyler";
```

There is one caveat when assigning literal values to strings: Visual C# .NET interprets slashes (\) as being a special type of escape sequence. If you pass a literal string containing one or more slashes to a variable, you'll get an error. What you have to do in such instances is preface the literal with the symbol @, like this:

```
strFilePath = @"c:\Temp";
```

When Visual C# .NET encounters the @ symbol after the equal sign like this, it knows to *not* treat slashes in the string as escape sequences.

To pass a literal value to a char variable, use single quotes instead of double quotes, like this:

```
chaMyCharacter = 'j';
```

For numeric values, you don't enclose the value in anything:

```
IntAnswerToEverything = 42;
```

Using Variables in Expressions

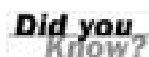
Variables can be used anywhere an expression is expected. The arithmetic functions, for example, operate on expressions. You could add two literal numbers and store the result in a variable like the following:

```
intMyVariable = 2 + 5;
```

You could replace either or both literal numbers with numeric variables or constants, as shown next:

```
intMyVariable = intFirstValue + 5;  
intMyVariable = 2 + intSecondValue;  
intMyVariable = intFirstValue + intSecondValue;
```

Variables are a fantastic way to store values during code execution, and you'll use variables all the time—from performing decisions and creating loops to using them only as a temporary place to stick a value. Remember to use a constant when you know the value at design time and the value won't change. When you don't know the value ahead of time or the value may change, use a variable with a data type appropriate to the function of the variable.



In Visual C# .NET, variables are created as objects. Feel free to create a variable and explore the members of the variable. You do this by entering the variable name and pressing a period (this will work only after you've entered the statement that defines the variable). For example, to determine the length of the text within a string variable, you can use the Length property of a string variable like this: strMyVariable.Length. There are some powerful features dangling off the data type objects.

Working with Arrays

An array is a special type of variable—it's a variable with multiple dimensions. Think of an ordinary variable as a single mail slot. You can retrieve or change the contents of the mail slot by referencing the variable. An array is like having an entire row of mail slots (called elements). You can retrieve and set the contents of any of the individual mail slots at any time by referencing the single array variable. You do this by using an index that points to the appropriate slot.

Declaring Arrays

Before you can use an array, you must first declare it (just as you have to declare variables). Consider the following statements:

```
string[] strMyArray;  
strMyArray = new string[10];
```

The first statement declares `strMyArray` as an array, and the second statement defines the array as having 10 string elements.

The number in brackets determines how many "mail slots" the array variable will contain, and it can be a literal value, a constant, or the value of another variable.

Referencing Array Variables

To place a value in an array index, you specify the index number when referencing the variable. Most computer operations consider 0 to be the first value in a series—not 1, as you might expect. This is how array indexing behaves. For example, for an array dimensioned with 10 elements (declared using `[10]`), you would reference the elements sequentially using the indexes 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9.

To place a value in the first element of the array variable, you would use 0 as the index, like this:

```
strMyArray[0] = "This value goes in the first element";
```

To reference the second element, you could use a statement like this:

```
strMyArray[1] = strMyArray[0];
```

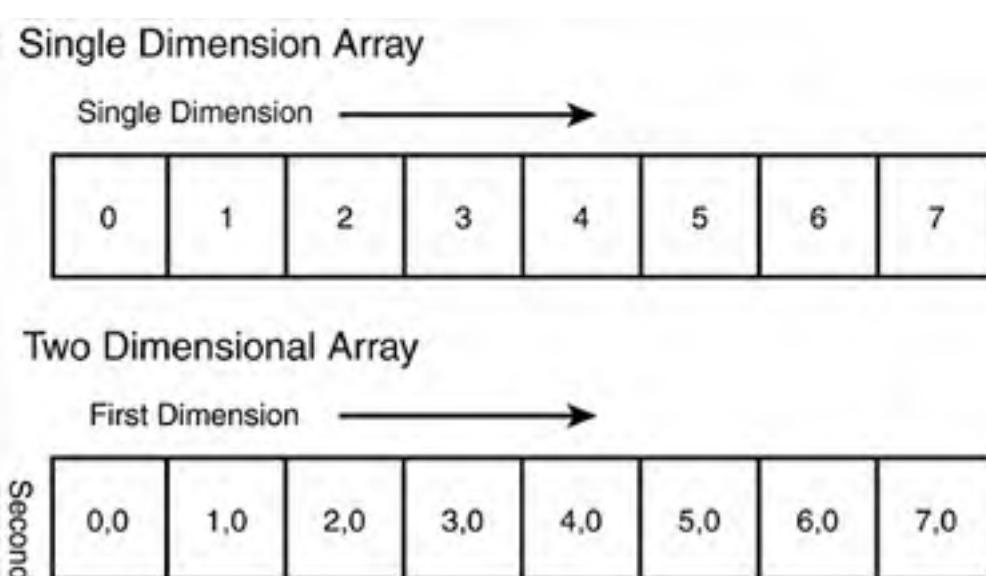
Creating Multidimensional Arrays

Array variables require only one declaration, yet they can store numerous pieces of data; this makes them perfect for storing sets of related information. The array example shown previously is a single-dimension array. Arrays can be much more complex than this example and can have multiple dimensions of data. For example, a single array variable could be defined to store the personal information shown previously for different people. Multidimensional arrays are declared with multiple parameters such as the following:

```
int[,] intMeasurements;  
intMeasurements = new int[3,2];
```

These statements create a two-dimensional array. The first dimension (defined as having four elements: 0, 1, 2, 3) serves as an index to the second dimension (defined as having three elements). Suppose that you wanted to store the height and weight of three people in this array. You reference the array as you would a single-dimension array, but you include the extra parameter index. The two indexes together specify an element, much as coordinates in Battleship relate to specific spots on the game board. [Figure 11.1](#) illustrates how the elements are related.

Figure 11.1. Two-dimensional arrays are like a wall of mail slots.



Dimension ↓	0,1	1,1	2,1	3,1	4,1	5,1	6,1	7,1
	0,2	1,2	2,2	3,2	4,2	5,2	6,2	7,2
	0,3	1,3	2,3	3,3	4,3	5,3	6,3	7,3

Elements are grouped according to the first index specified; think of the first set of indexes as being a single-dimension array. For example, to store the height and weight of a person in the array's first dimension (remember, arrays are zero-based), you could use code such as the following:

```
intMeasurements[0,0] = FirstPersonsHeight;  
intMeasurements[0,1] = FirstPersonsWeight;
```

I find it helpful to create constants for the array elements, which makes array references much easier to understand. Consider the following

```
const int c_Height = 0;  
const int c_Weight = 1;  
intMeasurements[0,c_Height] = FirstPersonsHeight;  
intMeasurements[0,c_Weight] = FirstPersonsWeight;
```

You could then store the height and weight of the second and third person like this:

```
intMeasurements[1,c_Height] = SecondPersonsHeight;  
intMeasurements[1,c_Weight] = SecondPersonsWeight;  
intMeasurements[2,c_Height] = ThirdPersonsHeight;  
intMeasurements[2,c_Weight] = ThirdPersonsWeight;
```

In this array, I've used the first dimension to differentiate people. I've used the second dimension to store a height and weight for each element in the first dimension.

Because I've consistently stored heights in the first slot of the array's second dimension and weights in the second slot of the array's second dimension, it becomes easy to work with these pieces of data. For example, you can retrieve the height and weight of a single person as long as you know the first dimension index used to store the data. You could, for instance, print out the total weight of all three people using the following code:

```
Debug.WriteLine(intMeasurements[0,c_Weight] + intMeasurements[1,c_Weight] +  
intMeasurements[2,c_Weight]);
```

When working with arrays, keep the following points in mind:

- The first element in any dimension of an array has an index of 0.
- Dimension an array to hold only as much data as you intend to put into it.
- Dimension an array with a data type appropriate to the values to be placed in the array's elements.

Arrays are a great way to store and work with related sets of data in Visual C# .NET code. Arrays can make working with larger sets of data much simpler and more efficient than using other methods. To maximize your effectiveness with arrays, study the [for](#) loop discussed in [Hour 14](#), "Looping for Efficiency." Using a [for](#) loop, you can quickly iterate (look sequentially) through all the elements in an array.

By the way

This section discussed the rectangular type of a Visual C# .NET multidimensional array. Visual C# .NET also supports another type of multidimensional array called *jagged*. Jagged arrays are an array of one-dimensional arrays, each of which can be of different lengths. However, teaching jagged arrays is beyond the scope of this book.

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Determining Constant and Variable Scope

Constants, variables, and arrays are extremely useful ways to store and retrieve data in Visual C# .NET code. Hardly a program is written that doesn't use at least one of these elements. To properly use them, however, it's critical that you understand *scope*.

You had your first encounter with scope in [Hour 10](#), "Creating and Calling Methods," with the keywords `private` and `public`. You learned that code is written in procedures and that procedures are stored in modules. Scope refers to the level that a constant, a variable, an array, or a procedure can be "seen" in code. For a constant or variable, scope can be one of the following levels:

- Block
- Method (local)
- Private

By the Way

Scope has the same affect on array variables as it does on ordinary variables. For the sake of clarity, I'll reference variables in this discussion on scope, but understand that what I discuss applies equally to arrays (and constants, for that matter).

The different levels of scope are explained in the following sections.

Understanding Block Scope

Block scope, also called structure scope, is when a variable is declared within a structure, and if so, it gives the variable block scope.

Structures are coding constructs that consist of two statements as opposed to one. For example, the standard `do` structure is used to create a loop; it looks like this:

```
do
  <statements to execute in the loop>
while(i <10)
```

By the Way

Visual C# .NET uses the word *structure* to mean a user-defined type. However, when talking about code, structure is also used to mean a block of code that has a beginning and an end. For the purpose of this discussion, it is this code block that I am referring to.

Another example is the `for` loop, which looks like this:

```
for (int i = 1; i<10;i++)
{
  <statements to execute when expression is True>
}
```

If a variable is declared within a structure, the variable's scope is confined to the structure; the variable isn't created until the declaration statement occurs, and it's destroyed when the structure completes. If a variable is needed only within a structure, think about declaring it within the structure to give it block scope. Consider the following example:

```
if (bInCreateLoop)
{
    int intCounter ;

    for (intCounter=1; intCounter<=100; intCounter++)
        // Do something
}
```

By placing the variable declaration statement within the **if** structure, you ensure that the variable is created only if it is needed. In fact, you can create a block simply by enclosing statements in opening and closing braces like this:

```
{
    int intMyVariable = 10;
    Console.WriteLine(intMyVariable);
}
```

By the Way The various structures, including looping and decision-making structures, are discussed in later hours.

Understanding Method-Level (Local) Scope

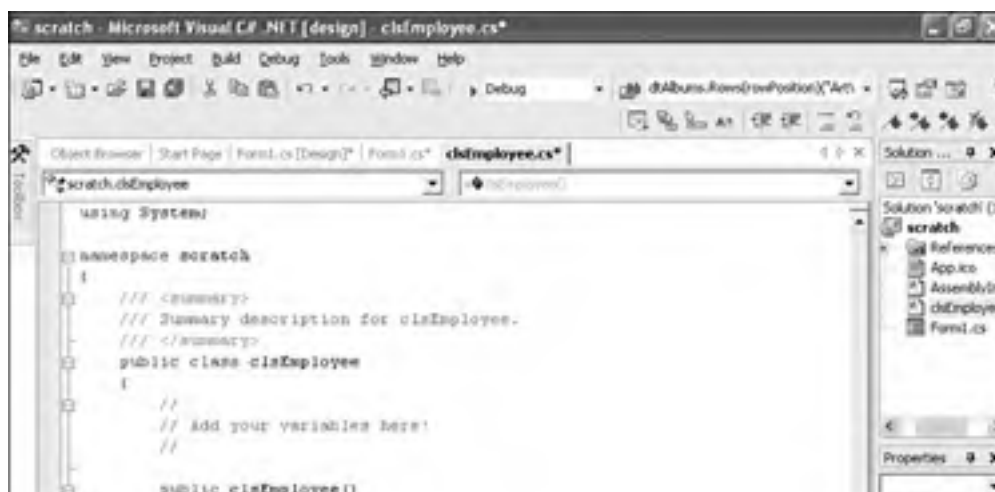
When you declare a constant or variable within a method, that constant or variable has **method-level**, or **local**, scope. Most of the variables you'll create will have method scope. In fact, almost all the variables you've created in previous hours have had method-level scope. You can reference a local constant or variable within the same method, but it isn't visible to other methods. If you try to reference a local constant or variable from a method other than the one in which it's defined, Visual C# .NET returns a compile error to the method making the reference (the variable or constant doesn't exist). It's generally considered best practice to declare all your local variables at the top of a method, but Visual C# .NET doesn't care where you place declaration statements within a method. Note, however, that if you place a declaration statement within a structure, the corresponding variable will have block scope, not local scope.

Understanding Private-Level Scope

When a constant or variable has private-level scope, it can be viewed by all methods within the class containing the declaration. To methods in all other classes, however, the constant or variable doesn't exist. To create a constant or variable with private-level scope, you must place the declaration within a class but not within a method. Class member declarations are generally done at the beginning of the class (right after the opening brace of the class). Use private-level scope when many methods must share the same variable and when passing the value as a parameter is not a workable solution.

For all modules other than those used to generate forms, it's easy to add code to the declarations section; simply add the declaration statements just after the class declaration line and prior to any method definitions, as shown in [Figure 11.2](#).

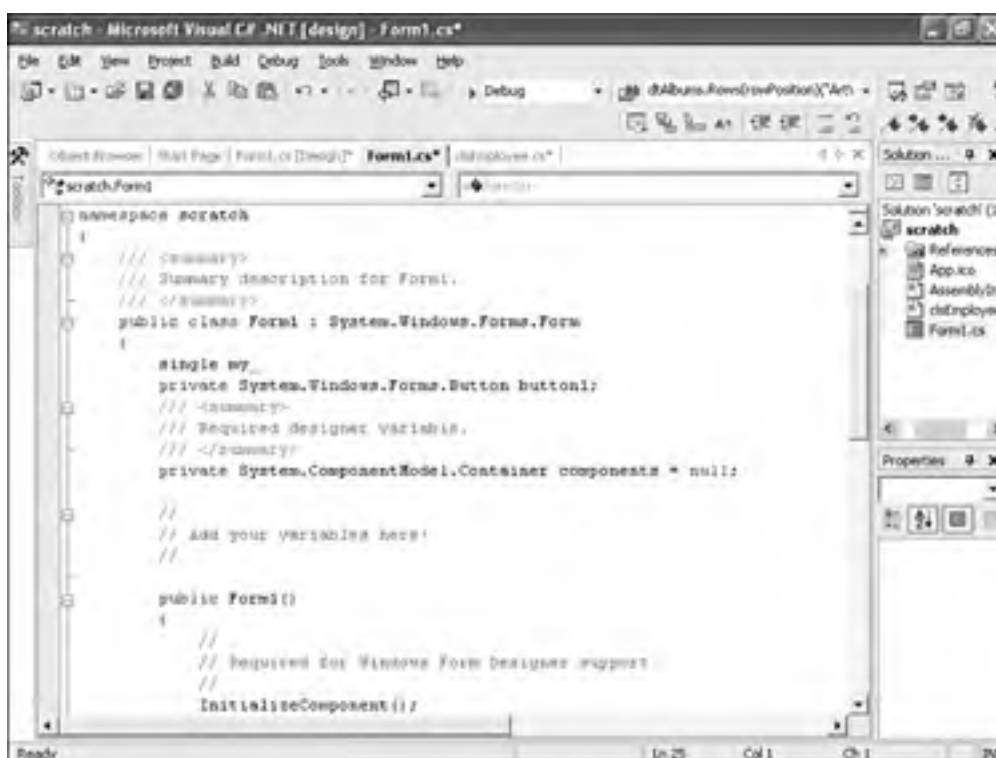
Figure 11.2. The declarations section exists above all declared methods.





Classes used to generate forms have lots of system-generated code within them, so it might not be so obvious where to place private-level variables. Visual C# .NET inserts many private statements in classes used to build forms, so place your variable declarations after any and all form-type declaration statements in such classes (see [Figure 11.3](#)).

Figure 11.3. The declarations section includes the Visual C# .NET generated statements.



Did you Know? You can hover the pointer over any variable in code and a ToolTip will appear showing you the declaration of the variable.

Did you Know? In general, the smaller the scope the better. When possible, give a variable block or local scope. If you have to increase scope, attempt to make the variable a private-level variable. You should use public variables only when absolutely necessary (and there are times when it is necessary to do so). The higher the scope, the more possibilities exist for problems and the more difficult it is to debug those problems.

Naming Conventions

To make code more self-documenting (always an important goal) and to reduce the chance of programming errors, you need an easy way to determine the exact data type of a variable or the exact type of a referenced control in Visual C# .NET code.



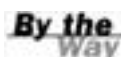
Variable naming conventions have long been a hot topic—some find them beneficial while others don't. Please be aware that using a naming convention is optional; if you don't like naming conventions, you don't have to use them.

Using Prefixes to Denote Data Type

[Table 11.3](#) lists the prefixes of the common data types.

Table 11.3. Prefixes for Common Data Types

Data Type	Prefix	Sample Value
Boolean	bln	blnLoggedIn
Byte	byt	bytAge
Char	chr	chrQuantity
Decimal	dec	decSalary
Double	dbl	dblCalculatedResult
Integer	int	intLoopCounter
Long	lng	lngCustomerID
Object	obj	objWord
Short	sho	shoTotalParts
String	str	strFirstName



The prefix of obj should be reserved for situations when a specific prefix isn't available. The most common use of this prefix is when referencing Automation libraries of COM applications. For instance, when automating Microsoft Word, you create an instance of Word's Application object. Because no prefix exists specifically for Word objects, obj works just fine. That is, `Word.Application objWord = new Word.Application;`

Denoting Scope Using Variable Prefixes

Prefixes are useful not only to denote data types, they also can be used to denote scope (see [Table 11.4](#)). In particularly large applications, a scope designator is almost a necessity. Again, Visual C# .NET doesn't care whether you use prefixes, but consistently using prefixes benefits you as well as others who have to review your code.

Table 11.4. Prefixes for Variable Scope

Prefix	Description	Example
g	Global	<i>g_strSavePath</i>
m	Private to class	<i>m_blnDataChanged</i>
(no prefix)	Nonstatic variable, local to method	fltInterestRate

Using Other Prefixes

Prefixes aren't just for variables. All standard objects (including forms and controls) can use a three-character prefix. There are simply too many controls and objects to list all the prefixes here, although you will find that I use control prefixes throughout this book.

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Summary

In this hour, you learned how to eliminate magic numbers by creating constants. By using constants in place of literal values, you increase code readability, reduce the possibilities of coding errors, and make it much easier to change a value in the future.

In addition, you learned how to create variables for data elements in which the initial value isn't known at design time or for elements whose values will be changed at runtime. You learned how arrays add dimensions to variables and how to declare and reference them in your code.

Visual C# .NET enforces strict data typing, and in this hour you learned about the various data types and how they're used, as well as tips for choosing data types and functions for converting data from one type to another. Finally, you learned about scope—a very important programming concept—and how to manage scope within your projects.

Writing code that can be clearly understood even by those who didn't write it is a worthwhile goal. Naming prefixes goes a long way toward accomplishing this goal. In this hour you learned the naming prefixes for the common data types, and you learned to use prefixes to denote scope.

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Q&A

Q1: *Are any performance tricks related to the many data types?*

A1: One trick when using whole numbers (values with no decimal places) is to use the data type that matches your processor. For instance, most current home and office computers have 32-bit processors. The Visual C# .NET integer data type is made up of 32 bits. Believe it or not, Visual C# .NET can process an integer variable faster than it can process a short variable, even though the short variable is smaller. This has to do with the architecture of the CPU, memory, and bus. The explanation is complicated, but the end result is that you should usually use integer rather than short, even when working with values that don't require the larger size of the integer.

Q2: *Are arrays limited to two dimensions?*

A2: Although I showed only two dimensions (that is, `intMeasurements[3,1]`), arrays can have many dimensions, such as `intMeasurements[3,3,3,4]`. The technical maximum is 60 dimensions, but you probably won't use more than three.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** What data type would you use to hold currency values?
- 2:** Which data type can be used to hold any kind of data and essentially serves as a generic data type?
- 3:** What values does a bool hold?
- 4:** What can you create to eliminate magic numbers by defining a literal value in one place?
- 5:** What type of data element can you create in code that can have its value changed as many times as necessary?
- 6:** What are the first and last indexes of an array dimensioned using `string_strMyArray[5]`?
- 7:** What word is given to describe the visibility of a constant or variable?
- 8:** In general, is it best to limit the scope of a variable or to use the widest scope possible?

Exercises

- 1:** Create a project with a text box, a button, and a label control. When the user clicks the button, move the contents of the text box to a variable, and then move the contents of the variable to the Text property of the label. (Hint: A string variable will do the trick.)
- 2:** Rewrite the following code so that a single array variable is used rather than two standard variables. (Hint: Do not use a multidimensional array.)

```
string strGameTitleOne;  
string strGameTitleTwo;  
strGameTitleOne = "Raven Shield";  
strGameTitleTwo = "No One Lives Forever";
```

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Hour 12. Performing Arithmetic, String Manipulation, and Date/Time Adjustments

Just as arithmetic is a necessary part of everyday life, it's also vital to developing Windows programs. You probably won't write an application that doesn't add, subtract, multiply, or divide some numbers. In this hour, you'll learn how to perform arithmetic in code. You'll also learn about order of operator precedence, which determines how Visual C# .NET evaluates complicated expressions (or equations). After you understand operator precedence, you'll learn how to compare equalities—something you'll do all the time.

Boolean logic is the logic Visual C# .NET itself uses to evaluate expressions in decision-making constructs. If you've never programmed before, Boolean logic may be a new concept to you. However, in this hour I explain what you need to know about Boolean logic to create efficient code that performs as expected. Finally, I show you how to manipulate strings and work with dates and times.

The highlights of this hour include the following:

- Performing arithmetic
- Understanding the order of operator precedence
- Comparing equalities
- Understanding Boolean logic
- Manipulating strings
- Working with dates and times

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Performing Basic Arithmetic Operations with Visual C# .NET

To be a programmer, you have to have solid math skills; you'll be performing a lot of basic arithmetic when writing Visual C# .NET applications. To get the results you're looking for in any given calculation, you must

- Know the mathematical operator that performs the desired arithmetic function
- Understand and correctly use order of precedence

Using the correct mathematical operator is simple. Most are easy to commit to memory, and you can always look up the ones you're not quite sure of. I'm not going to go into great detail on any of the math functions (if you've made it this far, I'm sure you have a working grasp of math), but I'll cover them all.

By the way

In [Hour 7](#), "Working with the Traditional Controls," I mentioned how the `System.Diagnostics.Debug.WriteLine()` method prints text to the Output window. I use this method in the examples throughout this hour. You will not be asked to create a project in this chapter, but you may want to try some of these examples in a test project. Because you will be using several debug statements, it will be helpful to declare the `System.Diagnostics` namespace in the header of your class. This permits you to use the methods of the namespace without having to qualify the entire namespace. The following is the line you need to add at the beginning of your class (put it with the other `using` statements created automatically by Visual C# .NET):

```
using System.Diagnostics;
```

For more specific information on the `Debug` object, refer to [Hour 15](#), "Debugging Your Code."

Performing Addition

Simple addition is performed using the standard addition symbol, the `+` character. The following line prints the sum of 4, 5, and 6:

```
Debug.WriteLine(4 + 5 + 6);
```

You don't have to use a hard-coded value with arithmetic operators. You can use any of the arithmetic operators on numeric variables and constants. For example:

```
const int c_FirstValue = 4;  
const int c_SecondValue = 5;  
Debug.WriteLine(c_FirstValue + c_SecondValue);
```

This bit of code prints the sum of the constants `c_FirstValue` and `c_SecondValue`, which, in this case, is 9.

Performing Subtraction and Negation

You're probably familiar with the subtraction operator because—like the addition operator—it's the same one you would use on a calculator or when writing an equation: the `-` character. The following line of code prints 2 (the total of 6-4):

```
Debug.WriteLine(6 - 4);
```

As with written math, the `-` character is also used to denote a negative number. For example, to print the value `-6`, you would use a statement such as the following:

```
Debug.WriteLine(-6);
```

Performing Multiplication

If you work with adding machines, you already know the multiplication operator. The multiplication character is the asterisk (*) character. You can enter this character using Shift+8 or by pressing the * key located in the upper row of the keypad section of the keyboard. Although you would ordinarily use an "x" when writing multiplication equations such as $6 = 3 \times 2$ on paper, you'll receive an error if you try this in code; you have to use the * character. The following statement prints 20 (5 multiplied by 4):

```
Debug.WriteLine(5 * 4);
```

Performing Division

Division is accomplished using the division operator, which is a slash (/). This operator is easy to remember if you think of division as fractions. For example, one-eighth is written as $1/8$, which literally means one divided by eight. The following statement prints 8 (32 divided by 4):

```
Debug.WriteLine(32 / 4);
```

Visual C# .NET overloads the division operator. This means that based on the input arguments, the results may vary. For example, Visual C# .NET division will return an integer when dividing integers, but it will return a fractional number if a float, a double, or a decimal data type is used. Hence, $32 / 5$ will return 6, dropping the remainder (2, in this case). If you wanted to return the actual value of the operation $32 / 5$, you would have to specify the numbers with decimal places (that is, $32.0 / 5.0$).

Performing Modulus Arithmetic

Modulus arithmetic is the process of performing division on two numbers but keeping only the remainder. Modulus arithmetic is performed using the % operand, in contrast to using a slash (/) operator symbol. The following are examples of modulus statements and the values they would print:

```
Debug.WriteLine(10 % 5); // Prints 0
```

```
Debug.WriteLine(10 % 3); // Prints 1
```

```
Debug.WriteLine(12 % 4.3); // Prints 3.4
```

```
Debug.WriteLine(13.6 % 5); // Prints 3.6
```

The first two statements are relatively easy to understand: 5 goes into 10 twice with no remainder and 3 goes into 10 three times with a remainder of 1. Visual C# .NET processes the third statement as 4.3 going into 12 two times with a remainder of 3.4. In the last statement, Visual C# .NET performs the modulus operation as 5 going into 13.6 twice with a remainder of 3.6.

Determining the Order of Operator Precedence

When several arithmetic operations occur within a single equation (called an expression), Visual C# .NET has to resolve the expression in pieces. The order in which these pieces are evaluated is known as **operator precedence**. To fully understand operator precedence, you have to brush up a bit on your algebra (most of the math you perform in code is algebraic).

Consider the following expression:

```
Debug.WriteLine(6 + 4 * 5);
```

Two arithmetic operations occur in this single expression. To evaluate the expression, Visual C# .NET must perform both operations: multiplication and addition. Which operation does Visual C# .NET perform first? Does it matter? Absolutely. If Visual C# .NET performs the addition before the multiplication, you end up with the following:

Step 1: $6 + 4 = 10$

Step 2: $10 * 5 = 50$

The final result would be that of Visual C# .NET printing 50. Now look at the same equation with the multiplication performed prior to addition:

Step 1: $4 * 5 = 20$

Step 2: $20 + 6 = 26$

In this case, Visual C# .NET would print 26—a dramatically different number from the one computed when the multiplication is performed first. To prevent these types of problems, Visual C# .NET consistently performs arithmetic operations in the same order—the order of operator precedence (in this case, multiplication and then addition). [Table 12.1](#) lists the order of operator precedence for **arithmetic** and **Boolean operators**. (Boolean operators are discussed later in this hour.) If you're familiar with algebra, you'll note that the order of precedence used by Visual C# .NET is the same as that used in algebraic formulas.

Table 12.1. Visual C# .NET 's Order of Operator Precedence, Highest to Lowest

Category	Operators
Multiplicative	$*$ / $\%$
Additive	$+$ -
Equality	$==$ (equal), $!=$ (not equal)
Logical AND	$\&$
Logical XOR	\wedge
Logical OR	$ $
Conditional AND	$\&\&$
Conditional OR	$ $
Conditional	$?:$



Notice that two equal signs are used to denote equality, not one as you might expect.

All **comparison operators** such as $>$, $<$, and $>=$ (discussed in the next section) have an equal precedence. When operators have an equal precedence, Visual C# .NET evaluates them from left to right. Notice that multiplication and division operators have an equal precedence, so in an expression that has both, the operators would be evaluated from left to right. The same holds true for addition and subtraction. When expressions contain operators from more than one category (arithmetic, comparison, or logical), arithmetic operators are evaluated first, comparison operators are evaluated next, and *logical operators* are evaluated last.

Just as when writing an equation on paper, you can use parentheses to override the order of operator precedence. Operations placed within parentheses are always evaluated first. Consider the previous example:

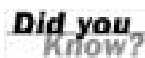
```
Debug.WriteLine(6 * 5 + 4);
```

Using the order of operator precedence, Visual C# .NET evaluates the equation like this:

```
Debug.WriteLine((6 * 5) + 4);
```

The multiplication is performed first, and then the addition. If you wanted the addition performed prior to the multiplication, you could write the statement like this:

```
Debug.WriteLine(6 * (5 + 4));
```



When writing complex expressions, you absolutely must keep in mind the order of operator precedence and use parentheses to override the default operator precedence when necessary. Personally, I try to always use parentheses so that I'm sure of what's happening and my code is easier to read.

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Comparing Equalities

Comparing values, particularly variables, is even more common than performing arithmetic (but you need to know how Visual C# .NET arithmetic works before you can understand the evaluation of equalities).

Comparison operators are most often used in decision-making structures, as explained in the next hour. Indeed, these operators are best understood using a simple **if** decision structure. In an **if** construct, Visual C# .NET considers the expression in the **if** statement, and if the expression equates to **true**, the code statement(s) are executed. For example, the following is an **if** operation (a silly one at that) expressed in English, not in Visual C# .NET code:

IF DOGS BARK, THEN SMILE.

If this were in Visual C# .NET code format, Visual C# .NET would evaluate the **if** condition, which in this case is *dogs bark*. If the condition is found to be **true**, the code following the expression is performed. Because dogs bark, you'd smile.

Notice how these two things (dogs barking and you smiling) are relatively unrelated. This doesn't matter; the point is that if the condition evaluates to **true**, certain actions (statements) occur.

You'll often compare the value of one variable to that of another variable or to a specific value when making decisions. The following are some basic comparisons and how Visual C# .NET evaluates them:

```
Debug.WriteLine(6 > 3); // Evaluates to true
```

```
Debug.WriteLine(3 == 4); // Evaluates to false
```

```
Debug.WriteLine(3 >= 3); // Evaluates to true
```

```
Debug.WriteLine(5 <= 4); // Evaluates to false
```

Performing comparisons is pretty straightforward. If you get stuck writing a particular comparison, try to write it in English before creating it in code.

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Understanding Boolean Logic

Boolean logic is a special type of arithmetic/comparison that is used to evaluate expressions down to either true or false. This may be a new concept to you, but don't worry; it's not difficult to understand. Boolean logic is performed using a logical operator. Consider the following sentence:

If black is a color and wood comes from trees, then print "ice cream."

At first glance, it might seem that this is nonsensical. However, Visual C# .NET could make sense of this statement using Boolean logic. First, notice that three expressions are actually being evaluated within this single sentence. I've added parentheses in the following sentence to clarify two of the expressions.

If (black is a color) and (wood comes from trees) then print "ice cream."

Boolean logic evaluates every expression to either **true** or **false**. Therefore, substituting **true** or **false** for each of these expressions yields the following:

if (true) And (true) then print "ice cream."

Now, for the sake of clarity, here is the same sentence with parentheses placed around the final expression to be evaluated:

If (True And True) then print "ice cream."

This is the point where the logical operators come into play. The And (**&&**) operator returns **true** if the expressions on each side of the And (**&&**) operator are **true** (see [Table 12.2](#) for a complete list of logical operators). In the sentence we're considering, the expressions on both sides of the And (**&&**) operator are **true**, so the expression evaluates to **true**. Replacing the expression with **true** yields:

If True then print "ice cream."

This would result in the words "ice cream" being printed. If the expression had evaluated to **false**, nothing would be printed. As you'll see in the next hour, the decision constructs always fully evaluate their expressions to either **true** or **false**, and statements execute according to the results.

Table 12.2. Logical (Boolean) Operators

Operator	Description
And (&&)	Evaluates to true when the expressions on both sides are true .
Not (!)	Evaluates to true when its expression evaluates to false ; otherwise, it returns false (the true/false value of the expression is negated, or reversed).
Or ()	Evaluates to true if an expression on either side evaluates to true .
Xor (^)	Evaluates to true if one, and only one, expression on either side evaluates to true .

Each of these operators is discussed in the following sections.

Using the And (&&) Operator

The And (&&) operator is used to perform a logical conjunction. If the expressions on both sides of the And (&&) operator evaluate to **true**, the And (&&) operation evaluates to **true**. If either expression is **false**, the And (&&) operation evaluates to **false**, as illustrated in the following examples:

```
Debug.WriteLine(true && true);    // Prints true
Debug.WriteLine(true && false);   // Prints false
Debug.WriteLine(false && true);  // Prints false
Debug.WriteLine(false && false); // Prints false
Debug.WriteLine((32 > 4) && (6 == 6)); // Prints true
```

Using the Not(!) Operator

The Not(!) operator performs a logical negation. That is, it returns the opposite of the expression. Consider the following examples:

```
Debug.WriteLine(! (true));    // Prints false
Debug.WriteLine(! (false));   // Prints true
Debug.WriteLine(! (5 == 5));  // Prints false
Debug.WriteLine(! (4 < 2));   // Prints true
```

The first two statements are easy enough; the opposite of `true` is `false` and vice versa. For the third statement, remember that Visual C# .NET's operator precedence dictates that arithmetic operators are evaluated first (even if no parentheses are used), so the first step of the evaluation would look like this:

```
Debug.WriteLine( ! (true));
```

The opposite of `true` is `false`, of course, so Visual C# .NET prints `false`.

The fourth statement would evaluate to

```
Debug.WriteLine( !(false));
```

This happens because 4 is *not* less than 2, which is the expression Visual C# .NET evaluates first. Because the opposite of `false` is `true`, this statement would print `true`.

Using the Or (||) Operator

The Or (||) operator is used to perform a logical disjunction. If the expression to the left or right of the Or (||) operator evaluates to `true`, the Or (||) operation evaluates to `true`. The following are examples using Or (||) operations, and their results:

```
Debug.WriteLine(true || true);    // Prints true
Debug.WriteLine(true || false);   // Prints true
Debug.WriteLine(false || true);   // Prints true
Debug.WriteLine(false || false);  // Prints false
Debug.WriteLine((32 < 4) || (6 == 6)); // Prints true
```

Using the Xor (^) Operator

The Xor (^) operator performs a nifty little function. I personally haven't had to use it much, but it's great for those times when its functionality is required. If one—and only one—of the expressions on either side of the Xor (^) operator is true, the Xor (^) operation evaluates to `true`. Take a close look at the following statement examples to see how this works:

```
Debug.WriteLine(true ^ true);     // Prints false
Debug.WriteLine(true ^ false);    // Prints true
Debug.WriteLine(false ^ true);    // Prints true
Debug.WriteLine(false ^ false);   // Prints false
Debug.WriteLine((32 < 4) ^ (6 == 6)); // Prints true
```

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Manipulating Strings

Recall from the previous hour that a string is text. Although string manipulation isn't technically arithmetic, the things that you do with strings are very similar to things you do with numbers, such as adding two strings together; string manipulation is much like creating equations. Chances are you'll be working with strings a lot in your applications. Visual C# .NET includes a number of methods that enable you to do things with strings, such as retrieve a portion of a string or find one string within another. In the following sections, you'll learn the basics of string manipulation.

Concatenating Strings of Text

Visual C# .NET makes it possible to "add" two strings of text together to form one string. Although purists will say it's not truly a form of arithmetic, it's very much like performing arithmetic on strings, so this hour is the logical place in which to present this material. The process of adding two strings together is called **concatenation**. Concatenation is very common. For example, you may want to concatenate variables with hard-coded strings to display meaningful messages to the user, such as *Are you sure you want to delete the user XXX?*, where XXX is the contents of a variable.

To concatenate two strings, you use the + operator as shown in this line of code:

```
Debug.WriteLine("This is" + "a test.");
```

This statement would print:

```
This isa test.
```

Notice that there is no space between the words *is* and *a*. You could easily add a space by including one after the word *is* in the first string or before the *a* in the second string, or you could concatenate the space as a separate string, like this:

```
Debug.WriteLine("This is" + " " + "a test.");
```

Text placed directly within quotes is called a **literal**. Variables are concatenated in the same way as literals and can even be concatenated with literals. The following code creates two variables, sets the value of the first variable to "James," and sets the value of the second variable to the result of concatenating the variable with a space and the literal "Tyler":

```
string strFullName;  
string strFirstName = "James";  
  
strFullName = strFirstName + " " + "Tyler";
```

The final result is that the variable `strFullName` contains the string James Tyler. Get comfortable with concatenating strings of text—you'll do this often.

Using the Basic String Methods and Properties

The .NET Framework includes a number of functions that make working with strings of text considerably easier than it might be otherwise. These functions enable you to easily retrieve a piece of text from a string, compute the number of characters in a string, and even determine whether one string contains another. The following sections summarize the basic string functions.

Determining the Number of Characters Using Length

The `Length` property of the string object returns the variable's length. The following statement prints 26, the total number of characters in the literal string "Pink Floyd reigns supreme." Remember, the quotes surrounding the string tell Visual C# .NET that the text within them is a literal; they are not part of the string.

```
Debug.WriteLine(("Pink Floyd reigns supreme.").Length); // Prints 26
```

Retrieving Text from a String Using the Substring() Method

The `Substring()` method retrieves a part of a string.

The `Substring()` method can be used with the following parameters:

```
public string Substring(startposition, numberofcharacters);
```

For example, the following statement prints `Queen`, the first five characters of the string:

```
Debug.WriteLine("Queen to Queen's Level Three.").Substring(0,5);
```

The arguments used in this `Substring` example are 0 and 5. The 0 indicates starting at the 0 position of the string (beginning). The 5 indicates the specified length to return (characters to retrieve).

The `Substring()` method is commonly used with the `IndexOf()` method (discussed shortly) to retrieve the path portion of a variable containing a filename and path combination, such as `c:\Myfile.txt`. If you know where the `\` character is, you can use `Substring()` to get the path.



If the number of characters requested is greater than the number of characters in the string, an exception (error) occurs. If you're unsure about the number of characters in the string, use the `Length` property of the string to find out. (Exception handling is reviewed in [Hour 15](#).)

Determining Whether One String Contains Another Using `IndexOf()` Method

At times you'll need to determine whether one string exists within another. For example, suppose you let users enter their full name into a text box, and you want to separate the first and last names before saving them into individual fields in a database. The easiest way to do this is to look for the space in the string that separates the first name from the last. You could use a loop to examine each character in the string until you find the space, but Visual C# .NET includes a string method that does this for you, faster and easier than you could do it yourself: the `IndexOf()` method. The basic `IndexOf()` method has the following syntax:

```
MyString.IndexOf(searchstring);
```

The `IndexOf()` method of a string searches the string for the occurrence of a string passed as an argument. If the string is found, the location of character at the start of the string is returned. If the search string is not found within the other string, `-1` is returned. The `IndexOf()` method can be used with the following arguments:

- `public int IndexOf(searchstring);`
- `public int IndexOf(searchstring, startinglocation);`
- `public int IndexOf(searchstring, startinglocation, numberofcharacterstosearch);`

The following code searches a variable containing the text `"Jason Goss"`, locates the space, and uses the `Substring()` method and `Length` property to place the first and last names in separate variables.

```
string strFullName = "Jason Goss";  
string strFirstName, strLastName;  
int intLocation, intLength;
```

```
intLength = strFullName.Length;  
intLocation = strFullName.IndexOf(" ");
```

```
strFirstName = strFullName.Substring(0,intLocation );  
strLastName = strFullName.Substring(intLocation + 1);
```



This code assumes that a space will be found and that it won't be the first or last character in the string. In your applications, your code may need to be more robust, including checking to ensure that `IndexOf()` returned a value other than `-1`, which would indicate that no space was found.

When this code runs, `IndexOf()` returns 5, the location in which the first space is found. Notice how I subtracted an additional character when using `SubString()` to initialize the `strLastName` variable; this was to take the space into account.

Trimming Beginning and Trailing Spaces from a String

As you work with strings, you'll often encounter situations in which spaces exist at the beginning or ending of strings. The .NET Framework includes the following four methods for automatically removing spaces from the beginning or end of a string:

Method	Description
<code>String.Trim</code>	Removes spaces from the beginning and end of a string
<code>String.TrimEnd</code>	Removes spaces from the end of a string
<code>String.TrimStart</code>	Removes spaces from the beginning of a string
<code>String.Remove</code>	Removes a specified number of characters from a specified index position in a string

Replacing Text Within a String

It's not uncommon to have to replace a piece of text within a string with some other text. For example, some people still put two spaces at the end of a sentence, even though this is no longer necessary because of proportional fonts. You could replace all double-spaces with a single space using a loop and the string manipulation functions discussed so far, but there is an easier way: the `Replace` method of the `String` class. A basic `Replace` method call has the following syntax:

Stringobject.Replace(findtext, replacetext)

The *findtext* argument is used to specify the text to look for within *expression*, and the *replacetext* argument is used to specify the text used to replace the *findtext*. Consider the following code:

```
string strText = "Give a man a fish";  
strText = strText.Replace("fish", "sandwich");
```

When this code completes, `strText` contains the string 'Give a man a sandwich'. `Replace` is a powerful function that can save many lines of code, and you should use it in place of a "home-grown" replace function whenever possible.

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Working with Dates and Times

Dates are a rather unique type of data. In some ways, they act like strings in which you can concatenate and parse pieces. In other ways, dates seem more like numbers in that you can add to or subtract from them. Although you'll often perform math-type functions on dates (such as adding a number of days to a date or determining the number of months between two dates), you don't use the typical arithmetic operations. Instead, you use functions specifically designed for working with dates.

Understanding the DateTime Data Type

Working with dates is very common. No matter the application, you'll probably need to create a variable to hold a date using the DateTime data type. You can get a date into a DateTime variable in several ways. Recall that when setting a string variable to a literal value, the literal is enclosed in quotes. When setting a numeric variable to a literal number, the number is not closed in quotes:

```
string strMyString = "This is a string literal";  
int intMyInteger = 69;
```

The more common way to set a DateTime variable to a literal date is to instantiate the variable passing in the date, like this (year, month, day):

```
DateTime dteMyBirthday = new DateTime(1969,7,22);
```

You cannot pass a string directly to a DateTime variable. For instance, if you let the user enter a date into a text box and you want to move the entry to a DateTime variable, you'll have to parse out the string to be able to adhere to one of the allowable DateTime constructors. The DateTime data type is one of the more complicated data types. This chapter will expose you to enough information to get started, but this is only the tip of the iceberg. I suggest reviewing the MSDN documentation of this curious data type for more information.

It's important to note that DateTime variables store a date and a time—always. Take a look at the example in the following code:

```
DateTime dteMyBirthday = new DateTime(1969,7,22);  
Debug.WriteLine(dteMyBirthday.ToString());
```

It produces this output:

```
7/22/1969 12:00:00 AM
```

Notice that this example printed the time **12:00:00 AM**, even though no time was specified for the variable. This is the default time placed in a DateTime variable when only a date is specified. Although a DateTime variable always holds a date and a time, on occasion, you'll be concerned only with either the date or the time. Later, I'll show you how to use the `GetDateTimeFormats()` method to retrieve just a date or a time.

Adding to or Subtracting from a Date or Time

To add a specific amount of time (such as one day or three months) to a specific date or time, you use methods of the DateTime class. [Table 12.3](#) lists the methods as described in Microsoft Developers Network (MSDN). These methods do not change the value of the current DateTime variable; instead, they return a new DateTime instance whose value is the result of the operation.

Table 12.3. Available Data Adding Methods (Source MSDN)

Method	Description
<code>Add</code>	Adds the value of the specified TimeSpan instance to the value of this instance
<code>AddDays</code>	Adds the specified number of days to the value of this instance
<code>AddHours</code>	Adds the specified number of hours to the value of this instance
<code>AddMilliseconds</code>	Adds the specified number of milliseconds to the value of this instance
<code>AddMinutes</code>	Adds the specified number of minutes to the value of this instance

<code>AddMonths</code>	Adds the specified number of months to the value of this instance
<code>AddSeconds</code>	Adds the specified number of seconds to the value of this instance
<code>AddYears</code>	Adds the specified number of years to the value of this instance

For instance, to add six months to the date 7/22/69, you could use the following statements:

```
DateTime dteMyBirthday = new DateTime(1969,7,22);  
DateTime dteNewDate = objMyBirthday.AddMonths(6);
```

After this second statement executes, `dteNewDate` contains the date `1/22/1970 12:00:00 AM`.

The following code shows sample addition methods and the date they would return:

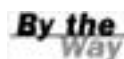
```
dteNewDate = dteMyBirthday.AddYears(2); // Returns 7/22/1971 12:00:00 AM  
dteNewDate = dteMyBirthday.AddMonths(5); // Returns 12/22/1969 12:00:00 AM  
dteNewDate = dteMyBirthday.AddMonths(-1); // Returns 6/22/1971 12:00:00 AM  
dteNewDate = dteMyBirthday.AddHours(7); // Returns 7/22/1969 7:00:00 AM
```

Retrieving Parts of a Date

Sometimes, it can be extremely useful to know just a part of a date. For example, you may have let a user enter his or her birth date, and you want to perform an action based on the month in which they were born. To retrieve part of a date, the `DateTime` class exposes properties such as `Month`, `Day`, `Year`, `Hour`, `Minute`, `Second`, and so on.

The following should illustrate the retrieval of some properties of the `DateTime` class (the instance date is still 7/21/1969):

```
objMyBirthday.Month // Returns 7  
objMyBirthday.Day // Returns 22  
objMyBirthday.DayOfWeek // Returns DayOfWeek.Monday
```



The `Hour` property will return the hour in military format. Also, note that `DayOfWeek` returns an enumerated value.

Formatting Dates and Times

As I stated earlier, at times you'll want to work with only the date or a time within a `DateTime` variable. In addition, you'll probably want to control the format in which a date or time is displayed. All this and more can be accomplished via the `DateTime` class by way of the following:

- Using the `DateTime` methods to retrieve formatted strings
- Using standard-format strings
- Using custom-format strings

I can't possibly show you everything regarding formatting a `DateTime` value here, but I do want to show you how to use formatting to output either the date portion or the time portion of a `DateTime` variable.

The following illustrates some basic formatting methods available with the `DateTime` class. (Note that the instance date is still 7/22/1969 12:00:00 AM.)

```
dteMyBirthday.ToLongDateString(); // Returns Monday, July 21, 1969
```

```
dteMyBirthday.ToShortDateString(); // Returns 7/21/1969  
dteMyBirthday.ToLongTimeString(); // Returns 12:00:00 AM  
dteMyBirthday.ToShortTimeString(); // Returns 12:00 AM
```

Retrieving the Current System Date and Time

Visual C# .NET gives you the capability to retrieve the current system date and time. Again, this is accomplished by way of the `DateTime` class. For example, the `Today` property returns the current system date. To place the current system date into a new `DateTime` variable, for example, you could use a statement such as this:

```
DateTime objToday = DateTime.Today;
```

To retrieve the current system date *and* time, use the `Now` property of `DateTime`, like this:

```
DateTime objToday = DateTime.Now;
```

Commit `DateTime.Today` and `DateTime.Now` to memory. You'll need to retrieve the system date and/or time in an application, and this is by far the easiest way to get that information.

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Summary

Being able to work with all sorts of data is crucial to your success as a Visual C# .NET developer. Just as you need to understand basic math to function in society, you need to be able to perform basic math in code to write even the simplest of applications. Knowing the arithmetic operators and understanding the order of operator precedence will take you a long way in performing math using Visual C# .NET code.

Boolean logic is a special form of evaluation used by Visual C# .NET to evaluate simple and complex expressions alike down to a value of `true` or `false`. In the following hours, you'll learn how to create loops and how to perform decisions in code. What you learned here about Boolean logic is critical to your success with loops and decision structures; you'll use Boolean logic perhaps even more often than you'll perform arithmetic.

Manipulating strings and dates each takes special considerations. In this hour, you learned how to work with both types of data to extract portions of values and to add pieces of data together to form a new whole. String manipulation is pretty straightforward, and you'll get the hang of it soon enough as you start to use some of the string functions. Date manipulation, on the other hand, can be a bit tricky. Even experienced developers need to refer to the online help at times. You learned the basics in this hour, but don't be afraid to experiment on your own.

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Q&A

Q1: *Should I always specify parentheses to ensure that operators are evaluated as I expect them to be?*

A1: Visual C# .NET never fails to evaluate expressions according to the order of operator precedence, so using parentheses isn't necessary when the order of precedence is correct for an expression. However, using parentheses assures you that the expression is being evaluated and may make the expression easier to read by other people. This really is your choice.

Q2: *I would like to learn more about the properties and methods available in the DateTime structure; where can I find all the members listed?*

A2: I would look at the DateTime members documentation found within the .NET Framework documentation. This is available on the MSDN site and as an installable option when installing Visual Studio .NET.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** To get only the remainder of a division operation, you use which operator?
- 2:** Which operation is performed first in the following expression—the addition or the multiplication?
- 3:** Does this expression evaluate to **true** or to **false**?
- 4:** Which Boolean operator performs a logical negation?
- 5:** The process of appending one string to another is called?
- 6:** What property can be used to return the month of a given date?

Exercises

- 1:** Create a project that has a single text box on a form. Assume that the user enters a first name, a middle initial, and a last name into the text box. Parse the contents into three variables—one for each part of the name.
- 2:** Create a project that has a single text box on a form. Assume that the user enters a valid birthday into the text box. Use the date functions as necessary to tell the user the number of the month in which they were born.

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Hour 13. Making Decisions in Visual C# .NET Code

In [Hour 10](#), "Creating and Calling Methods," you learned how to separate code into multiple methods so that the methods can be called in any order required. This goes a long way in organizing code, but you still need a way to selectively execute code procedures or groups of statements within a procedure. You can use decision-making techniques to accomplish this. Decision-making constructs are coding structures that you use to execute (or omit) code based on the current situation, such as the value of a variable. Visual C# .NET includes two constructs that enable you to make any type of branching decision you can think of: `if...else` and `switch`.

In this hour, you'll learn how to use the decision constructs provided by Visual C# .NET to perform robust yet efficient decisions in Visual C# .NET code. In addition, you'll learn how to use the `goto` statement to redirect code. You'll probably create decision constructs in every application you build, so the faster you master these skills, the easier it will be to create robust applications.

The highlights of this hour include the following:

- Making decisions using `if` statements
- Expanding the capability of `if` statements using `else`
- Evaluating an expression for multiple values using the `switch` statement

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Making Decisions Using `if` Statements

By far the most common decision-making construct used in programming is the `if` construct. A simple `if` construct looks like this:

```
if (expression)
    ... statement to execute when expression is true;
```

The `if` construct uses Boolean logic, as discussed in [Hour 12](#), "Performing Arithmetic, String Manipulation, and Date/Time Adjustments," to evaluate an expression to either `true` or `false`. The expression may be simple (`if (x == 6)`) or complicated (`if (x==6 && y>10)`). If the expression evaluates to `true`, the statement or block of statements (if enclosed in braces) gets executed. If the expression evaluates to `false`, Visual C# .NET doesn't execute the statement or statement block for the `if` construct.



Remember that compound statements, also frequently called *block* statements, can be used anywhere a statement is expected. A compound statement consists of zero or more statements enclosed in braces `{}`. Following is an example of the `if` construct using a block statement:

```
if (expression)
{
    statement 1 to execute when expression is true;
    statement 2 to execute when expression is true;
    ... statement n to execute when expression is true;
}
```

You're going to create a simple `if` construct in a Visual C# .NET project. Create a new Windows Application named **Decisions** and follow these steps:

1. Rename the default form to **fclsDecisions** and set the Text property of the form to **Decisions Example**.
2. Update the entry point `Main()` to reference **fclsDecisions** instead of `Form1`.
3. Add a new text box to the form by double-clicking the Textbox icon in the toolbox. Set the properties of the text box as follows:

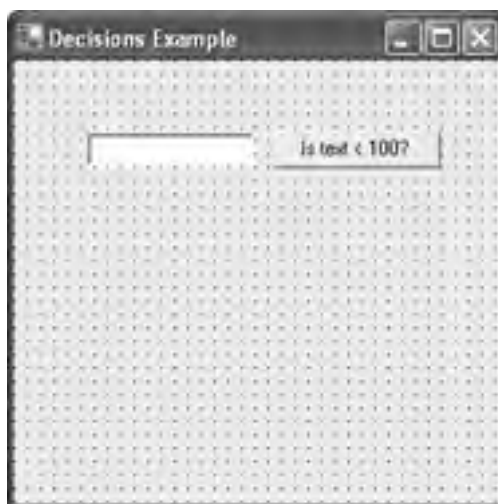
Property	Value
Name	txtInput
Location	44,44
Text	(make blank)

4. Add a new button to the form by double-clicking the Button icon in the toolbox. Set the button's properties as follows:

Property	Value
Name	btnIsLessThanHundred
Location	156,42
Size	100,23
Text	Is text < 100?

Your form should now look like the one in [Figure 13.1](#).

Figure 13.1. You'll use the `if` statement to determine whether the value of the text entered into the text box is less than 100.



You're now going to add code to the button's Click event. This code will use a simple **if** construct and the `int.Parse()` method. The `int.Parse()` method is used to convert text into its numeric equivalent, and you'll use it to convert the text in `txtInput` into an integer. The **if** statement will then determine whether the number entered into the text box is less than 100. Double-click the button now to access its Click event, and enter the following code:

```
if (int.Parse(txtInput.Text)< 100 )  
    MessageBox.Show("The text entered is less than 100.");
```

This code is simple when examined one statement at a time. Look closely at the first statement and recall that a simple **if** statement looks like this:

```
if (expression)  
    statement;
```

In the code you entered, *expression* is

```
int.Parse(txtInput.Text)< 100
```

What you are doing is asking Visual C# .NET to evaluate whether the parsed integer is less than 100. In this case, `Parse` is a method of the `int` (integer) class. `int.Parse` converts a supplied string to an integer data type—which can be used for numerical computations and evaluations. So, the value in the text box is cast to an integer and then compared to see if it is less than 100. If it is, the evaluation returns **true**. If the value is greater than or equal to 100, the expression returns **false**. If the evaluation returns **true**, execution proceeds with the line immediately following the **if** statement and a message is displayed. If the evaluation returns **false**, the line statement (or block of statements) following the **if** statement doesn't execute, and no message is displayed.



If the user leaves the text box empty or enters a string, an exception will be thrown. Therefore, you'd normally implement exception handling around this type of code. You'll learn about exception handling in [Hour 15](#), "Debugging Your Code."

Executing Code When *Expression* Is False

If you want to execute some code when *expression* evaluates to **false**, include the optional **else** keyword, like this:

```
if (expression)  
    statement to execute when expression is true;  
else  
    statement to execute when expression is false;
```



If you want to execute code only when *expression* equates to **false**, not



when **true**, use the not-equal operator (**!=**) in the expression. Refer to [Hour 12](#) for more information on Boolean logic.

By including an **else** clause, you can have one or more statements execute when *expression* is true and other statements execute when the *expression* is false. In the example you've built, if a user enters a number less than 100, the user will get a message. However, if the number is greater than or equal to 100, the user receives no feedback. Modify your code to look like the following, which ensures that the user always gets a message:

```
if (int.Parse(txtInput.Text)< 100 )  
    MessageBox.Show("The text entered is less than 100.");  
else  
    MessageBox.Show("The text entered is greater than or equal to 100.");
```

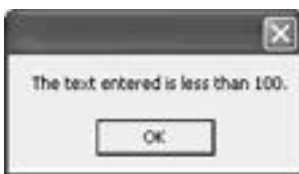
Now, if the user enters a number less than 100, the message **The text entered is less than 100** is displayed, but nothing more. When Visual C# .NET encounters the **else** statement, it ignores the statement(s) associated with the **else** statement. The statements for the **else** condition execute only when *expression* is false. Likewise, if the user enters text that is greater than or equal to 100, the message **The text entered is greater than or equal to 100** is displayed, but nothing more; when *expression* evaluates to **false**, execution immediately jumps to the **else** statement.

Follow these steps:

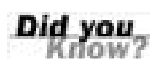
1. Click Save All on the toolbar to save your work.
2. Press F5 to run the project.
3. Enter a number into the text box and click the button.

A message box appears, telling you whether the number you entered is less than or greater than 100 (see [Figure 13.2](#)).

Figure 13.2. As implied with this message box, the if statement gives you great flexibility in making decisions.



Feel free to enter other numbers and click the button as often as you like. When you're satisfied that the code is working, choose Stop Debugging from the Debug menu.



Get comfortable with **if**; chances are good that you'll include at least one in every project you create.

Nesting if Constructs

As mentioned earlier, you can nest **if** statements to further refine your decision making. The format you use can be something like the following:

```
if ( expression1 )  
    if ( expression2 )  
        ...  
    else  
        ...  
else  
    ...
```

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Evaluating an Expression for Multiple Values Using `switch`

At times, the `if` construct isn't capable of handling a decision situation without a lot of extra work. One such situation is when you need to perform different actions based on numerous possible values of an expression, not just `true` or `false`. For instance, suppose that you wanted to perform actions based on a user's profession. The following shows what you might create using `if`:

```
if (strProfession == "programmer")
    ...
else if (strProfession == "teacher")
    ...
else if (strProfession == "accountant")
    ...
else
    ...
```

As you can see, this structure can be a bit hard to read. If the number of supported professions increases, this type of construction will get harder to read and debug. In addition, executing many `if` statements like this is rather inefficient from a processing standpoint.

The important thing to realize here is that each `else...if` is really evaluating the same expression (`strProfession`) but considering different values for the expression. Visual C# .NET includes a much better decision construct for evaluating a single expression for multiple possible values: `switch`.

A `switch` construct looks like the following:

```
switch (expression)
{
    case value1:
        ...
        jump-statement

    default:
        ...
        jump-statement
}
```



default is used to define code that executes only when *expression* doesn't evaluate to any of the values in the case statements. Use of *default* is optional.

Here's the Profession example shown previously, but this time `switch` is used:

```
switch (strProfession)
{
    case "teacher" :
        MessageBox.Show("You educate our young");
        break;
    case "programmer":
        MessageBox.Show("You are most likely a geek");
        break;
    case "accountant":
        MessageBox.Show("You are a bean counter");
        break;
    default:
        MessageBox.Show("Profession not found in switch statement");
        break;
}
```

The flow of the `switch` statement is as follows: When the case expression is matched, the code statement or statements within the case are executed. This must be followed by a jump statement, such as `break`, to transfer control out of the case body.



If you create a **case** construct but fail to put code statements or a jump-statement within the **case**, execution will fall through to the next **case** statement, even if the expression doesn't match.

The **switch** makes decisions much easier to follow. Again, the key with **switch** is that it's used to evaluate a single expression for more than one possible value.

Building a **switch** Example

You're now going to build a project that uses expression evaluation in a **switch** construct. This simple application will display a list of animals in a combo box to the user. When the user clicks a button, the application will display the number of legs of the animal chosen in the list (if an animal is selected). Create a new Windows Application named **Switch Example** and follow these steps:

1. Rename the default form to **fclsSwitchExample**.
2. Set the form's Text property to **Switch Example**.
3. Update the entry point in procedure Main() to reference **fclsSwitchExample** instead of Form1.
4. Add a new combo box to the form by double-clicking the ComboBox item on the toolbox. Set the combo box's properties as follows:

Property	Value
Name	cboAnimals
Location	80,100
Text	(make blank)

5. Next, you'll add some items to the list. Click the Items property of the combo box, and then click the Build button that appears in the property to access the String Collection Editor for the combo box.
6. Enter the text as shown in [Figure 13.3](#); be sure to press Enter at the end of each list item to make the next item appear on its own line.

Figure 13.3. Each line you enter here becomes an item in the combo box at runtime.



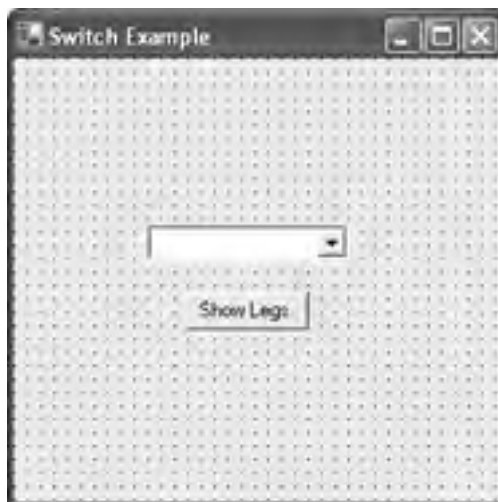
7. Next you'll add a Button control. When the button is clicked, a **switch** construct will be used to determine which

animal the user has selected and to tell the user how many legs the selected animal has. Add a new button to the form by double-clicking the Button tool in the toolbox, and set the button's properties as follows:

Property	Value
Name	btnShowLegs
Location	102,140
Text	Show Legs

Your form should now look like the one in [Figure 13.4](#). Click Save All on the toolbar to save your work before continuing.

Figure 13.4. This example uses only a combo box and a Button control.



All that's left to do is add the code. Double-click the Button control to access its Click event, and then enter the following code:

```
switch (cboAnimals.Text)
{
    case "Bird":
        MessageBox.Show("The animal has 2 legs.");
        break;
    case "Dog":
        // Notice there is no code here to execute.
    case "Cat":
        MessageBox.Show("The animal has 4 legs.");
        break;
    case "Snake":
        MessageBox.Show("The animal has no legs.");
        break;
    case "Centipede":
        MessageBox.Show("The animal has 100 legs.");
        break;
    default:
        MessageBox.Show("You did not select from the list!");
        break;
}
```

Here's what's happening: The `switch` construct compares the content of the `cboAnimals` combo box to a set of predetermined values. Each `case` statement is evaluated in the order in which it appears in the list. Therefore, the expression is first compared to "Bird." If the content of the combo box is Bird, the `MessageBox.Show()` method immediately following the `case` statement is called, followed by the `break` statement, which transfers control outside of the `switch` construct. If the combo box doesn't contain Bird, Visual C# .NET looks to see if the content is "Dog," and so on. Notice that the Dog case contains no code; therefore, the execution of the code in the following case (Cat) is executed if the text Dog was selected (this is known as **execution falling through**). In this situation, you end up with the correct output. However, what happens if you move the Snake case in front of Cat? You'd end up telling the user that the dog has no legs! When using this technique, you must be careful that all situations will produce the desired behavior.

Each successive `case` statement is evaluated in the same way. If no matches are found for any of the `case` statements,

the `MessageBox.Show()` method in the default statement is called. If there were no matches and no default statement, no code would execute.

As you can see, adding a new animal to the list can be as simple as adding a `case` statement.

Try it now by pressing F5 to run the project and then follow these steps:

1. Select an animal from the list and click the button.
2. Try clearing the contents of the combo box and clicking the button.
3. When you're finished, choose Debug, Stop Debugging to stop the project, and click Save All on the toolbar.

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Summary

In this hour you learned how to use Visual C# .NET's decision constructs to make decisions in Visual C# .NET code. You learned how to use **if** statements to execute code when an expression evaluates to **true** and to use **else** to run code when the expression evaluates to **false**. For more complicated decisions, you learned how to use **else...if** to add further comparisons to the decision construct and nest **if** structures for more flexibility.

In addition to **if**, you learned how to use **switch** to create powerful decision constructs to evaluate a single expression for many possible values. Finally, you learned how you can check for multiple possible values using a fall-through **case** statement.

Decision-making constructs are often the backbone of applications. Without the capability to run specific sets of code based on changing situations, your code would be very linear and hence very limited. Become comfortable with the decision constructs and make a conscious effort to use the best construct for any given situation. The better you are at writing decision constructs, the faster you'll be able to produce solid and understandable code.

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Q&A

Q1: *What if I want to execute code only when an expression in an if statement is false, not true? Do I need to place the code in an else clause, and no code after the if?*

A1: This is where Boolean logic helps. What you need to do is make the expression evaluate to `true` for the code you want to run. This is accomplished using the `not` operator (!) in the expression, like this:

```
if (!expression)  
...
```

Q2: *How important is the order in which case statements are created?*

A2: This all depends on the situation. In the earlier example in which the selected animal was considered and the number of legs it has was displayed, the order of the Dog case was important. If all `case` statements contained code, the order has no effect.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** Which decision construct should you use to evaluate a single expression to either **true** or **false**?
- 2:** Evaluating expressions to **true** or **false** for both types of decision constructs is accomplished using _____ logic.
- 3:** If you want code to execute when the expression of an **if** statement evaluates to **false**, include an _____ clause.
- 4:** Which decision construct should you use when evaluating the result of an expression that may equate to one of many possible values?
- 5:** Is it possible that more than one **case** statement may have its code execute?

Exercises

- 1:** Create a project that enables the user to enter text into a text box. Use an **if** construct to determine whether the text entered is a Circle, Triangle, Square, or Pentagon, and display the number of sides the entered shape has. If the text doesn't match one of these shapes, let the users know that they must enter a shape.
- 2:** Rewrite the the project you created in Exercise 1 so that it uses a switch construct instead of an if construct.

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Hour 14. Looping for Efficiency

As you develop your Visual C# .NET programs, you'll encounter situations in which you'll need to execute the same code statement or statements repeatedly. Often, you'll need to execute these statements a specific number of times, but you may need to execute them as long as a certain condition persists (an expression is true) or until a condition occurs (an expression becomes true). Visual C# .NET includes constructs that enable you to easily define and execute these repetitive code routines: *loops*. This hour shows you how to use the two major looping constructs to make your code smaller, faster, and more efficient.

The highlights of this hour include the following:

- Looping a specific number of times using `for` statements
- Looping based on a condition using `do...while` and `while` statements

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Looping a Specific Number of Times Using `for` Statements

The simplest type of loop to create is the `for` loop, which has been around since the earliest forms of the BASIC language. With a `for` loop, you instruct Visual C# .NET to begin a loop by starting a counter at a specific value. Visual C# .NET then executes the code within the loop, increments the counter by a defined incremental value, and repeats the loop until the counter reaches an upper limit you've set. The following is the syntax for the basic `for` loop:

```
for ([initializers]; [expression]; [iterators]) statement
```

Initiating the Loop Using the `for` Statement

The `for` statement both sets up and starts the loop. The `for` statement has the components shown in [Table 14.1](#).

Table 14.1. Components of the `for` Statement

Part	Description
<i>initializers</i>	A comma-separated list of expressions or assignment statements to initialize the loop counters.
<i>expression</i>	An expression that can be implicitly converted to Boolean. The expression is used to test the loop-termination criteria.
<i>iterators</i>	Expression statement(s) to increment or decrement the loop counters.
<i>statement</i>	The embedded statement(s) to execute.

The following is a simple example of a `for` loop, followed by an explanation of what it's doing:

```
for (int intCounter = 1; intCounter <= 100; intCounter++)  
    Debug.WriteLine(intCounter);
```

This `for` statement initializes an Integer named `intCounter` at 1; the condition `intCounter <= 100` is tested and returns `true`; therefore, the statement `debug.WriteLine(intCounter)` is executed. After the statement(s) are executed, the variable `intCounter` is incremented (`intCounter++`). This loop would execute 100 times, printing the numbers 1 through 100 to the Output debug window.



To use the `Debug` object, you need to use the `System.Diagnostics` namespace.

To execute multiple statements within a `for` loop, braces (`{}`) are used; a single-line `for` statement does not require braces. Here is the preceding `for` loop written to execute multiple statements:

```
for (int intCounter = 1; intCounter <= 100; intCounter++)  
{  
    Debug.WriteLine(intCounter);  
    Debug.WriteLine(intCounter-1);  
}
```



There may be times when you want to terminate a `for` loop before the expression evaluates to `true`. To exit a `for` loop at any time, use the `break` statement.

Building a `for` Loop Example

You're now going to create a method containing two `for` loops—one nested within the other. The first loop counts from 1 to 100 and sets the `Width` property of a `Label` control to the current counter value; this will emulate a Windows progress meter. The second loop will be used to slow the execution of the first loop—an old programmer's trick using a `for` loop.

Create a new Windows Application named **ForExample** and follow these steps:

1. Set the form's `Text` to **For Statement Example**.
2. Add a `Label` control to the form by double-clicking the `Label` tool in the toolbox, and set the label's properties as follows:

Property	Value
Name	lblMeter
BackColor	(Set to a light blue or any color you like.)
Location	100,100
Text	(make blank)
Size	100,17

3. Add a button to the form by double-clicking the `Button` item in the toolbox. Set the button's properties as follows:

Property	Value
Name	btnForLoop
Location	88,125
Size	125,23
Text	Run a For Loop

Your form should look like the one shown in [Figure 14.1](#).

Figure 14.1. This simple project will emulate a progress meter.



All that's left to do is to write the code. Double-click the button to access its `Click` event, and enter the following:

```
for (int intLabelWidth=1; intLabelWidth<=100; intLabelWidth++)  
{  
    lblMeter.Width = intLabelWidth;  
    lblMeter.Refresh();  
    for (int intPauseCounter=1; intPauseCounter<=5000000; intPauseCounter++)  
    }  
}
```



Using a loop to create a delay is actually a very poor and outdated coding technique. Other options can be used for creating a delay, such as calling

System.Threading.Thread.Sleep()). This example is designed to illustrate nested loops—which it does—not to show the best way to create a delay.

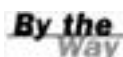


Remember that Visual C# .NET is case sensitive. (Hint: **for**, **int**, and **long** are all lowercase).

The first line starts the first **for** loop. It starts by creating and initializing the variable `intLabelWidth`; next comes an expression used to evaluate the variable, and the third part is the iterator, which increments `intLabelWidth` by one each time the loop completes.

The first statement within this **for** loop sets the width of the Label control to the value of `intLabelWidth`. The next statement calls the `Refresh` method of the Label control to ensure that it paints itself. Often, painting catches up when the CPU has idle time. Because you want the transition from a small label to a large one to be smooth, you need to make sure the label paints itself after each update to its `Width` property. After all the statements within the braces execute, `intLabelWidth` is incremented by one (`intLabelWidth++`) and the expression is evaluated once more. This means that the code within the loop will execute 100 times.

The next statement starts a second **for** loop using the `intPauseCounter` variable, creating and initializing `intPauseCounter` to 1 and setting the upper limit of the loop to 5,000,000. Following this **for** statement is a semicolon (;) with no statement before it. This creates an empty statement. Why is there no code for this **for** statement of the `intPauseCounter` loop? This loop is used simply to create a delay within the processor. Most computers are so fast that if you didn't add a delay here, the first **for** loop would update the label's width from 1 to 100 so fast that you might not even see it update!



I wrote this code on a 2.4GHz machine; you may have to alter the upper limit if your processor speed is much different. If you have a slower CPU, reduce this value. If you have a much faster processor, increase this value. Wait until you test this code before making changes to the upper limit, however. Again, using another method, such as calling `System.Threading.Thread.Sleep()`, would allow precise control over the delay, regardless of the speed of the machine.

Follow these steps to test the project:

1. Click Save All on the toolbar and press F5 to run the project. The label starts with a width of 100.
2. Click the button, and you'll see the label's width change to 1 and then increment to 100.
3. If the speed is too slow or too fast, stop the project and adjust the upper limit of the inner **for** loop.

If you were to forgo a loop and write each and every line of code necessary to draw the label with a width from 1 to 100, it would take 100 lines of code. Using a simple **for** loop, you performed the same task in just a few lines.

A **for** loop is best when you know the number of times you want the loop to execute. This doesn't mean that you have to actually know the number of times you want the loop to execute at design time; it simply means that you must know the number of times you want the loop to execute when you first start the loop. You can use a variable to define any of the arguments of the **for** loop, as illustrated in the following code:

```
int intUpperLimit=100;
for (int intCounter=1; intCounter<=intUpperLimit;intCounter++)
    Debug.WriteLine(intCounter);
```



One of the keys to writing efficient code is to eliminate redundancy. If you find yourself typing the same (or a similar) line of code repeatedly in the same procedure, chances are it's a good candidate for a loop (and you may even want to place the duplicate code in its own method).

Using `do...while` to Loop an Indeterminate Number of Times

In some situations, you won't know the exact number of times a loop needs to be performed—not even when the loop begins. When you need to create such a loop, using the `do...while` loop is the best solution.

The `do...while` comes in a number of flavors. Its most basic form has the following syntax:

`do statement while (expression);`



The following syntax is used to execute multiple statements:

```
do
{
  [Statements]
} while (expression);
```

Ending a `do...while` Loop

A `do...while` loop without some sort of exit mechanism or defined condition is an endless loop. In its most basic form, nothing is present to tell the loop when to stop looping. At times you may need an endless loop (game programming is an example), but more often, you'll need to exit the loop when a certain condition is met. As with the `for` loop, you can use the `break` statement to exit a `do...while` loop at any time. For example, you could expand the `do...while` loop to include a `break` statement like the following:

```
do
{
  [Statements]
  if (expression)
    break;
} while (x==x);
```

In this code, the loop would execute until *expression* evaluates to `true`. Generally, the expression is based on a variable that's modified somewhere within the loop. Obviously, if the expression never changes, the loop never ends.

The second flavor of the `while` loop is the `while...do` loop. The following is a simple `while...do` loop:

`while (expression) statement`

As long as *expression* evaluates to `true`, the loop continues to occur. If *expression* evaluates to `false` when the loop first starts, the code between the statement(s) doesn't execute—not even once.

The difference between the `do...while` and the `while...do` loops is that the code statements within the `do...while` loop *always* execute at least once; *expression* isn't evaluated until the loop has completed its first cycle. Therefore, such a loop always executes at least once, regardless of the value of expression. The `while` loop evaluates the expression first; therefore, the statements associated with it may not execute at all.

Creating a `do...while` Example

You're now going to create an example using a `do...while` loop that updates a label to once again simulate a progress meter. This loop performs the same purpose as the `for` loop you created in the previous example, but its structure is quite different.

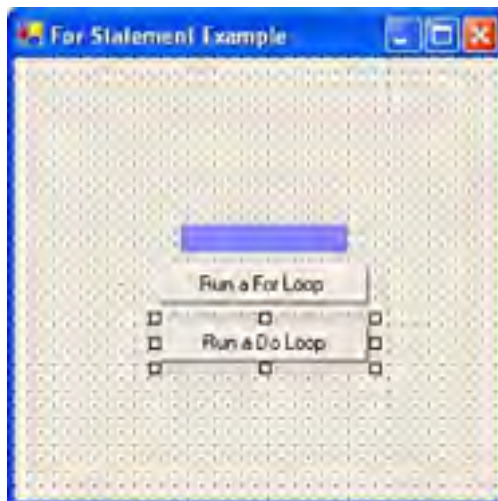
If your `for` example is currently running, choose Debug, Stop Debugging. Add another button to the form and set the new button's properties as follows:

Property	Value
Name	btnDoLoop

Location	88,160
Size	125,23
Text	Run a Do Loop

Your form should now look like the one shown in [Figure 14.2](#).

Figure 14.2. You'll use the same form for both loop examples.



Double-click the new button to access its Click event and then enter the following code:

```
int intLabelWidth=1;

while (intLabelWidth != 100)
{
    lblMeter.Width = intLabelWidth;
    lblMeter.Refresh();
    intLabelWidth++; // Increment by one.
    for (int intPauseCounter=1; intPauseCounter<=5000000; intPauseCounter++);
}
```

Again, this code is more easily understood when broken down, as shown in the following list:

- The first line creates the `intLabelWidth` variable and sets it to 1.
- A `while` statement is used to start a loop. This loop will execute until `intLabelWidth` has the value 100. It can also be read as "the statements will execute while `intLabelWidth` does not equal 100."
- The Label's Width property is set to the value of `intLabelWidth`.
- The Label is forced to refresh its appearance.
- The `intLabelWidth` variable is incremented by 1.
- A `for` loop is used to slow down the procedure, just as in the previous example. Again, this is just to illustrate nested loops. Calling `System.Threading.Thread.Sleep()` would be a better way to create a delay.

Click Save All on the toolbar to save the project, and then press F5 to run it. Click the Run a Do Loop button to see the progress meter set itself to 1 pixel and then update itself by 1 until it reaches 100 pixels.

You've now seen how to perform the same function with two entirely different coding techniques. This is fairly common when creating programs; multiple approaches usually exist to achieve a solution to a given problem. Simply being aware of your options makes writing code that much easier. When you hear of people optimizing their code, they're usually looking for a different, faster approach to a problem they've already solved.

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Summary

Looping is a powerful technique that enables you to write tighter code. Tighter code is smaller, more efficient, and usually—but not always—more readable. In this hour, you learned to write `for` loops for situations in which you know the precise number of times you want a loop executed. Remember, it's not necessary to know the number of iterations at design time, but you must know the number at runtime to use a `for` loop. You learned how to use iterators to increment the counter of a `for` loop, and even how to exit a loop prematurely using `break`.

In this hour, you also learned how to use the very powerful `do...while` loop. The `do...while` loop enables you to create very flexible loops that can handle almost any looping scenario. You learned how evaluating *expression* in a `do...while` loop makes the loop behave differently than when evaluating the expression in a `while...do` loop. If a `for` loop can't do the job, some form of the `do...while` or `while...do` loop will.

In addition to learning the specifics about loops, you've seen firsthand how multiple solutions to a problem can exist. Often, one approach is clearly superior to all other approaches, although you may not always find it. Other times, one approach may be only marginally superior or multiple approaches may all be equally applicable. Expert programmers are able to consistently find the best approaches to any given problem. With time, you'll be able to do the same.

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Q&A

Q1: *Are there any specific cases in which one loop is appropriate over another?*

A1: Usually, when you have to walk an index or sequential set of elements (such as referencing all elements in an array), the `for` loop is the best choice.

Q2: *Should I be concerned about the performance differences between the two types of loops?*

A2: With today's fast processors, chances are good that the performance difference between the two loop types in any given situation will be overshadowed by the readability and functionality of the best choice of loop. If you have a situation in which performance is critical, write the loop using all the ways you can think of, benchmark the results, and choose the fastest loop.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** True or False: You have to know the start and end values of a `for` loop at design time to use this type of loop.
- 2:** Is it possible to nest loops?
- 3:** What type of loop would you most likely need to create if you didn't have any idea how many times the loop would need to occur?
- 4:** If you evaluate the expression in a `do...while` on the `while` statement, is it possible that the code within the loop may never execute?
- 5:** What statement do you use to terminate a `do...while` without evaluating the expression on the `do` or `while` statements?

Exercises

- 1:** The status meter example using `do...while` has a deliberate "bug." The meter will display only to 99 (the label's width will adjust only to 99 pixels, not 100). The problem has to do with how the expression is evaluated. Find and correct this problem.
- 2:** Use two `for` loops nested within each other to size a label in two dimensions. Have the outer loop change the Width property of the label from 1 to 100 and have the inner loop change the Height property from 1 to 100. You may be surprised by the result—it is rather odd.

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Hour 15. Debugging Your Code

No one writes perfect code. You're most certainly familiar with those problems that prevent code from executing properly—they're called *bugs*. Because you are new to Visual C# .NET, your code will probably contain a fair number of bugs. As you gain proficiency, the number of bugs in your code will decrease, but they will never disappear entirely. Debugging is a skill and an art. This book can't teach you how to debug every possible build or runtime error you encounter; however, in this hour you will learn the basic skills necessary to trace and correct most bugs in your code.

The highlights of this hour include the following:

- Adding comments to your code
- Identifying the two basic types of errors
- Working with break points
- Using the Command window
- Using the Output window
- Creating a structured error handler



The Task List window is useful for addressing build errors in code. However, because its use goes beyond this simple debugging application, I discuss the Task List in [Hour 10](#), "Creating and Calling Methods."

Before proceeding, create a new Windows Application project named **Debugging Example**. Change the name of the default form to **fclsDebuggingExample**, set its Text property to **Debugging Example**, and change the Main entry point of the project to **fclsDebuggingExample**.

Add a new text box to the form by double-clicking the TextBox item in the toolbox. Set the text box's properties as follows:

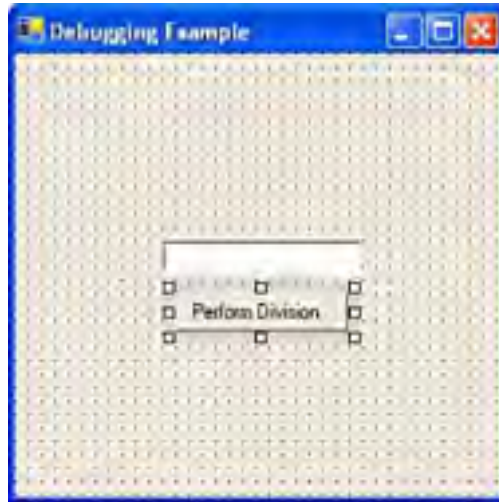
Property	Value
Name	txtInput
Location	88,112
Size	120,20
Text	(make blank)

Next, add a new button to the form by double-clicking the Button item in the toolbox, and then set its properties as follows:

Property	Value
Name	btnPerformDivision
Location	96,144
Size	104,23
Text	Perform Division

Your form should now look like the one shown in [Figure 15.1](#).

Figure 15.1. This simple interface will help teach you debugging techniques.



All this little project will do is divide 100 by whatever is entered into the text box. As you write the code to accomplish this, various bugs will be introduced (on purpose), and you'll learn to correct them. Save your project now by clicking the Save All button on the toolbar.

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Adding Comments to Your Code

One of the simplest things you can do to reduce bugs from the start—and make tracking down existing bugs easier—is to add comments to your code. A code comment is simply a line of text that Visual C# .NET knows isn't actual code. Comment lines are stripped from the code when the project is compiled to create a distributable component, so comments don't affect performance. Visual C# .NET's code window shows comments as green text. This makes it easier to read and understand procedures. You should consider adding comments to the top of each procedure stating the purpose of the procedure. In addition, you should add liberal comments throughout all procedures, detailing what's occurring in the code.

Did you Know?

Comments are meant to be read by humans, not by computers. Strive to make your comments intelligible. Keep in mind that a comment that is hard to understand isn't much better than no comment at all. Also, remember that comments serve as a form of documentation. Just as documentation for an application must be clearly written, code comments should also follow good writing principles as well.

To create a comment, precede the comment text by two forward slash marks (`//`). For example, a simple comment might look like this:

```
// This is a comment because it is preceded by double forward slashes.
```

Comments can also be placed at the end of a line of code, like this:

```
int intAge;    // Used to store the user's age in years.
```

Everything to the right of and including the double forward slashes in this statement is a comment. Visual C# .NET also supports a second type of comment. This allows for comments to span multiple lines without forcing the developer to add `//` characters to each line. Such a comment begins with an open comment mark of a forward slash, followed by an asterisk (`/*`), and the comment closes with a close mark of an asterisk followed by a forward slash (`*/`). For example, a comment can look like this:

```
/* Chapter 15 in Sams TY Visual C# .NET  
focuses on debugging code; something most developers  
spent a lot of time on. */
```

By adding comments to your code, you don't have to rely on memory to decipher the code's purpose or mechanics. If you've ever had to go back and work with code you haven't looked at in a while, or had to work with someone else's code, you probably already have a great appreciation for comments.

Double-click the button now to access its `Click` event and add the following two lines of code (comments, actually):

```
// This procedure divides 100 by the value entered in  
// the text box txtInput.
```

Notice that after you enter the second forward slash, both slashes turn green. Comments, whether single-line (`//`) or multiline (`/* comments */`), will be displayed in a green font in Visual Studio .NET.

When creating code comments, strive to do the following:

- Document the purpose of the code (the *why*, not the *how*).
- Clearly indicate the thinking and logic behind the code.
- Call attention to important turning points in code.
- Reduce the need for readers to run a simulation of code execution in their heads.

By the Way

Visual C# .NET also supports an additional type of comment denoted with three slashes (`///`). When the Visual C# .NET compiler encounters these

comments, it processes them into an XML file. These types of comments are often used to create documentation for code. Creating XML files from comments is a bit advanced for this book, but if these features intrigue you, I highly recommend that you look into it.

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Identifying the Two Basic Types of Errors

Essentially, two types of errors can occur in code: **compile errors** and **runtime errors**. A compile error (commonly called a **build** error) is an error in code that prevents Visual C# .NET's compiler from being able to process the code. Visual C# .NET won't compile a project that has a build error in it. A method call with incorrect parameters, for example, will generate a build error. Runtime errors are errors that don't occur at compile time but are encountered when the project is being run. Runtime errors are usually a result of trying to perform an invalid operation on a variable.

For example, the following code won't generate a compile error:

```
intResult = 10 / intSomeOtherVariable;
```

Under most circumstances, this code won't even generate a runtime error. However, what happens if the value of `intSomeOtherVariable` is 0? Ten divided by zero is undefined, which won't fit into `intResult` (`intResult` is an Integer variable). Attempting to run the code with the variable having a value of 0 causes Visual C# .NET to return a runtime error. A runtime error is called an *exception*, and when an exception occurs, it is said to be **thrown** (that is, Visual C# .NET throws an exception when a runtime error occurs). When an exception is thrown, code execution stops at the offending statement and Visual C# .NET displays an error message. You can prevent Visual C# .NET from stopping execution when an exception is thrown by writing special code to handle the exception (writing error handlers is discussed later in this hour).

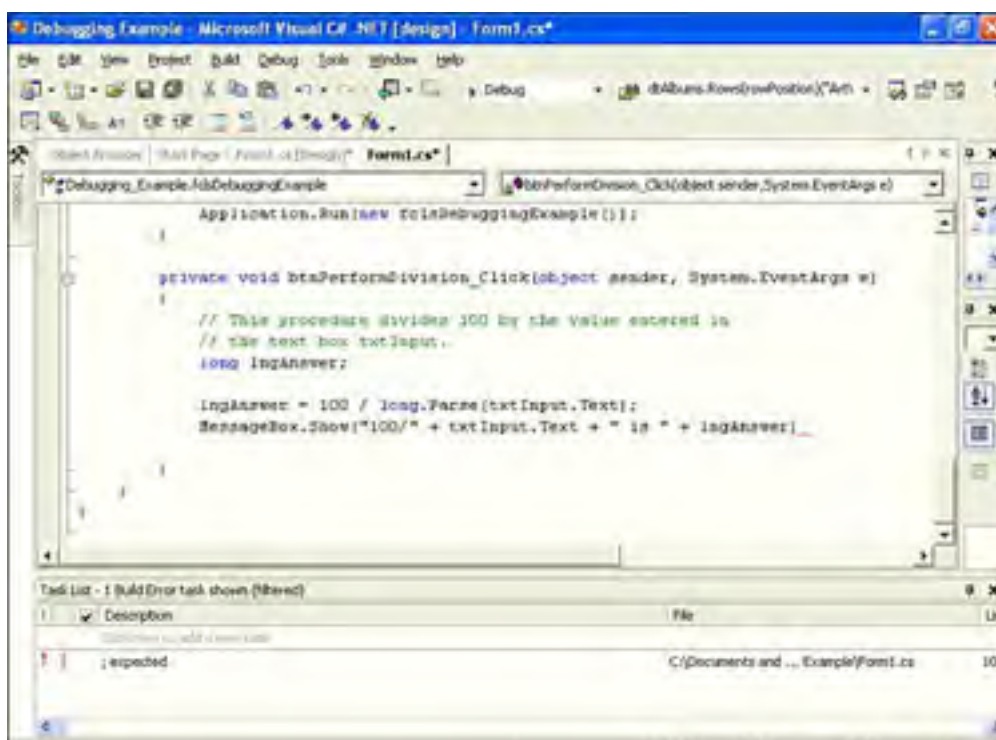
Add the following statements to the Click event, right below the two comment lines:

```
long lngAnswer;
```

```
lngAnswer = 100 / long.Parse(txtInput.Text);  
MessageBox.Show("100/" + txtInput.Text + " is " + lngAnswer)
```

The missing semicolon in the `MessageBox.Show` line is intentional; type in the preceding line of code exactly as it appears. Although you've missed the ending semicolon, Visual C# .NET doesn't return an immediate error. However, notice how Visual C# .NET displays a wavy red line at the end of the statement. Notice the Description in the Task List following an exclamation point and a wavy red line; Visual C# .NET displays a tip explaining the nature of the error (see [Figure 15.2](#)).

Figure 15.2. Using wavy underlines, Visual C# .NET highlights build errors in the code window.



Press F5 to run the project. When you do, Visual C# .NET displays a message that a build error was found and asks you whether you want to continue. Because the code won't run, there's no point in continuing, so click No to return to the code editor. Take a look at the Task List (if it's not displayed, use the View menu to show it). All build errors in the current project appear in the Task List (refer to [Figure 15.2](#)). To view a particular offending line of code, double-click its item in the Task List.

Build errors are very serious in that they prevent code from being compiled; therefore, they completely prevent execution. Build errors must be corrected before you can run the project. Double-click the build error in the Task List to go directly to the error.

Correct the problem by following these steps:

1. Add a semicolon to the end of the line.
2. Press F5 to run the project. Visual C# .NET no longer returns a build error; you've just successfully debugged a problem!
3. Click the Perform Division button now, and you'll receive another error (see [Figure 15.3](#)).

Figure 15.3. A runtime exception halts code execution at the offending line.



This time, the error is a runtime error, or exception. If an exception occurs, you know that the code compiled without a problem because build errors prevent code from compiling and executing. This particular exception is a Format exception. Format exceptions generally occur when you attempt to perform a method using a variable, and the variable is of an incompatible data type for the specified operation. Click Break to view the offending line of code. Visual C# .NET denotes the offending statement with a green arrow (the arrow indicates the current statement). At this point, you know that the statement has a "bug," and you know it is related to data typing. Choose Debug, Stop Debugging now to stop the running project and return to the code editor.

Using Visual C# .NET's Debugging Tools

Visual C# .NET includes a number of debugging tools to help you track down and eliminate bugs. In this section, you'll learn how to use break points, the Command window, and the Output window—three tools that form the foundation of any debugging arsenal.

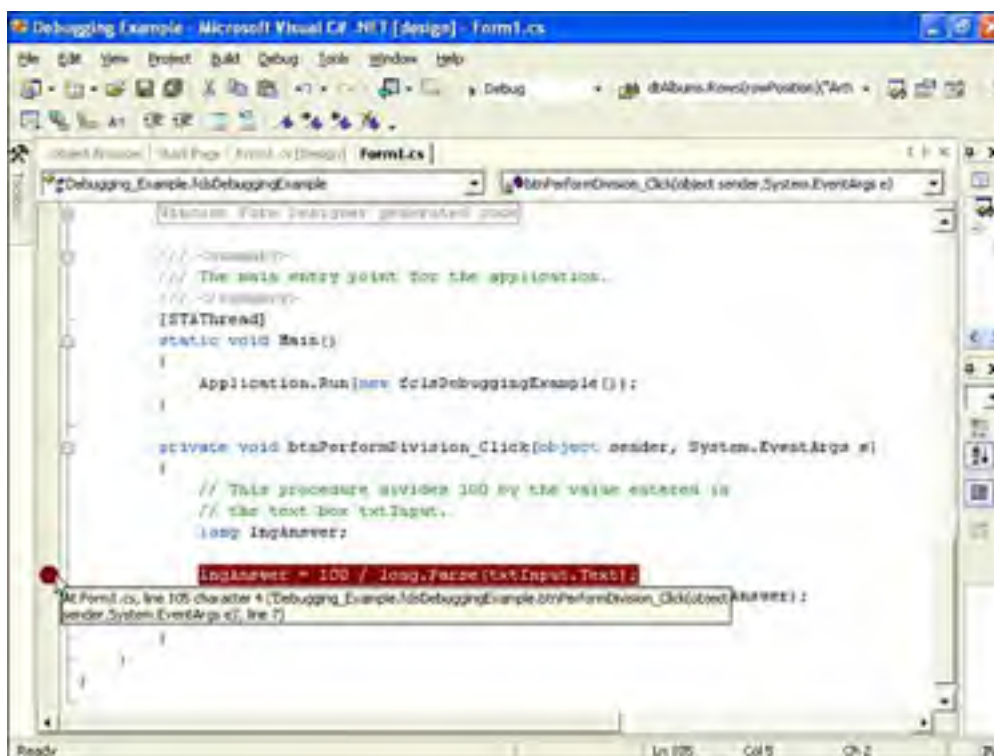
Working with Break Points

Just as an exception halts the execution of a method, you can deliberately stop execution at any statement of code by creating a **break point**. When Visual C# .NET encounters a break point while executing code, execution is halted at the **break** statement prior to it being executed. Break points enable you to query or change the value of variables at a specific instance in time, and they let you step through code execution one line at a time.

You're going to create a break point to help troubleshoot the exception in your `MessageBox.Show` statement.

Adding a break point is simple. Just click in the gray area to the left of the statement at which you want to break code execution. When you do so, Visual C# .NET displays a red circle, denoting a break point at that statement (see [Figure 15.4](#)). To clear a break point, click the red circle.

Figure 15.4. Break points give you control over code execution.

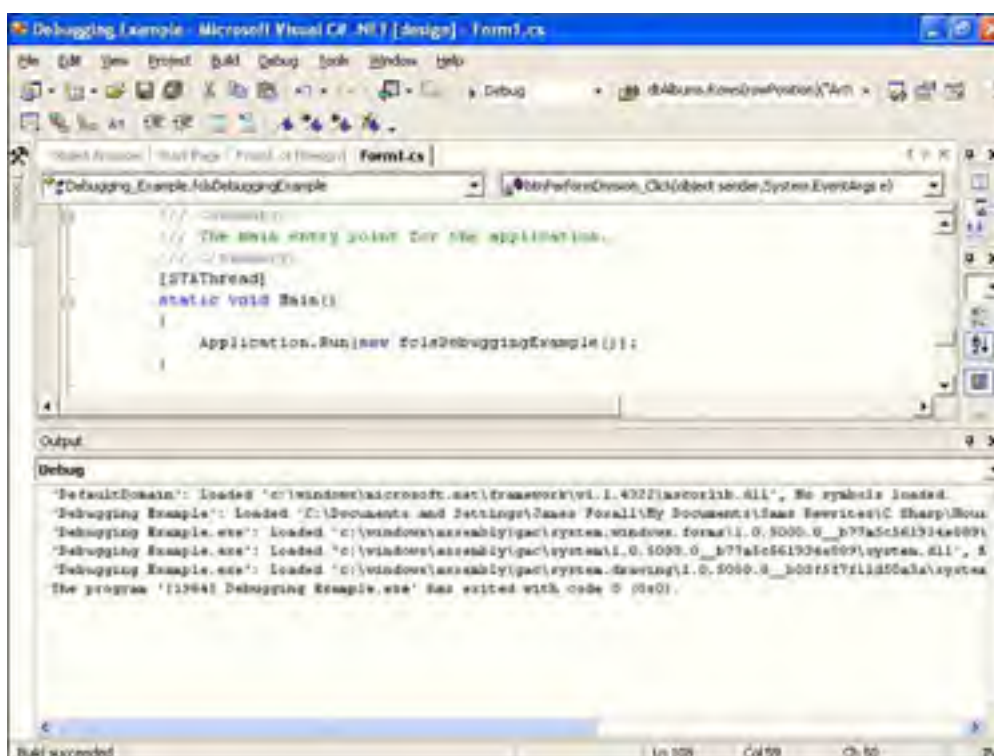


By the way

Break points are saved with the project. This makes it much easier to suspend a debugging session; you don't have to reset all your break points each time you open the project.

Stop the running project by clicking the Stop button on the toolbar, and then set a new break point on the statement shown in [Figure 15.4](#) (the statement where `lngAnswer` is set). Do this by clicking in the gray area to the left of the statement. After you've set the break point, press F5 to run the program. Again, click the button. When Visual C# .NET encounters the break point, code execution is halted and the procedure with the break point is shown. In addition, the cursor is conveniently placed at the statement with the current break point. Notice the yellow arrow overlaying the red circle of the break point (see [Figure 15.5](#)). This yellow arrow marks the next statement to be executed. It just so happens that the statement has a break point, so the yellow arrow appears over the red circle (the yellow arrow won't always be over a red circle, but it will always appear in the gray area aligned with the next statement to be executed).

Figure 15.5. A yellow arrow denotes the next statement to be executed.



When code execution is halted at a break point, you can do a number of things. See [Table 15.1](#) for a list of the most common actions. For now, press F5 to continue program execution. Again, you get the Format exception. Click Break to access the code procedure with the error.

Table 15.1. Actions That Can Be Taken at a Break Point

Action	Keystroke	Description
Continue Code Execution	F5	Continues execution at the current break statement.
Step Into	F11	Executes the statement at the break point and then stops at the next statement. If the current statement is a method call, F11 enters the method and stops at the first statement in the method.
Step Over	F10	Executes the statement at the break point and then stops at the next statement. If the current statement is a method call, the method is run in its entirety; then execution stops at the statement following the method call.
Step Out	Shift+F11	Runs all the statements in the current procedure and halts execution at the statement following the one that called the current procedure.

Using the Command Window

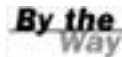
Break points themselves aren't usually sufficient to debug a procedure. In addition to break points, you'll often use the Command window to debug code. The Command window is a Visual Studio .NET window that generally appears only when your project is in Run mode. If the Command window isn't displayed, press Ctrl+Alt+A to display it now (or choose View, Other Views). Using the Command window, you can type in code statements that Visual C# .NET executes immediately. You'll use the Command window now to debug our problem statement example.

Type the following statement into the Command window and press Enter:

```
? txtInput.Text
```

Although it's not intuitive, the ? character has been used in programming for many years as a shortcut for the word "print." The statement that you entered simply prints the contents of the Text property of the text box.

Notice how the command window displays "" on the line below the statement you entered. This indicates that the text box contains an empty string (also called a *zero-length string*). The statement throwing the exception is attempting to use the long.Parse() method to convert the contents of the text box to a Long. The long.Parse() method expects data to be passed to it, yet the text box has no data (the Text property is empty). Consequently, a Format exception occurs.



Generally, when you receive a Format exception, you should look at any variables or properties being referenced to ensure that the data they contain is appropriate data for the statement. Often, you'll find that the code is trying to perform an operation that is inappropriate for the data being supplied.

You can do a number of things to prevent this error. The most obvious is to ensure that the text box contains a value before attempting to use the long.Parse() method. You'll do this now. Visual C# .NET doesn't allow you to modify code when in break mode, so choose Debug, Stop Debugging before continuing.

Add the following statement to your method, right above the statement that throws the exception (the one with the break point):

```
if (txtInput.Text == "") return;
```

Press F5 to run the project once more, and then click the button. This time, Visual C# .NET won't throw an exception, and it won't halt execution at your break point; the test you just created causes code execution to leave the procedure before the statement with the break point is reached.

Next, follow these steps:

1. Type your name into the text box and click the button again. Now that the text box is no longer empty, execution passes the statement with the exit test and stops at the break point.
2. Press F5 to continue executing the code, and again you'll receive an exception. Click Break to enter Break mode, and type the following into the Command window (be sure to press Enter when done):

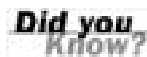
```
? txtInput.Text
```

The Command window prints your name.

Well, you eliminated the problem of not supplying any data to the long.Parse() method, but something else is wrong. Press F5 to continue executing the code and take a closer look at the exception text. The last statement in the text says *Input string was not in a correct format*. It apparently still doesn't like what's being passed to the long.Parse() method.

By now, it may have occurred to you that no logical way exists to convert alphanumeric text to a number; long.Parse() needs a number to work with. You can easily test this by following these steps:

1. Click Break and choose Debug, Stop Debugging.
2. Press F5 to run the project once more.
3. Enter a number into the text box and click the button. Code execution again stops at the break point.
4. Press F11 to execute the statement. No errors this time! Press F5 to continue execution and Visual C# .NET will display the message box (finally).
5. Click OK to dismiss the message box and then close the form to stop the project.



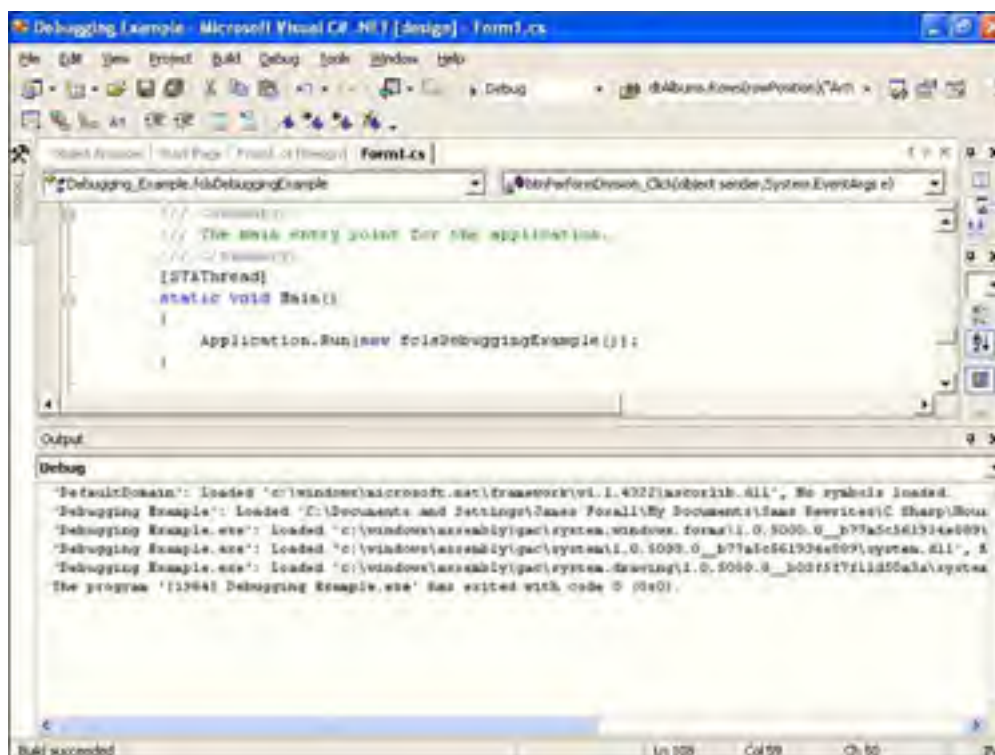
You can use the Command window to change the value of a variable in addition to printing the value.

Because the long.Parse() method expects a number, but the text box contains no intrinsic way to force numeric input, you have to accommodate this situation in your code. You will learn how to deal with exceptions later on in this chapter using a *catch* statement.

Using the Output Window

The Output window (see [Figure 15.6](#)) is used by Visual C# .NET to display various status messages and build errors. The most useful feature of the Output window, for general use, is the capability to send data to it from a running application. This is especially handy when debugging applications.

Figure 15.6. The Output window displays a lot of useful information—if you know what you're looking for.



You've already used the Output window in previous hours, but you might not have seriously considered its application as related to debugging. As you can see from [Figure 15.6](#), some data sent to the Output window by Visual C# .NET isn't that intuitive—in fact, you can ignore much of what is automatically sent to the Output window. What you'll want to use the Output window for is printing data for debugging (as you have done and will do throughout this book). Therefore, it's no coincidence that printing to the Output window is accomplished via the Debug object.

To print data to the Output window, use the WriteLine() method of the Debug object, like this:

```
Debug.WriteLine("Results = " + lngResults);
```

The Debug object is a member of the System.Diagnostics namespace. Therefore, to define the scope for Debug.WriteLine statements, you will need to add **using System.Diagnostics** to the top of your code file.

By the way

If you don't add **using System.Diagnostics** to the top of your code file, you can still access Debug.WriteLine() by writing out the full expression: **System.Diagnostics.Debug.WriteLine()**.

Whatever you place within the parentheses of the WriteLine() method is what is printed to the Output window. Note that you can print literal text and numbers, variables, or expressions. WriteLine() is most useful in cases where you want to know the value of a variable, but you don't want to halt code execution using a break point. For instance, suppose you have a number of statements that manipulate a variable. You can sprinkle WriteLine() statements into the code to print the variable's contents at strategic points. When you do this, you'll want to print some text along with the variable's value so that the output makes sense to you. For example:

```
Debug.WriteLine("Results of area calculation = " + sngArea);
```

You can also use WriteLine() to create checkpoints in your code, like this:

```
Debug.WriteLine("Passed Checkpoint 1");  
// Execute statement here  
Debug.WriteLine("Passed Checkpoint 4");  
// Execute another statement here  
Debug.WriteLine("Passed Checkpoint 3");
```

Many creative uses exist for the Output window. Just remember that the Output window isn't available to a compiled component; calls to the Debug object are ignored by the compiler when creating distributable components.

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Writing an Error Handler Using `try...catch...finally`

It's very useful to have Visual C# .NET halt execution when an exception occurs. When the code is halted while running with the IDE, you receive an error message and you're shown the offending line of code. However, when your project is run as a compiled program, unhandled exceptions will cause the program to terminate (crash to the desktop). This is one of the most undesirable things an application can do. Fortunately, you can prevent exceptions from stopping code execution (and terminating compiled programs) by writing code specifically designed to deal with exceptions. Exception-handling code is used to instruct Visual C# .NET on how to deal with an exception, rather than relying on Visual C# .NET's default behavior.

Visual C# .NET supports *structured error handling* (a formal way of dealing with errors) in the form of a `try` block and/or `catch` block(s) and/or a `finally` block. Creating structured error-handling code can be a bit confusing at first, and like most coding principles, it is best understood by doing it.

Create a new Windows Application called **Structured Exception Handling**. Change the name of the default form to **fclsErrorHandlingExample**, set its Text property to **Try...Catch...Finally**, and change the Main entry point of the project to **fclsErrorHandlingExample**.

Next, add a new button to the form and set its properties as follows:

Property	Value
Name	btnCatchException
Location	104,128
Size	96,23
Text	Catch Exception

Double-click the button and add the following code.

```
try
{
    Debug.WriteLine("Try");
}
catch
{
    Debug.WriteLine("Catch");
}
finally
{
    Debug.WriteLine("Finally");
}
Debug.WriteLine("Done Trying");
```



Remember to add **using System.Diagnostics;** to the top of your code file (below the `using` statements) so that you can use the `Debug.WriteLine()` statement without an explicit reference to the `System.Diagnostics` namespace.

As you can see, the `try`, `catch`, and `finally` statements use the braces (`{}`) to enclose statements. The `try`, `catch`, and `finally` structure is used to wrap code that may cause an exception; it provides the means of dealing with thrown exceptions. [Table 15.2](#) explains the sections of this structure.

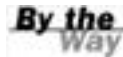
Table 15.2. The `try`, `catch`, and `finally` Structure

Part	Description
<code>try</code>	The <code>try</code> section is where you place code that may cause an exception. You can place all of a procedure's code within the <code>try</code> section, or just a few lines.
<code>catch</code>	Code within a general <code>catch</code> clause executes only when an exception occurs; it's the code you write to catch any exception. There may be multiple <code>catch</code> clauses to handle specific exceptions.
<code>finally</code>	Code within the <code>finally</code> section occurs when the code within the <code>try</code> and/or code within the <code>catch</code> sections

completes. This section is where you place your "cleanup" code—code that you want always executed regardless of whether an exception occurs.

There are three forms of `try` statements:

- A `try` block followed by one or more `catch` blocks.
- A `try` block followed by a `finally` block.
- A `try` block followed by one or more `catch` blocks, followed by a `finally` block.



This example is using a `try` block, followed by a `catch` block, followed by a `finally` block.

Press F5 to run the project and then click the button. Next, take a look at the contents of the Output window. The Output window should contain the following lines of text:

```
Try  
Finally  
Done Trying
```

Here's what happened:

1. The `try` block begins, and code within the `try` section executes.
2. No exception occurs, so code within the `catch` section doesn't execute.
3. When all statements within the `try` section finish executing, the code within the `finally` section executes.
4. When all statements within the `finally` section finish executing, execution jumps to the statement immediately following the `try`, `catch`, and `finally` statements.

Stop the project now by choosing Debug, Stop Debugging. Now that you understand the basic mechanics of the `try`, `catch`, and `finally` structure, you're going to add statements within the structure so that an exception occurs and gets handled.

Change the contents of the procedure to match this code:

```
long lngNumerator = 10;  
long lngDenominator = 0;  
long lngResult;  
  
try  
{  
    Debug.WriteLine("Try");  
    lngResult = lngNumerator / lngDenominator;  
}  
catch  
{  
    Debug.WriteLine("Catch");  
}  
finally  
{  
    Debug.WriteLine("Finally");  
}  
  
Debug.WriteLine("Done Trying");
```

Again, press F5 to run the project; then click the button and take a look at the Output window. This time, the text in the Output window should read

```
Try  
Catch  
Finally  
Done Trying
```

Notice that this time the code within the `catch` section is executed. This happens because the statement that sets `lngResult` causes a `DivideByZero` exception. Had this statement not been placed within a `catch` block, Visual C# .NET

would have raised the exception and an error dialog box would have appeared. However, because the statement is placed within the `try` block, the exception is "caught." Caught means that when the exception occurred, Visual C# .NET directed execution to the `catch` section (you do not have to use a `catch` section, in which case caught exceptions are simply ignored). Notice also how the code within the `finally` section executed after the code within the `catch` section. Remember, code within the `finally` section always executes, regardless of whether an exception occurs.

Dealing with an Exception

Catching exceptions so that they don't crash your application is a noble thing to do, but it's only part of the error-handling process. Usually, you'll want to tell the user (in a friendly way) that an exception has occurred. You'll probably also want to tell the user what type of exception occurred. To do this, you have to have a way of knowing what exception was thrown. This is also important if you intend to write code to deal with specific exceptions. The `catch` statement enables you to specify a variable to hold a reference to an Exception object. Using this Exception object, you can get information about the exception. The following is the syntax used to place the exception in an Exception object:

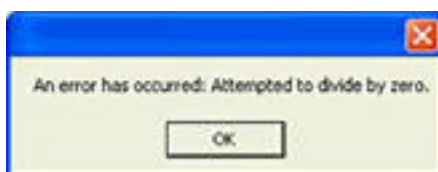
```
catch (Exception variablename)
```

Modify your `catch` section to match the following:

```
catch (Exception objException)
{
    Debug.WriteLine("Catch");
    MessageBox.Show("An error has occurred: " + objException.Message);
}
```

The Message property of the Exception object contains the text that describes the specific exception that occurs. Run the project, click the Catch Exception button, and Visual C# .NET displays your custom error message (see [Figure 15.7](#)).

Figure 15.7. Structured exception handling lets you decide what to do when an exception occurs.



Handling an Anticipated Exception

At times, you'll anticipate a specific exception being thrown. For example, you may write code that attempts to open a file when the file does not exist. In such an instance, you'll probably want the program to perform certain actions when this exception is thrown. When you anticipate a specific exception, you can create a `catch` section designed specifically to deal with that one exception.

Recall from the previous section that you can retrieve information about the current exception using a `catch` statement such as:

```
catch (Exception objException)
```

By creating a generic Exception variable, this `catch` statement will catch any and all exceptions thrown by statements within the `try` section. To catch a specific exception, change the data type of the exception variable to a specific exception type. Remember the code you wrote earlier that caused a Format exception when an attempt was made to pass an empty string to the `long.Parse()` method? You could have used a `try` structure to deal with the exception, using code such as this:

```
long lngAnswer;

try
{
    lngAnswer = 100 / long.Parse(txtInput.Text);
    MessageBox.Show("100/" + txtInput.Text + " is " + lngAnswer);
}
```

```
}  
catch (System.FormatException)  
{  
    MessageBox.Show("You must enter a number in the text box.");  
}  
catch  
{  
    MessageBox.Show("Caught an exception that wasn't a format exception.");  
}
```

Notice that two `catch` statements are in this structure. The first `catch` statement is designed to catch only a `Format` exception; it won't catch exceptions of any other type. The second `catch` statement doesn't care what type of exception is thrown; it catches all of them (as long as they are not a `Format` exception). This second `catch` statement acts as a "catch all" for any exceptions that aren't `Format` exceptions, because `catch` sections are evaluated from top to bottom, much like `case` statements in the `switch` structure. You could add more `catch` sections to catch other specific exceptions if the situation calls for it.

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Summary

In this hour, you learned the basics for debugging applications. You learned how adding useful and plentiful comments to your procedures makes debugging easier. However, no matter how good your comments are, you'll still have bugs.

You learned about the two basic types of errors: build errors and runtime errors (exceptions). Build errors are easier to troubleshoot because the compiler tells you exactly what line contains a build error and generally provides useful information about the error. Exceptions, on the other hand, can crash your application if not handled properly. You learned how to track down exceptions using break points, the Command window, and the Output window. Finally, you learned how to make your applications more robust by creating structured error handlers using the `try` structure.

No book can teach you everything you need to know to write bug-free code. However, in this hour you learned the basic skills to track down and eliminate many types of errors in your programs. As your skills as a programmer improve, so will your debugging abilities.

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Q&A

Q1: *Should I alert the user that an exception has occurred or just let the code keep running?*

A1: If you've written code to handle the specific exception, there's probably no need to tell the user about it. However, if an exception occurs that the code doesn't know how to address, you should provide the user with the exception information so that he or she can report the problem and you can fix it.

Q2: *Should I comment every statement in my application?*

A2: Probably not. However, you should consider commenting every decision-making and looping construct in your program. Usually, these sections of code are pivotal to the success of the procedure, and it's not always obvious what they do.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** What type of errors prevent Visual C# .NET from compiling and running code?
- 2:** What is the name of a runtime error: an error that usually occurs as a result of attempting to process inappropriate data?
- 3:** What characters are used to denote a single-line comment?
- 4:** To halt execution at a specific statement in code, you set a what?
- 5:** Explain the yellow arrow and red circles that can appear in the gray area in the code editor.
- 6:** What IDE window would you use to poll the contents of a variable in Break mode?
- 7:** True or False: You must always specify a `catch` section in a `try` structure.

Exercises

- 1:** In the code example that sets `lngAnswer` to the result of a division expression, change `lngAnswer` from a long to a single (call it `sngAnswer`). Next, remove the `if` statement that tests the contents of the text box *before* performing the division. Do you get the same exceptions that you did when the variable was a long? Why or why not?
- 2:** Rewrite the code that sets `lngAnswer` to the result of a division expression so that the code is wrapped in a `try` structure. Remove the `if` statements that perform data validation, and create two `catch` sections—one for each of the possible exceptions that may be thrown.

Hour 16. Designing Objects Using Classes

You learned about what makes an object an object in [Hour 3](#), "Understanding Objects and Collections." Since that hour, you've learned how to manipulate objects such as forms and controls. The real power of leveraging objects comes from being able to design and implement custom objects of your own design. In this hour, you'll learn how to create your own objects by using classes (in contrast to using static methods). You'll learn how to define the template for an object and how to create your own custom properties and methods.

The highlights of this hour include the following:

- Encapsulating data and code using classes
- Comparing instance member classes with static member classes
- Constructors and destructors
- Creating an object interface
- Exposing object attributes as properties
- Exposing methods
- Instantiating objects from classes
- Binding an object reference to a variable
- Releasing object references
- Understanding object lifetime

By the Way

There is simply no way to become an expert on programming classes in a single hour. However, when you've finished with this hour, you'll have a working knowledge of creating classes and deriving custom objects from those classes; consider this hour a primer on object-oriented programming. I strongly encourage you to seek other texts that focus on object-oriented programming after you feel comfortable with the material presented throughout this book.

Understanding Classes

Classes enable you to develop applications using object-oriented programming (OOP) techniques. Classes are templates that define objects. Although you may not have known it, you have been programming with classes throughout this book. When you create a new form in a Visual C# .NET project, you are actually creating a class that defines a form; forms instantiated at runtime are derived from the class. Using objects derived from predefined classes (such as a Visual C# .NET Form class), is just the start of enjoying the benefits of object-oriented programming—to truly realize the benefits of OOP, you must create your own classes.

The philosophy of programming with classes is considerably different from that of "traditional" programming. Proper class-programming techniques can make your programs better, both in structure and in reliability. Class programming forces you to consider the logistics of your code and data more thoroughly, causing you to create more reusable and extensible object-based code.

Encapsulating Data and Code Using Classes

An object derived from a class is an encapsulation of data and code; that is, the object consists of its code *and* all the data it uses. For example, suppose that you need to keep track of employees in an organization and that you must store many pieces of information for each employee, such as Name, Date Hired, and Title. In addition, suppose that you need methods for adding and removing employees, and you want all this information and functionality available to many functions within your application. You could use static methods to manipulate the data, but doing so would most likely require many variable arrays as well as code to manage those arrays.

A better approach is to *encapsulate* all the employee data and functionality (adding and deleting routines and so forth) into a single, reusable object. Encapsulation is the process of integrating data and code into one entity: an object. Your application, as well as external applications, could then work with the employee data through a consistent interface—the Employee object's interface. An *interface* is a set of exposed functionality—essentially, code routines that define methods, properties, and events.



Creating objects for use outside of your application is beyond the scope of this book. The techniques you'll learn in this hour, however, are directly applicable to creating externally creatable objects.

The encapsulation of data and code is the key detail of classes. By encapsulating the data and the routines to manipulate the data into a single object by way of a class, you free application code that needs to manipulate the data from the intricacies of data maintenance. For example, suppose that company policy has changed so that when a new employee is added to the system, a special tax record must be generated and a form must be printed. If the data and code routines weren't encapsulated in a common object but were written in various places throughout your code, you would have to modify each and every module that contained code to create a new employee record. By using a class to create an object, you need to change the code in only one location: within the object. As long as you don't modify the interface of the object (discussed shortly), all the routines that use the object to create a new employee will instantly have the policy change in effect.

Comparing Instance Members with Static Members

You learned in [Hour 10](#), "Creating and Calling Methods," that Visual C# .NET does not support global methods, but supports only class methods. By creating static methods, you create methods that can be accessed from anywhere in the project through the class.

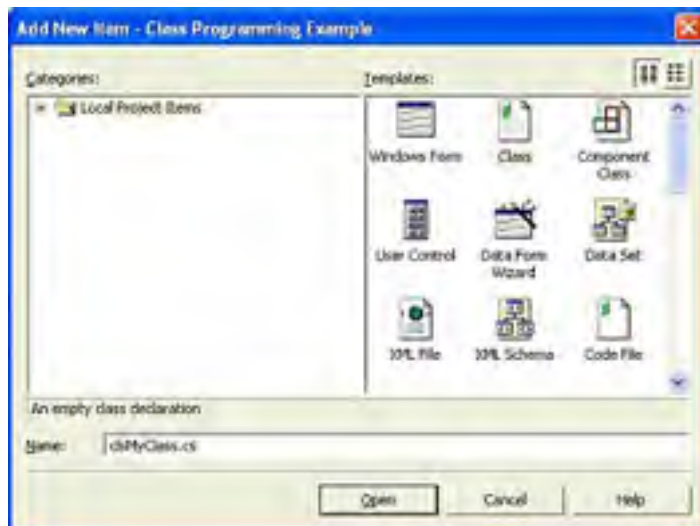
Instance methods are similar to static methods in how they appear in the Visual C# .NET design environment and in the way in which you write code within them. However, the behavior of classes at runtime differs greatly from that of static members. With static members, all static data is shared by all members of the class. In addition, there are never multiple instances of the static class data. With instance member classes, objects are instantiated from a class and each object receives its own set of data. Static methods are accessed through the class, whereas nonstatic methods (also called instance methods) are accessed through instances of the class.

Instance methods differ from static methods in more ways than just how their data behaves. When you define a static method, it is instantly available to other classes within your application. However, instant member classes aren't immediately available in code. Classes are templates for objects. At runtime, your code doesn't interact with the code in the class per se, but it instantiates objects derived from the class. Each object acts as its own class "module" and thus it has its own set of data. When classes are exposed externally to other applications, the application containing the class's code is called the *server*. Applications that create and use instances of objects are called **clients**. When you use instances of classes in the application that contains those classes, the application itself acts as both a client and a server. In this hour, I'll refer to the code instantiating an object derived from a class as *client code*.

Begin by creating a new Windows Application titled **Class Programming Example**. Change the name of the default form to **fcIsClassExample** and set its Text property to **Class Example**. Next, change the entry point of the project in the method Main() to reference **fcIsClassExample** instead of Form1.

Add a new class to the project by choosing Project, Add Class. Save the class with the name **clsMyClass.cs** (see [Figure 16.1](#)).

Figure 16.1. Classes are added to a project just as other object files are added.



Understanding Constructors and Destructors

As you open your new class file, you'll notice that Visual C# .NET added the public class declaration and a method called `clsMyClass()`. This is known as the *class constructor*. A constructor has the same name as the class, includes no return type, and has no return value. A class constructor is called whenever a class object is instantiated. Therefore, it's normally used for initialization if some code needs to be executed automatically when a class is instantiated. If a constructor isn't specified in your class definition, the common language runtime will provide a default constructor.

By the way

Objects consume system resources. The .NET Framework (discussed in [Appendix A](#), "The 10,000-Foot View") has a built-in mechanism to free resources used by objects. This mechanism is called the *garbage collector* (and it is discussed in [Appendix A](#) as well). Essentially, the garbage collector determines when an object is no longer being used and then destroys the object. When the garbage collector destroys an object, it calls the object's destructor method. If you aren't careful about how to implement a destructor method, you can cause problems.

Creating an Object Interface

For an object to be created from a class, the class must expose an interface. As I mentioned earlier, an interface is a set of exposed functionality (properties, methods, and events). An interface is the means by which client code communicates with the object derived from the class. Some classes expose a limited interface, whereas some expose complex interfaces. The content and quantity of your class's interface is entirely up to you.

The interface of a class consists of one or more of the following members:

- Properties
- Methods
- Events

For example, assume that you're creating an Employee object (that is, a class used to derive employee objects). You must first decide how you want client code to interact with your object. You'll want to consider both the data contained within the object and the functions that the object can perform. You might want client code to be able to retrieve the name of an employee and other information such as sex, age, and the date of hire. For client code to get these values from the object, the object must expose an interface member for each of the items. You'll recall from [Hour 3](#) that values exposed by an object are called properties. Therefore, each piece of data discussed here would have to be exposed as a property of the Employee object.

In addition to properties, you can expose functions—such as a Delete or AddNew function. These functions may be simple in nature or very complex. The Delete function of the Employee object, for example, might be quite complex. It might need to perform all the actions necessary to delete an employee, including such things as removing the employee from an assigned department, notifying the accounting department to remove the employee from the payroll, notifying the security area to revoke the employee's security access, and so on. Publicly exposed functions of an object, as you probably remember from [Hour 3](#), are called methods.

Properties and methods are the most commonly used interface members. Although designing properties and methods may be new to you, by now using them isn't—you've been using properties and methods in almost every hour so far. Here, you're going to learn the techniques for creating properties and methods for your own objects.

For even more interaction between the client and the object, you can expose custom events. Custom object events are similar to the events of a form or a text box. However, with custom events you have complete control over the following:

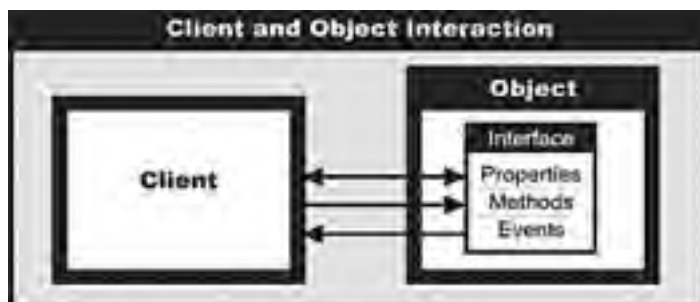
- The name of the event
- The parameters passed to the event
- When the event occurs

By the way

Events in Visual C# .NET are based on delegates. Creating custom events is complicated, and I'll be covering only custom properties and methods in this hour.

Properties, methods, and events together make up an object's interface. This interface acts as a contract between the client application and the object. Any and all communication between the client and the object must transpire through this interface (see [Figure 16.2](#)).

Figure 16.2. Clients interact with an object via the object's interface.



The technical details of the interaction between the client and the object by way of the interface are, mercifully, handled by Visual C# .NET. Your responsibility is to define the properties, methods, and events of an object so that its interface is logical, consistent, and exposes all the functionality a client needs to use the object.

Exposing Object Attributes as Properties

Properties are the attributes of objects. Properties can be read-only, or they can allow both reading and writing of their values. For example, you may want to let a client retrieve the value of a property containing the path of the component, but not let the client change it because the path of a running component can't be changed.

You can add properties to a class in two ways. The first is to declare public variables. Any variable declared as public instantly becomes a property of the class (actually, it acts like a property but it's technically referred to as a *field*). For example, suppose you have the following statement in the Declarations section of a class:

```
int long Quantity;
```

Clients could read from and write to the property using code such as the following:

```
objMyObject.Quantity = 139;
```

This works, but significant limitations exist that make this approach less than desirable:

- You can't execute code when a property value changes. For example, what if you wanted to write the quantity change to a database? Because the client application can access the variable directly, you have no way of knowing when the value of the variable changes.
- You can't prevent client code from changing a property, because the client code accesses the variable directly.
- Perhaps the biggest problem is this: How do you control data validation? For instance, how could you ensure that Quantity was never set to a negative value?

You simply can't work around these issues using a public variable. Instead of exposing public variables, you should create class properties using property procedures.

Property procedures enable you to execute code when a property is changed, to validate property values, and to dictate whether a property is read-only, write-only, or both readable and writable. Declaring a property procedure is similar to declaring a method, but with some important differences. The basic structure of a property looks like this:

```
Private int privatevalue;  
  
public int propertyname  
{  
    get  
    {  
        return privatevalue; // Code to return the property's value.  
    }  
    set  
    {  
        privatevalue = value; // Code that accepts a new value.  
    }  
}
```

The first word in the property declaration simply designates the scope of the property (public or private). Properties declared with public are available to code outside of the class (they can be accessed by client code). Properties declared as private are available only to code within the class. Immediately following public or private are the data type and property name.

Enough of the theory—back to the code you're writing. Place your cursor after the left bracket following the statement `public class clsMyclass` and press Enter to create a new line. Type the following statements into your class:

```
private int m_intHeight;  
  
public int Height  
{  
    get  
    {  
    }  
    set  
    {  
    }  
}
```

You might be wondering why you just created a module-level variable of the same name as your property procedure (with a naming prefix, of course). After all, I just finished preaching about the problems of using a module-level variable as a property. The reason is that a property has to get its value from somewhere, and a module-level variable is usually the best place to store it. The property procedure will act as a wrapper for this variable. Notice that here the variable is private rather than public. This means that no code outside the class can view or modify the contents of this variable; as far as client code is concerned, this variable doesn't exist.

Between the property declaration statement and its closing brace are two constructs: the `get` construct and a `set` construct. Each of these constructs is discussed in its own section.

Creating Readable Properties Using the get Accessor

The `get` accessor is used to place code that returns a value for the property when read by a client. If you remove the `get` accessor and its corresponding brackets, clients won't be able to read the value of the property. It's rare that you'll want to create such a property, but you can.

Think of the `get` accessor as a method; whatever you return as the result of the method becomes the property value. Add the following statement between the `get` brackets:

```
return m_intHeight;
```

You return the value of the property by using the `return` keyword followed by the value.

Creating Writable Properties Using the `set` Accessor

The `set` accessor is where you place code that accepts a new property value from client code. If you remove the `set` accessor (and its corresponding brackets), clients won't be able to change the value of the property. Leaving the `get` accessor and removing the `set` accessor creates a read-only property; clients can retrieve the value of the property but they cannot change it.

Add the following statement between the `set` brackets:

```
m_intHeight = value;
```

The `set` clause uses a special variable called `value`, which is provided automatically by Visual C# .NET and always contains the value being passed to the property by the client code. The statement you just entered assigns the new value to the module-level variable.

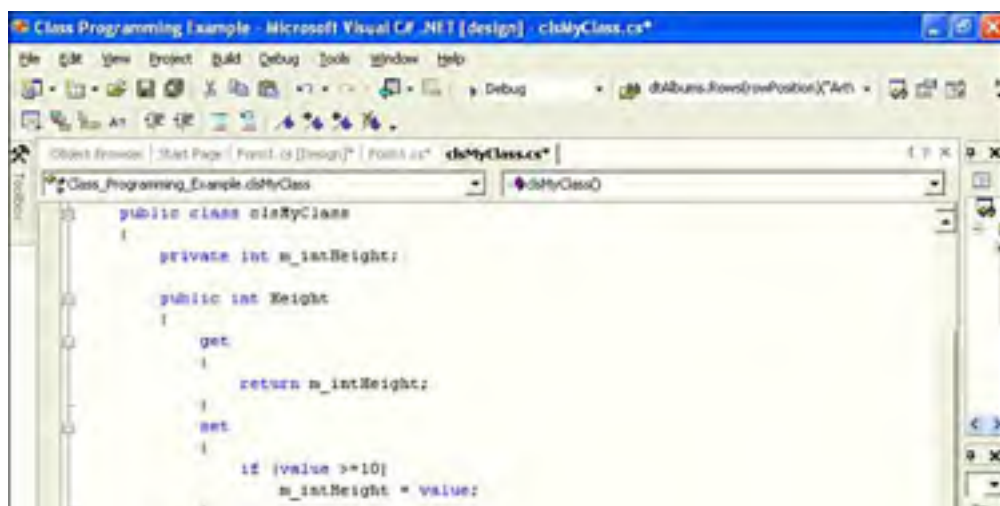
As you can see, the property method is a wrapper around the module-level variable. When the client code sets the property, the `set` accessor stores the new value in the variable. When the client retrieves the value of the property, the `get` accessor returns the value in the module-level variable.

So far, the property code, with its `get` and `set` accessor, doesn't do anything different from what it would do if you were to simply declare a public variable (only the property procedure requires more code). However, look at this variation of the same `set` accessor:

```
set  
{  
    if (value >=10)  
        m_intHeight = value;  
}
```

This `set` accessor restricts the client to setting the Height property to a value greater than 10. If a value less than 10 is passed to the property, the property procedure terminates without setting `m_intHeight`. You're not limited to performing only data validation; you can pretty much add whatever code you want and even call other methods. Go ahead and add the verification statement to your code so that the `set` accessor looks like this one. Your code should now look like the procedure shown in [Figure 16.3](#).

Figure 16.3. This is a property procedure, complete with data validation.



A screenshot of a code editor window. The code shows a public constructor for a class named 'clsMyClass'. The code is as follows:

```
public clsMyClass()  
{  
    // TODO: Add constructor logic here  
}
```

The editor has a status bar at the bottom showing 'Ready', 'Ln:27', 'Col:1', 'Ch:1', and 'PS'. There are also some icons on the right side of the editor window.

Exposing Functions as Methods

Unlike a property that acts as an object attribute, a method is a function exposed by an object. A method can return a value, but it doesn't have to. Create the following method in your class now. Enter this code on the line following the closing bracket for the declared public int Height property (before the line `public clsMyClass()`):

```
public long AddTwoNumbers(int intNumber1, int intNumber2)  
{  
    return intNumber1 + intNumber2;  
}
```

Recall that methods defined with a data type return values, whereas methods defined with `void` don't. To make a method private to the class and therefore invisible to client code, declare the method as private rather than public.

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Instantiating Objects from Classes

After you obtain a reference to an object and assign it to a variable, you can manipulate the object using an object variable. You're going to do this now so follow these steps:

1. Click the Form1.cs Design tab to view the Form Designer.
2. Add a button to the form by double-clicking the Button item in the toolbox. Set the button's properties as follows:

Property	Value
Name	btnCreateObject
Location	104,120
Size	88,23
Text	Create Object

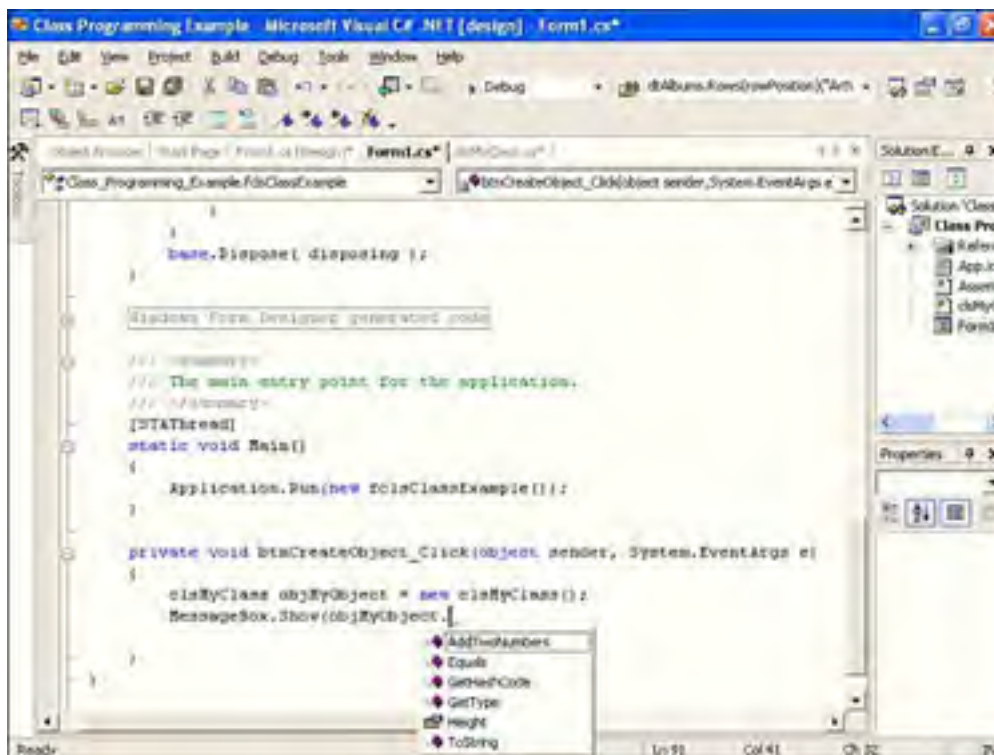
3. Double-click the button to access its Click event, and enter the following code:

```
clsMyClass objMyObject = new clsMyClass();  
MessageBox.Show(objMyObject.AddTwoNumbers(1,2).ToString());
```

The first statement creates a variable of type `clsMyClass`. (Declaring variables was discussed in [Hour 11](#), "Using Constants, Data Types, Variables, and Arrays.") The `new` keyword tells Visual C# .NET to create a new object, and the text following `new` is the name of the class to use to derive the object (remember, classes are object templates). The last statement calls the `AddTwoNumbers` method of your class and displays the result in a message box after converting the return value to a string.

Notice that Visual C# .NET displayed an IntelliSense drop-down list with all the members of the class (see [Figure 16.4](#)).

Figure 16.4. Visual C# .NET displays IntelliSense drop-down lists for members of early-bound objects.



Go ahead and run the project by pressing F5, and then click the button to make sure everything is working correctly. When you are finished, stop the project and save your work.

Binding an Object Reference to a Variable

An object can contain any number of properties, methods, and events; every object is different. When you write code to manipulate an object, Visual C# .NET has to understand the interface of the object or your code won't work. Resolving the interface members (the properties, methods, and events of the object) occurs when an object variable is bound to an object. The two forms of binding are *early binding* (which occurs at compile time) and **late binding** (which occurs at runtime). It's important that you have at least a working understanding of binding if you're to create code based on classes. Although I can't explain the intricacies and technical details of early binding versus late binding in this hour, I'll teach you what you need to know to perform each type of binding.



Both types of binding have benefits, but early binding is generally superior to late binding because code that uses late-bound objects requires more work (time and resources) by Visual C# .NET than code that uses early-bound objects.

Late Binding an Object Variable

When you declare a variable using the generic data type `Object`, you're late binding to the object. Unfortunately, Visual C# .NET requires you to handle additional details when late binding to an object (unlike Visual Basic .NET, which handles the details for you). Late binding is beyond the scope of this book (and early binding is the preferred binding anyway), so I'll be focusing on early binding for the remainder of this hour.

Late binding requires a great deal of overhead, and it adversely affects the performance of an application. Therefore, late binding isn't the preferred method of binding. Late binding does have some attractive uses; however, most of these are related to using objects outside your application, not for using objects derived from classes within the project.

One of the main drawbacks of late binding is that the compiler cannot check the syntax of the code manipulating an object. Because Visual C# .NET doesn't know anything about the members of a late bound object, the compiler has no way of knowing whether you're using a member correctly—or even if the member you're referencing exists. This can result in a runtime exception or some other unexpected behavior.

As explained in the previous hour, runtime exceptions are more problematic than build errors because they're usually encountered by end users and under varying circumstances. When you late bind objects, it's easy to introduce these types of problems; therefore, a real risk exists of throwing exceptions with late binding. As you'll see in the next section, early binding reduces a lot of these risks.

Early Binding an Object Variable

For a member of an object to be referenced, Visual C# .NET must determine and use the internal ID of the specified member. You don't have to know this ID yourself; just be aware that Visual C# .NET needs to know the ID of a member to use it. When an object is early bound (declared as a specific type of object), Visual C# .NET is able to gather the necessary ID information at compile time. This results in considerably faster calls to object members at runtime. In addition, Visual C# .NET can also validate a member call at compile time, reducing the chance of errors in your code.

Early binding occurs when you declare a variable as a specific type of object, rather than just as an object.

The following are important reasons to use early binding:

- Code using early binding is faster: Speed is good.
- Objects, their properties, and their methods appear in IntelliSense drop-down lists.
- The compiler can check for syntax and reference errors in your code so that many problems are found at compile time, rather than at runtime.

For early binding to take place, an object variable must be declared as a specific object type.

Releasing Object References

When an object is no longer needed, it should be destroyed so that all the resources used by the object can be reclaimed. Objects are destroyed automatically after the last reference to the object is released. Be aware, however, that objects aren't necessarily destroyed *immediately* when they are no longer referenced and that you don't have control over when they are destroyed. In [Appendix A](#), you'll learn how the garbage collector cleans up unused objects.

In this section, I'm going to focus on what you should do with an object when you're finished with it.

One way to release a reference to an object is simply to let the object variable holding the reference go out of scope, letting the garbage collector of .NET regain the memory space.

To explicitly release an object, set the object variable equal to null, like this:

```
objMyObject = null;
```

When you set an object variable equal to null, you're assured that the object reference is fully released. Again, just because the reference is released does not mean the object is destroyed! The garbage collector will periodically check for unused objects and reclaim the resources they consume, but this may occur a considerable length of time after the object is no longer used. Therefore, you should add a `Dispose()` method to all your classes. You should place cleanup code within your `Dispose()` method and always call `Dispose()` when you are finished with an object. One thing to keep in mind is that it's technically possible to have more than one variable referencing an object. When this occurs, calling `Dispose()` may cause cleanup code to execute and therefore cause problems for the code using the second object variable. As you can see, you need to consider many things when programming objects.



If you don't correctly release resources used by your objects, your application may experience resource leaks, become sluggish, and consume more resources than it should. If your object uses resources (such as memory or hardware resources), you should implement a `Dispose()` method. In addition, you should always call the `Dispose()` method of an object you are finished with if the object has implemented a `Dispose()` method.

Understanding the Lifetime of an Object

An object created from a class exists until the garbage collector (see [Appendix A](#)) determines that it is no longer used and then destroys the object. Fortunately, Visual C# .NET (or more specifically, the .NET Framework) handles the details of keeping track of the references to a given object; you don't have to worry about this when creating or using objects. Some time after all the references to an object are released, Visual C# .NET destroys the object. Your primary responsibility for destroying objects is to call `Dispose()` on any objects that you're finished with and to create a `Dispose()` method for your own classes that use resources. Beyond that, the garbage collector handles the details of destroying the objects.

- An object is created (and hence referenced) when an object variable is declared using the keyword `new` (for example, `clsMyClass objMyObject = new clsMyClass();`).
- An object is referenced when an object variable is assigned an existing object (for example, `objThisObject = objThatObject;`).
- An object reference is released when an object variable is set to null (see the section "[Releasing Object References](#)") or goes out of scope.
- When the last reference to an object is released, the object becomes eligible for garbage collection. Many factors, including available system resources, determine when the garbage collector executes next and destroys unused objects.

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Summary

Object-oriented programming is an advanced methodology that enables you to create more robust applications; programming classes is the foundation of OOP. In this hour, you learned how to create classes, which are the templates used to instantiate objects. You also learned how to create a custom interface consisting of properties and methods and how to use the classes you've defined to instantiate and manipulate objects by way of object variables.

You've also learned how you should implement a `Dispose()` method for classes that consume resources and how it is important to call `Dispose()` on objects that implement it to ensure that the object frees up its resources as soon as possible. Finally, you learned how objects aren't destroyed as soon as they are no longer needed; rather, they become eligible for garbage collection and are destroyed when the garbage collector next cleans up.

In this hour, you learned the basic mechanics of programming objects with classes. Object-oriented programming takes considerable skill, and you'll need to master the concepts in this book before you can really begin to take advantage of what OOP has to offer. Nevertheless, what you learned in this hour will take you further than you might think. Using an OOP methodology is as much a way of thinking as it is a way of programming; consider how things in your projects might work as objects, and before you know it, you'll be creating robust classes.

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Q&A

Q1: *Should I always try to place code into instance classes rather than static classes?*

A1: Not necessarily. As with most things, there are no hard and fast rules. Correctly programming instance classes takes some skill and experience, and programming static is easier for the beginner. If you want to experiment with instance classes, I encourage you to do so. However, don't feel as though you have to place everything into instantiated classes.

Q2: *I want to create a general class with a lot of miscellaneous methods—sort of a "catchall" class. What's the best way to do this?*

A2: If you want to create some sort of utility class, I recommend calling the class something like clsUtility. Then you can use this class throughout your application to access the utility functions.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** To create objects, you must first create a template. This template is called a:
- 2:** One of the primary benefits of object-oriented programming is that objects contain both their data and their code. This is called:
- 3:** With static classes, public variables and routines are always available to code via the static class in other modules. Is this true with public variables and routines in classes?
- 4:** True or False: Each object derived from a class has its own set of class-level data.
- 5:** What must you do to create a property that can be read but not changed by client code?
- 6:** What is the best way to store the internal value of a property within a class?
- 7:** Which is generally superior, early binding or late binding?
- 8:** What is the best way to release an object you no longer need?

Exercises

- 1:** Add a new property to your class called DropsInABucket. Make this property a Long, and set it up so that client code can read the property value but not set it. Finally, add a button to the form that, when clicked, prints the value of the property to the Output window. When this is working, modify the code so that the property always returns 1,000,000.
- 2:** Add a button to your form that creates two object variables of type clsMyClass(). Use the `new` keyword to instantiate a new instance of the class in one of the variables. Then set the second variable to reference the same object and print the contents of the Height property to the Output window.

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Hour 17. Interacting with Users

Forms and controls are the primary means by which users interact with an application, and vice versa. However, program interaction can and often does go deeper than that. For example, a program can display customized messages to a user, and it can be finely tuned to deal with certain keystrokes or mouse clicks. In this hour, you'll learn how to create functional and cohesive interaction between your application and the user. In addition, you'll learn how to program the keyboard and the mouse so that you can expand the interactivity of your program beyond what is natively supported by a form and its controls.

The highlights of this hour include the following:

- Displaying messages using the `MessageBox.Show()` method
- Creating custom dialog boxes
- Interacting with the keyboard
- Using the common mouse events

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Displaying Messages Using the `MessageBox.Show()` Method

A message box is a small dialog box that displays a message to the user (just in case that wasn't obvious enough). Message boxes are often used to tell the user the result of some action, such as **The file has been copied** or **The file could not be found**. A message box is dismissed when the user clicks one of the message box's available buttons. Most applications have many message boxes, yet developers don't often display messages correctly. It's important to remember that when you display a message to a user, you're communicating with the user. In this section, you'll not only learn how to use the `MessageBox.Show()` method to display messages, you're going to learn how to use the method effectively.

The `MessageBox.Show()` method can be used to tell a user something or ask the user a question. In addition to text, which is its primary function, you can also use this function to display an icon or display one or more buttons that the user can click. Although you're free to display whatever text you want, you must choose from a predefined list of icons and buttons.

A `MessageBox.Show()` method is an overloaded method. This means that the method was written with numerous constructs supporting various options. When you're coding in Visual Studio .NET, IntelliSense displays a drop-down scrolling list displaying any of the twelve overloaded `MessageBox.Show` method calls to aid in coding. Following are a few ways to call `MessageBox.Show()`.

To display a message box with specified text, a caption in the title bar, and an OK button, use this syntax:

```
MessageBox.Show(MessageText, Caption);
```

To display a message box with specified text, caption, and one or more specific buttons, use this syntax:

```
MessageBox.Show(MessageText, Caption, Buttons);
```

To display a message box with specified text, caption, buttons, and icon, use this syntax:

```
MessageBox.Show(MessageText, Caption, Buttons, Icon);
```

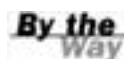
In all these statements, *MessageText* is the text to display in the message box, *Caption* determines what appears in the title bar, *Buttons* determines which buttons the user sees, and *Icon* determines what icon (if any) appears in the message box. Consider the following statement, which produces the message box shown in [Figure 17.1](#).

```
MessageBox.Show("This is a message.");
```

Figure 17.1. A message box in its simplest form.



As you can see, if you omit *Buttons*, Visual C# .NET displays only an OK button. You should always ensure that the buttons displayed are appropriate for the message.



The Visual Basic `MsgBox()` function defaults the caption for the message box to the name of the project. There is no default in Visual C# .NET.

Specifying Buttons and an Icon

Using the *Buttons* parameter, you can display one or more buttons in the message box. The *Buttons* parameter type is `MessageBoxButtons`, and the allowable values are shown in [Table 17.1](#).

Table 17.1. Allowable Enumerators for MessageBoxButtons

Members	Description
<code>AbortRetryIgnore</code>	Displays Abort, Retry, and Ignore buttons
<code>OK</code>	Displays OK button only
<code>OKCancel</code>	Displays OK and Cancel buttons
<code>YesNoCancel</code>	Displays Yes, No, and Cancel buttons
<code>YesNo</code>	Displays Yes and No buttons
<code>RetryCancel</code>	Displays Retry and Cancel buttons

Because the *Buttons* parameter is an enumerated type, Visual C# .NET gives you an IntelliSense drop-down list when you are specifying a value for this parameter. Therefore, committing these values to memory isn't all that important; you'll commit the ones you use most often to memory fairly quickly.

The *Icon* parameter determines the symbol displayed in the message box. The *Icon* parameter is an enumeration from the *MessageBoxIcon* type. The *MessageBoxIcon* has the values shown in [Table 17.2](#).

Table 17.2. Enumerators for MessageBoxIcon

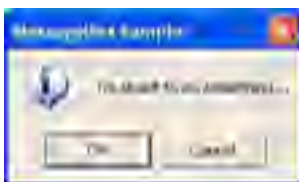
Members	Description
<code>Exclamation</code>	Displays a symbol consisting of an exclamation point in a triangle with a yellow background.
<code>Information</code>	Displays a symbol consisting of a lowercase letter I in a circle.
<code>None</code>	Displays no symbol.
<code>Question</code>	Displays a symbol consisting of a question mark in a circle.
<code>Stop</code>	Displays a symbol consisting of a white X in a circle with a red background.
<code>Warning</code>	Displays a symbol consisting of an exclamation point in a triangle with a yellow background.

The *Icon* parameter is also an enumerated type; therefore, Visual C# .NET gives you an IntelliSense drop-down list when you are specifying a value for this parameter.

The message box in [Figure 17.2](#) was created with the following statement:

```
MessageBox.Show("I'm about to do something...", "MessageBox sample",  
    MessageBoxButtons.OKCancel, MessageBoxIcon.Information);
```

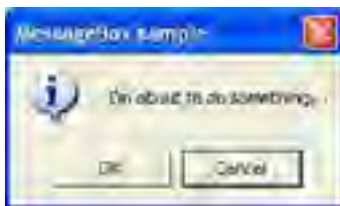
Figure 17.2. Assign the Information icon to general messages.



The message box in [Figure 17.3](#) was created with a statement almost identical to the previous one, except that the second button is designated as the default button. If a user presses the Enter key with a message box displayed, the message box acts as though the user clicked the default button. You'll want to give careful consideration to the default button in each message box. For example, if the application is about to do something that the user probably doesn't want to do, it's best to make the Cancel button the default button—in case the user is a bit quick when pressing the Enter key. Following is the statement used to generate the message box in [Figure 17.3](#):

```
MessageBox.Show("I'm about to do something...", "MessageBox sample",  
    MessageBoxButtons.OKCancel, MessageBoxIcon.Information,  
    MessageBoxDefaultButton.Button2);
```

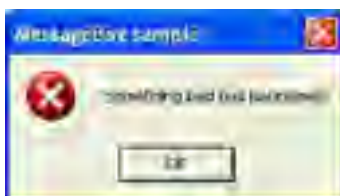
Figure 17.3. The default button has a dark border.



The Error icon is shown in [Figure 17.4](#). The Error icon is best used in rare circumstances, such as when an exception has occurred. Overusing the Error icon is like crying wolf—when a real problem emerges, the user might not pay attention. Notice here how I've displayed only the OK button. If something has already happened and there's nothing the user can do about it, don't bother giving the user a Cancel button. The following statement generated the message box shown in [Figure 17.4](#).

```
MessageBox.Show("Something bad has happened!", "MessageBox sample",  
    MessageBoxButtons.OK, MessageBoxIcon.Error);
```

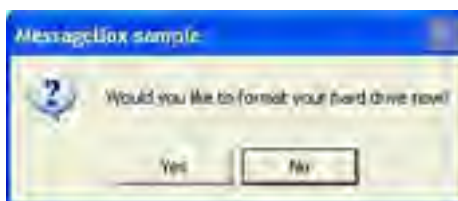
Figure 17.4. If users have no control over what has occurred, don't give them a Cancel button.



In [Figure 17.5](#), a question has been posed to the user, so I displayed the Question icon. Also note how I assumed that the user would probably choose No, so I made the second button the default. In the next section, you'll learn how to determine which button the user clicks. Here's the statement used to generate the message box shown in [Figure 17.5](#):

```
MessageBox.Show("Would you like to format your hard drive now?",  
    "MessageBox sample", MessageBoxButtons.YesNo, MessageBoxIcon.Question,  
    MessageBoxDefaultButton.Button2);
```

Figure 17.5. A message box can be used to ask a question.



As you can see, designating buttons and icons is not all that difficult. The real effort comes in determining which buttons and icons are appropriate for a given situation.

Determining Which Button Is Clicked

You'll probably find that many of your message boxes are simple, containing only an OK button. For other message boxes, however, you'll need to determine which button a user clicks. Why give the user a choice if you're not going to act on that choice? The `MessageBox.Show()` method returns the button clicked as a `DialogResult` enumeration. The `DialogResult` has the following values, as shown in [Table 17.3](#).

Table 17.3. Enumerators for DialogResult

Members	Description
Abort	Return value Abort, usually sent from a button labeled Abort.
Cancel	Return value Cancel, usually sent from a button labeled Cancel.

Ignore	Return value Ignore, usually sent from a button labeled Ignore.
No	Return value No, usually sent from a button labeled No.
None	Nothing is returned from the dialog box. The model dialog will continue running.
OK	Return value OK, usually sent from a button labeled OK.
Retry	Return value Retry, usually sent from a button labeled Retry.
Yes	Return value Yes, usually sent from a button labeled Yes.

Performing actions based on the button clicked is a matter of using one of the decision constructs. For example:

```
if (MessageBox.Show("Would you like to do X?","MessageBox sample",  
    MessageBoxButtons.YesNo,MessageBoxIcon.Question) == DialogResult.Yes)  
    // Code to do X would go here.
```

As you can see, `MessageBox.Show()` is a method that gives you a lot of "bang for your buck"; it offers considerable flexibility.

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Crafting Good Messages

The `MessageBox.Show()` method is surprisingly simple to use, considering all the different forms of messages it enables you to create. The real trick is in providing appropriate messages to users at appropriate times. In addition to considering the icon and buttons to display in a message, you should follow these guidelines for crafting message text:

- Use a formal tone. Don't use large words, and avoid using contractions. Strive to make the text immediately understandable and not overly fancy; a message box is not a place to show off your literary skills.
- Limit messages to two or three lines. Lengthy messages are not only harder for users to read, but they can also be intimidating. When a message box is used to ask a question, make the question as simple as possible.
- Never make users feel as though they've done something wrong. Users can, and do, make mistakes, but you should craft messages that take the sting out of the situation.
- Spell check all message text. Visual Studio .NET's code editor doesn't spell check for you, so you should type your messages into a program such as Word and spell check the text before pasting it into your code. Spelling errors have an adverse effect on a user's perception of a program.
- Avoid technical jargon. Just because someone uses software doesn't mean that he or she is a technical person; explain things in plain English (or whatever the native language of the GUI happens to be).
- Be sure the buttons match the text! For example, don't show the Yes/No buttons if the text doesn't present a question to the user.

Creating Custom Dialog Boxes

Most of the time, the `MessageBox.Show()` method should be a sufficient means to display messages to a user. At times, however, the `MessageBox.Show()` method is too limited for a given purpose. For example, suppose that you wanted to display a lot of text to a user (such as a log file of some sort) and therefore wanted a message box that is sizable by the user.

Custom dialog boxes are nothing more than standard modal forms with one notable exception: One or more buttons are designated to return a dialog result, just as the buttons on a message box shown with the `MessageBox.Show()` method return a dialog result.

You're now going to create a custom dialog box. Create a new Windows Application titled **Custom Dialog Example**. Change the name of the default form to **fclsMain**, set its `Text` property to **Custom Dialog Box Example**, and set the `Main()` entry point of the project to reference **fclsMain** rather than `Form1`. Add a new button to the form and set its properties as follows:

Property	Value
Name	<code>btnShowCustomDialogBox</code>
Location	<code>72,180</code>
Size	<code>152,23</code>
Text	<code>Show Custom Dialog Box</code>

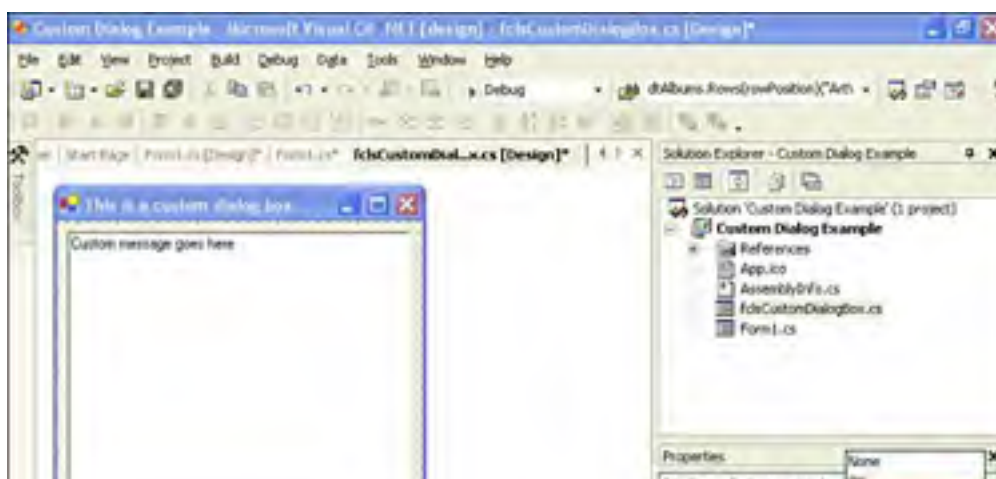
Next, you're going to create the custom dialog box. Add a new form to the project by choosing `Project, Add Windows Form`. Save the new form with the name **fclsCustomDialogBox.cs**. Change the `Text` property of the new form to **This is a custom dialog box**, and set its `FormBorderStyle` to **FixedSingle**.

Add a new text box to the form and set its properties as follows:

Property	Value
Name	<code>txtCustomMessage</code>
Location	<code>8,8</code>
Locked	<code>True</code>
Multiline	<code>True</code>
Size	<code>275,220</code>
Text	<code>Custom message goes here</code>

For a custom dialog box to return a result as a standard message box does, it must have buttons that are designated to return a dialog result. This is accomplished by setting the `DialogResult` property of a button (see [Figure 17.6](#)).

Figure 17.6. The `DialogResult` property determines the return value of the button.





Add a new button to the form and set its properties as shown in the following table. This button will act as the custom dialog box's Cancel button.

Property	Value
Name	btnCancel
DialogResult	Cancel
Location	216,240
Size	75,23
Text	Cancel

Last, you need to create an OK button for the custom dialog box. Create another button and set its properties as shown in the following table:

Property	Value
Name	btnOK
DialogResult	OK
Location	136,240
Size	75,23
Text	OK

Specifying a dialog result for one or more buttons is the first step in making a form a custom dialog box. The second part of the process is in how the form is shown. As you learned in [Hour 5](#), "Building Forms: The Basics," forms are displayed by calling the Show method of the form or setting its visible property to true. However, to show a form as a custom dialog box, you call the ShowDialog method instead. When a form is displayed using ShowDialog, the following occurs:

- The form is shown modally.
- If the user clicks a button that has its DialogResult property set to return a value, the form is immediately closed and that value is returned as the result of the ShowDialog method call.

Notice how you don't have to write code to close the form; clicking a button with a dialog result closes the form automatically. This simplifies the process of creating custom dialog boxes. Return to the first form in the form designer by clicking the Form1.cs [Design] tab.

Double-click the button you created and add the following code:

```
fclsCustomDialogBox objCustomDialogBox = new fclsCustomDialogBox();  
if (objCustomDialogBox.ShowDialog() == DialogResult.OK)  
    MessageBox.Show("You clicked OK.");  
else  
    MessageBox.Show("You clicked Cancel.");  
objCustomDialogBox = null;
```

Press F5 to run the project, click the button to display your custom dialog box (see [Figure 17.7](#)), and then click one of the available dialog box buttons. When you're satisfied that the project is working correctly, stop the project and save your work.

Figure 17.7. The ShowDialog method enables you to create custom message boxes.



**By the
Way**

If you click the Close (X) button in the upper-right corner of the form, the form is closed and the code behaves as if you've clicked Cancel; the `else` code runs.

The capability to create custom dialog boxes is a powerful feature. A call to `MessageBox.Show()` is usually sufficient, but when you need more control over the appearance and contents of a message box, creating a custom dialog box is the way to go.

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Interacting with the Keyboard

Almost every control on a form handles its own keyboard input; however, on occasion, you'll want to handle keyboard input directly. For example, you might want to perform an action when the user presses a specific key or releases a specific key. Most controls support three events that you can use to work directly with keyboard input. These are listed in [Table 17.4](#).

Table 17.4. Events That Handle Keyboard Input

Event Name	Description
KeyDown	Occurs when a key is pressed down while the control has the focus.
KeyPress	Occurs when a key is pressed (the key has been pushed down and then released) while the control has the focus.
KeyUp	Occurs when a key is released while the control has the focus.

These events fire in the same order in which they appear in [Table 17.4](#). Suppose, for example, that the user presses a key while a text box has the focus. The following list shows how the events would fire for the text box:

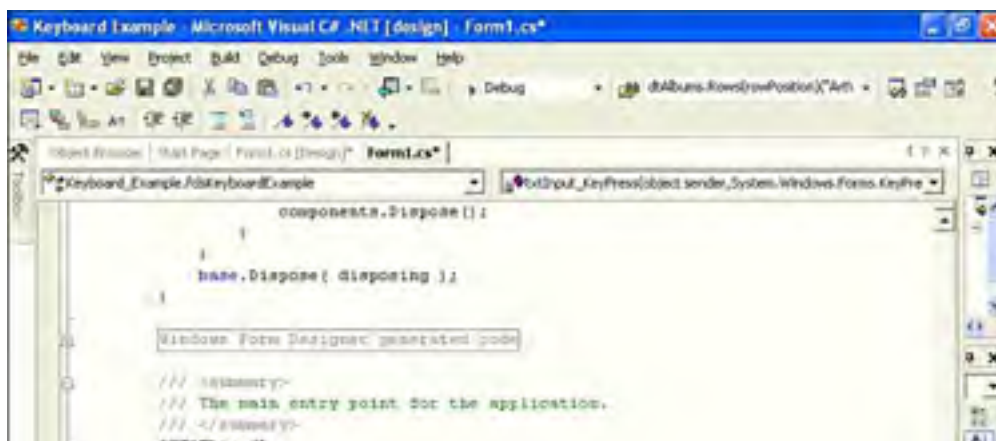
1. When the user presses a key, the [KeyDown](#) event fires.
2. When the user releases a key, the [KeyPress](#) event fires.
3. After the [KeyPress](#) event fires, the [KeyUp](#) event fires, completing the cycle of keystroke events.

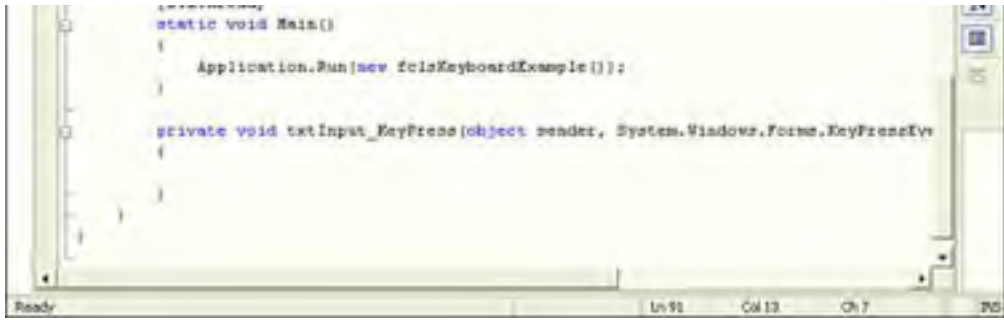
You're now going to create a project that illustrates handling keystrokes. This project has a text box that will refuse to display the letter "k." Start by creating a new Windows Application titled **Keyboard Example**. Change the name of the default form to **fclsKeyboardExample**, set its Text property to **Keyboard Example**, and set the Main() entry point of the project to reference **fclsKeyboardExample** instead of Form1. Add a new text box to the form and set its properties as shown in the following table:

Property	Value
Name	txtInput
Location	24,80
Multiline	true
Size	240,120
Text	(make blank)

You're going to add code to the [KeyPress](#) event of the text box to "eat" keystrokes made with the letter "k." Select the text box on the form and open the events list in the Properties window (remember, this is the lightning bolt icon). Scroll through the list and locate the [KeyPress](#) event. Next, double-click the [KeyPress](#) event to access it in code. Your code editor should now look like [Figure 17.8](#).

Figure 17.8. The [KeyPress](#) event is a good place to handle keyboard entry.





As you learned in [Hour 4](#), "Understanding Events," the `e` parameter contains information about the occurrence of this event. In the keyboard events, the `e` parameter contains information about the key being pressed; therefore, it's what you'll be using to work with the keystroke made by the user.

The key being pressed is available as the `KeyChar` property of the `e` parameter. You are going to write code that handles the keystroke when the key being pressed is "k." Add the following code to the `KeyPress` event:

```
if (e.KeyChar == 'k')  
    e.Handled = true;
```



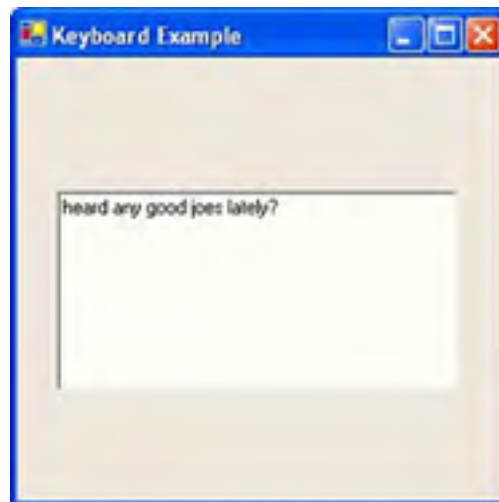
Be sure to surround the "k" with single quotes, not double quotes, because you're dealing with a character (`char`), not a string.

I would imagine that you're curious about the `Handled` property of the `e` object. When you set this property to `true`, you are telling Visual C# .NET that you handled the keystroke, and Visual C# .NET should ignore it. To see the effect this has, press F5 to run the project and enter the following into the text box:

Heard any good jokes lately?

What you'll end up with is the text shown in [Figure 17.9](#).

Figure 17.9. Notice how the letter k was "eaten" by your code.



Go ahead, try to enter another "k"—you can't. Next, try to enter an uppercase "K"; Visual C# .NET allows you to do this because uppercase and lowercase characters are considered different characters. Want to catch all "Ks" regardless of case? You could do so by adding the `OR (|)` operand to your decision construct, like this:

```
if (e.KeyChar == 'k' || e.KeyChar == 'K')  
    e.Handled = true;
```



When you paste data from the clipboard, the `KeyPress` event isn't fired for each keystroke. It's therefore possible that a "k" could appear in the text

box. If you absolutely needed to keep the letter "k" out of the text box, you'd need to make use of the TextChanged event.

**Did you
Know?**

It's not often that I need to catch a keypress, but every now and then I do. The three keystroke events have always made it easy to do what I need to do, but if there's any caveat I've discovered, it's that you need to give careful consideration to which event you choose (such as KeyPress or KeyUp, for example). Different events work best in different situations, and the best thing to do is to start with what seems like the most logical event, test the code, and change the event if necessary.

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Using the Common Mouse Events

As with keyboard input, most controls support mouse input natively; you don't have to write code to deal with mouse input. At times, you might need more control than that offered by the native functionality of a control, however. Visual C# .NET supports six events that enable you to deal with mouse input directly. These events are listed in [Table 17.5](#), in the order in which they occur.

Table 17.5. Events Used to Handle Mouse Input

Event Name	Description
MouseEnter	Occurs when the pointer enters a control.
MouseMove	Occurs when the pointer moves over a control.
MouseHover	Occurs when the pointer hovers over a control.
MouseDown	Occurs when the pointer is over a control and a button is pressed.
MouseUp	Occurs when the pointer is over a control and a button is released.
MouseLeave	Occurs when the pointer leaves a control.
Click	Occurs between the MouseDown and MouseUp events.

You're now going to build a project that illustrates interacting with the mouse, using the `MouseMove` event. This project will enable a user to draw on a form, much as you can draw in a paint program.

Begin by creating a new Windows Application titled **Mouse Paint**, and then follow these steps:

1. Change the name of the default form to **fclsMousePaint**.
2. Set the form's Text property to **Paint with the Mouse**.
3. Set the `Main()` entry point of the project to reference **fclsMousePaint** instead of `Form1`.
4. Double-click the form to access its default event, the Load event. Enter the following statement into the Load event:

```
m_objGraphics = this.CreateGraphics();
```

You've already used a graphics object a few times. What you're doing here is setting a graphics object to the client area of the form; any drawing performed on the object appears on the form. Because you're going to draw to this graphics object each time the mouse moves over the form, there's no point in creating a new graphics object each time you need to draw to it. Therefore, you're going to make `m_objGraphics` a module-level variable, which is instantiated only once—in the Load event of the form.

5. Enter this statement below the opening curly brace after the `public class fclsMousePaint : System.Windows.Forms.Form` class declaration:

```
private Graphics m_objGraphics;
```

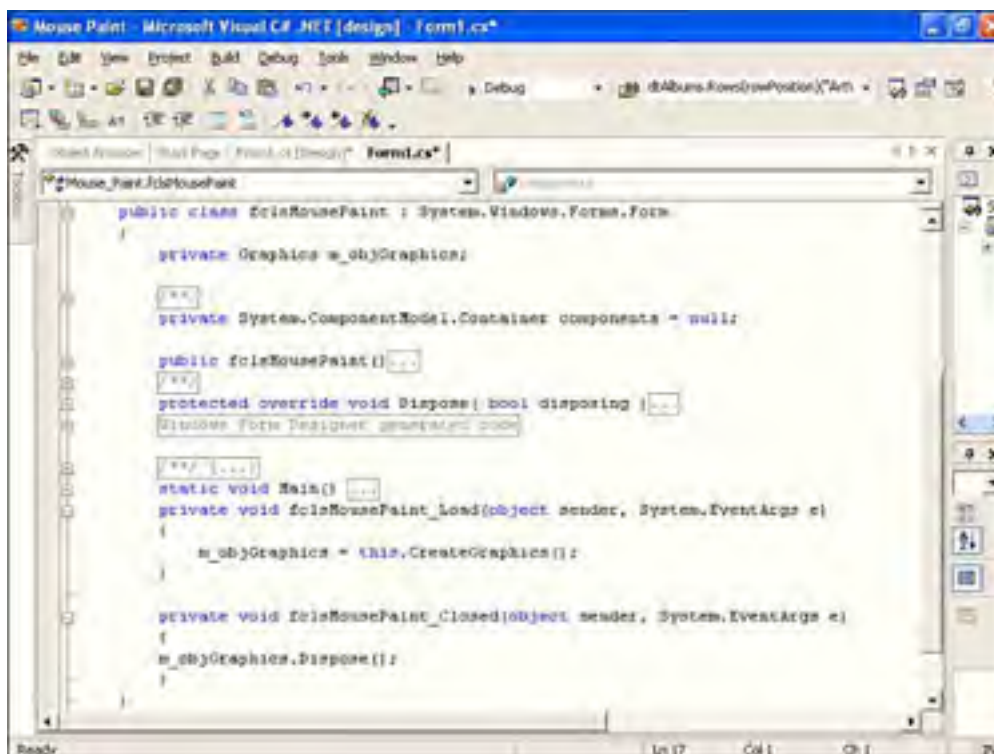
As I've said previously, you should always destroy objects when you're done with them. In this case, you want the object to remain in existence for the life of the form. Therefore, you'll destroy it in the Closed event of the form, which occurs when the form is unloaded.

6. Return to the `Form1.cs[Design]` tab, open the events list in the Property window, and double-click the Closed event to create and open the code window to the Closed event. Enter the following statement in the Closed event:

```
m_objGraphics.Dispose();
```

Your form class should now look similar to the one shown in [Figure 17.10](#).

Figure 17.10. Code in many places often works together to achieve one goal.



The last bit of code you need to add is the code that will draw on the form. You're going to place code in the MouseMove event of the form to do this. First, the code will make sure that the left mouse button is held down. If it's not, no drawing takes place; the user must hold down the mouse button to draw. Next, a rectangle will be created. The coordinates of the mouse pointer will be used to create a very small rectangle that will be passed to the DrawEllipse method of the graphics object. This has the effect of drawing a tiny circle where the mouse pointer is positioned. Again, return to the Form1.cs[Design] tab, open the events list in the Property window, and double-click the MouseMove event to create and open the code window to the MouseMove event. Add the following code to the MouseMove event:

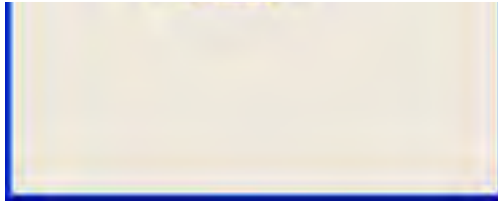
```
Rectangle rectEllipse = new Rectangle() ;  
  
if (e.Button != MouseButtons.Left) return;  
  
rectEllipse.X = e.X - 1 ;  
rectEllipse.Y = e.Y - 1 ;  
rectEllipse.Width = 2 ;  
rectEllipse.Height = 2 ;  
  
m_objGraphics.DrawEllipse(System.Drawing.Pens.Blue, rectEllipse);
```

Like all events, the *e* object contains information related to the event. In this example, you're using the X and Y properties of the *e* object, which is the coordinate of the pointer when the event fires. In addition, you're checking the Button property of the object to make sure that the user is clicking the left button.

Your project is now complete! Save your work by clicking Save All on the toolbar, and then press F5 to run the project. Move your mouse over the form—nothing happens. Now, hold down the left mouse button and move the mouse. This time, you'll be drawing on the form (see [Figure 17.11](#)).

Figure 17.11. Capturing mouse events opens many exciting possibilities.





Notice that the faster you move the mouse, the more space appears between circles. This shows you that the user is able to move the mouse faster than the MouseMove event can fire, so you can't get every single movement of the mouse. This is important to remember.

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Summary

Forms and controls allow for a lot of flexibility in the way a user interacts with an application. However, solid interactivity goes beyond what is placed on a form. In this hour, you learned how to use the `MessageBox.Show()` method to create informational dialog boxes. You learned how to specify an icon, buttons, and even how to designate a specific button as the default button. You also learned some valuable tips to help you create the best messages possible. You'll create message boxes frequently, so mastering this skill is important.

Finally, you learned how to interact with the keyboard and the mouse directly, through numerous events. The mouse or keyboard capabilities of a control sometimes fall short of what you want to accomplish. By understanding the concepts presented in this hour, you can go beyond the native capabilities of controls to create a rich, interactive experience for your users.

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Q&A

- Q1:** *Is it possible to capture keystrokes at the form level, rather than capturing them in control events?*
- A1:** Yes. For the form's keyboard-related events to fire when a control has the focus, however, you must set the form's `KeyPreview` property to `true`. The control's keyboard events will still fire, unless you set `KeyPressEventArgs.Handled` to `true` in the control's `KeyPress` event.
- Q2:** *You don't seem to always specify a button in your `MessageBox.Show()` statements throughout this book. Why?*
- A2:** If you don't explicitly designate a button or buttons, Visual C# .NET displays the OK button. Therefore, if all you want is an OK button, you don't need to pass a value to the `Buttons` argument.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Quiz Answers."

Quiz

- 1:** What minimal argument should you supply when calling `MessageBox.Show()`?
- 2:** If you don't supply a value for the *caption* parameter of `MessageBox.Show()`, what gets displayed in the title bar of the message?
- 3:** What type of data is always returned by the `MessageBox.Show()` method?
- 4:** Which event fires first, the `KeyUp` or `KeyPress` event?
- 5:** How do you determine which button is being pressed in a mouse-related event?

Exercises

- 1:** Modify your custom dialog box project so that the OK button is the Accept button of the form. That way, the user has only to press Enter to dismiss the dialog box. Next, make the Cancel button the Cancel button of the form so that the user can also press the Esc key to dismiss the form.
- 2:** Modify your mouse paint project so that the form clears each time the user starts drawing. Hint: Clear the graphics object in the `MouseDown` event.

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Hour 18. Working with Graphics

Visual C# .NET provides an amazingly powerful array of drawing capabilities, but this power comes at the price of a steep learning curve. Drawing isn't intuitive; you can't sit down for a few minutes with the online Help text and start drawing graphics. After you learn the basic principles involved, you'll find that drawing isn't that complicated. In this hour, you'll learn the basic skills for drawing shapes and text to a form or other graphical surface. You'll learn about pens, colors, and brushes (objects that help define graphics that you draw). In addition, you'll learn how to persist graphics on a form—and even how to create bitmaps that exist solely in memory.

The highlights of this hour include the following:

- Understanding the Graphics object
- Working with pens
- Using system colors
- Working with rectangles
- Drawing shapes
- Drawing text
- Persisting graphics on a form

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Understanding the Graphics Object

At first, you might not come up with many reasons to draw to the screen, preferring to use the many advanced controls found within Visual C# .NET to build your interfaces. However, as your applications grow in size and complexity, you'll find more and more occasion to draw your own interfaces directly to the screen. You might even choose to design your own controls (which you can do with Visual C# .NET). In this hour, you'll learn the basics of drawing and printing to the screen; when you need this functionality, you really *need* this functionality. Using the skills you acquire in this hour, you will be able to build incredibly detailed interfaces that look exactly the way you want them to look.

The code within the Windows operating system that handles drawing *everything* to the screen, including text, lines, and shapes, is called the *Graphics Device Interface* (GDI). The GDI processes all drawing instructions from applications as well as from Windows itself, and generates the proper output for the current display. Because the GDI generates what you see onscreen, it has the responsibility of dealing with the particular display driver installed on the computer and the settings of the driver, such as resolution and color depth. That means applications (and their developers) don't have to worry about these details; you write code that tells the GDI what to output and the GDI does whatever is necessary to produce that output. This behavior is called *device independence* because applications can instruct the GDI to display text and graphics using code that's independent of the particular display device.

Visual C# .NET code communicates with the GDI primarily via a Graphics object. The basic process is as follows:

- An object variable is created to hold a reference to a Graphics object.
- The object variable is set to a valid Graphics object (new or existing).
- To draw or print, you call methods of the Graphics object.

Creating a Graphics Object for a Form or Control

If you want to draw directly to a form or control, you can easily get a reference to the drawing surface by calling the `CreateGraphics()` method of the object in question. For example, to create a Graphics object that draws to a text box, you could use code such as:

```
System.Drawing.Graphics objGraphics;  
objGraphics = this.textBox1.CreateGraphics();
```

When you call `CreateGraphics()`, you're setting the object variable to hold a reference to the Graphics object of the form or control's client area. The client area of a form is the gray area within the borders and title bar of the form, whereas the client area of a control is usually the entire control. All drawing and printing done using the Graphics object is sent to the client area. In the code shown previously, the Graphics object references the client area of a text box, so all drawing methods executed on the Graphics object would draw on the text box only.



When you draw directly to a form or control, the object in question doesn't persist what's drawn on it. If the form is obscured in any way, such as by a window covering it or by minimizing the form, the next time the form is painted, it won't contain anything that was drawn on it. Later in this hour, you'll learn how to persist graphics on a form.

Creating a Graphics Object for a New Bitmap

You don't have to set a Graphics object to the client area of a form or control; you can also set a Graphics object to a bitmap that exists only in memory. For performance reasons, you might want to use a memory bitmap to store temporary images or to use as a place to build complex graphics before sending them to a visible element (like a form or control). To do this, you first have to create a new bitmap.

To create a new bitmap, you declare a variable to hold a reference to the new bitmap using the following syntax:

```
Bitmap variable = new Bitmap(width, height, pixelformat);
```

The *width* and *height* arguments are exactly what they appear to be: the width and height of the new bitmap. The *pixelformat* argument, however, is less intuitive. This argument determines the color depth of the bitmap and may also

specify whether the bitmap has an alpha layer (used for transparent portions of bitmaps). [Table 18.1](#) lists a few of the common values for PixelFormat (see Visual C# .NET's online Help for the complete list of values and their meanings). Note that the *pixelformat* parameter is referenced as `System.Drawing.Imaging.PixelFormat.formatenumeration`.

Table 18.1. Common Values for PixelFormat

Value	Description
<code>Format16bppGrayScale</code>	The pixel format is 16 bits per pixel. The color information specifies 65,536 shades of gray.
<code>Format16bppRgb555</code>	The pixel format is 16 bits per pixel. The color information specifies 32,768 shades of color, of which 5 bits are red, 5 bits are green, and 5 bits are blue.
<code>Format24bppRgb</code>	The pixel format is 24 bits per pixel. The color information specifies 16,777,216 shades of color, of which 8 bits are red, 8 bits are green, and 8 bits are blue.

To create a new bitmap that's 640 pixels wide by 480 pixels tall and has a pixel depth of 24 bits, for example, you could use the following statement:

```
objMyBitMap = new Bitmap(640, 480,  
    System.Drawing.Imaging.PixelFormat.Format24bppRgb);
```

After the bitmap is created, you can create a Graphics object that references the bitmap using the `FromImage()` method, like this:

```
objGraphics = Graphics.FromImage(objMyBitMap);
```

Now, any drawing or printing done using `objGraphics` would be performed on the memory bitmap. For the user to see the bitmap, you'd have to send the bitmap to a form or control. You'll do this later in the section "[Persisting Graphics on a Form](#)."

Disposing of an Object When It Is No Longer Needed

When you're finished with a Graphics object, you should call its `Dispose()` method to ensure that all resources used by the Graphics object are freed. Simply letting an object variable go out of scope doesn't ensure that the resources used by the object are freed. Graphics objects can use considerable resources, so you should always call `Dispose()` when you're finished with any graphics object (including Pens and other types of objects).

Visual C# .NET also supports a way of automatically disposing object resources. This can be accomplished utilizing Visual C# .NET's `using` statement. The `using` statement wraps a declared object or objects in a block and disposes of those objects after the block is done. As a result, after the code is executed in a block, the block is exited and the resources are disposed of on exit. Following is the syntax for the `using` statement and a small sample:

```
using (expression | type identifier = initializer)  
{  
    // Statements to execute  
}  
  
using (MyClass objClass = new MyClass())  
{  
    objClass.Method1();  
    objClass.Method2();  
}
```

One thing to keep in mind is that the `using` statement acts as a wrapper for an object within a specified block of code; therefore, it is only useful for declaring objects that are used and scoped within a method (scope is discussed in [Hour 11](#), "Using Constants, Data Types, Variables, and Arrays").



Earlier in the book you learned how to use a `using` statement to include a namespace, such as `System.Diagnostics`. Note that the user of `using` in this case is different; the same keyword is used for multiple purposes.

Working with Pens

A **pen** is an object that defines characteristics of a line. Pens are used to define color, line width, and line style (solid, dashed, and so on). Pens are used with almost all the drawing methods you'll learn about in this hour.

Visual C# .NET supplies a number of predefined pens, and you can also create your own. To create your own pen, use the following syntax:

```
Pen variable = new Pen(color, width);
```

After a pen is created, you can set its properties to adjust its appearance. For example, all Pen objects have a DashStyle property that determines the appearance of lines drawn with the pen. [Table 18.2](#) lists the possible values for DashStyle.

Table 18.2. Possible Values for DashStyle

Value	Description
Dash	Specifies a line consisting of dashes.
DashDot	Specifies a line consisting of a pattern of dashes and dots.
DashDotDot	Specifies a line consisting of alternating dashes and double dots.
Dot	Specifies a line consisting of dots.
Solid	Specifies a solid line.
Custom	Specifies a custom dash style. The Pen object contains properties that can be used to define the custom line.

The enumeration for DashStyle is part of the Drawing.Drawing2D namespace. Therefore, to create a new, dark blue pen that draws a dotted line, you would use code like the following:

```
Pen objMyPen = new Pen(System.Drawing.Color.DarkBlue, 3);  
objMyPen.DashStyle = System.Drawing.Drawing2D.DashStyle.Dot;
```

Note that the 3 passed as the second argument to create the new Pen defines the width of the pen in pixels.

Visual C# .NET includes many standard pens, which are available via the System.Drawing.Pens class, as in the following:

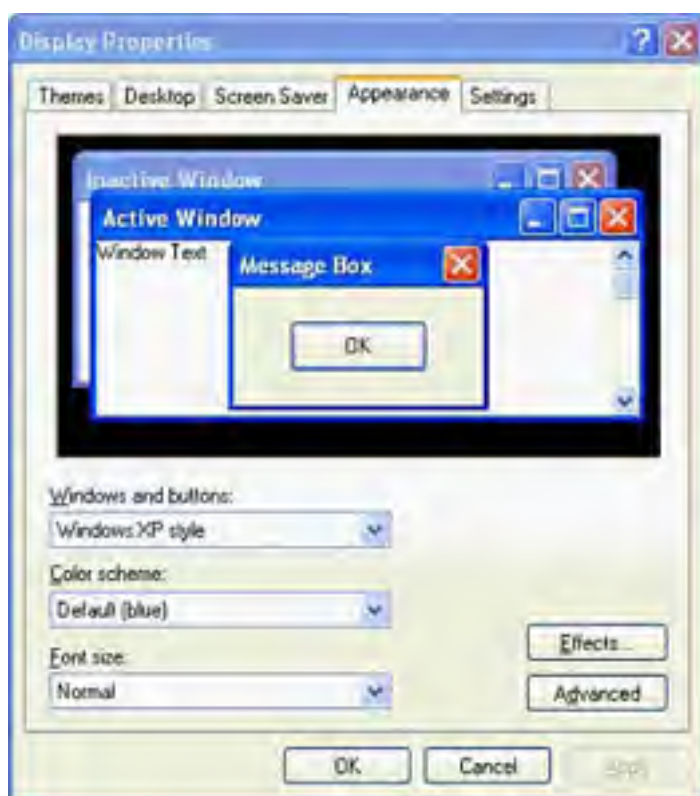
```
objPen = System.Drawing.Pens.DarkBlue;
```

When drawing using the techniques discussed shortly, you can use custom pens or system-defined pens—it's your choice.

Using System Colors

At some point, you may have changed your Windows theme, or perhaps you changed the image or color of your desktop. What you may not be aware of is that Windows enables you to customize the colors of almost all Windows interface elements. The colors that Windows allows you to change are called *system colors*. To change your system colors, right-click the desktop and choose Properties from the shortcut menu to display the Display Properties dialog box, and then click the Appearance tab (see [Figure 18.1](#)). To change the color for a specific item, you can select the item from the Item drop-down list, or you can click the element in the top half of the tab.

Figure 18.1. The Display Properties dialog box lets you select the colors of most Windows interface elements.



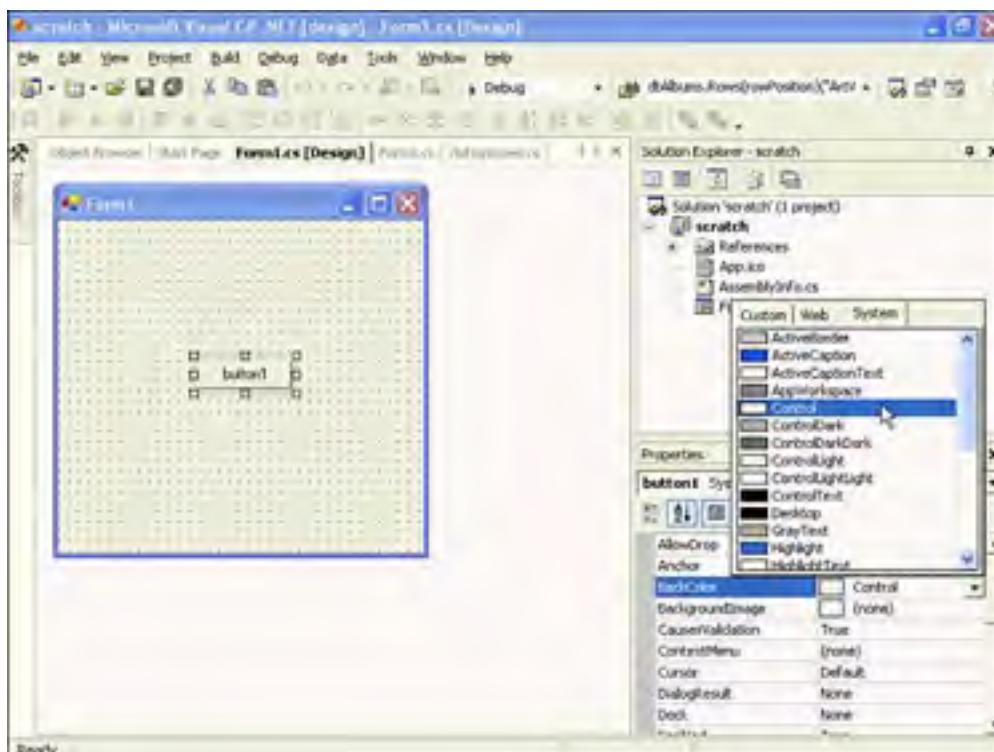
By the way

On Windows XP, you'll need to click Advanced on the Appearance tab to change your system colors.

When you change a system color using the Display Properties dialog box, all loaded applications should change their appearance to match your selection. In addition, when you start any new applications, they should also match their appearance to your selection. If you had to write code to manage this behavior, you would have to write a *lot* of code, and you would be justified in avoiding the whole mess. However, making an application adjust its appearance to match the user's system color selections is actually relatively simple; therefore, there's no reason not to do it. For the most part, it's automatic with controls that you add to a form.

To designate that an interface color should stay in sync with a user's system colors, you assign a system color to a color property of the item in question (see [Figure 18.2](#)). [Table 18.3](#) lists the system colors you can use. For example, if you wanted to ensure that the color of a button matches the user's corresponding system color, you would assign the system color named Control to the BackColor property of the Button control.

Figure 18.2. System colors are assigned using the System palette tab.



When a user changes a system color using the Display Properties dialog box, Visual C# .NET automatically updates the appearance of objects that use system colors; you don't have to write a single line of code to do this. Fortunately, when you create new forms and when you add controls to forms, Visual C# .NET automatically assigns the proper system color to the appropriate properties so you usually won't have to muck with them.

Be aware that you aren't limited to assigning system colors to their logically associated properties. You can assign system colors to any color property you want, and you can also use system colors when drawing. This enables you to draw custom interface elements that match the user's system colors, for example. Be aware, however, that if you do draw with system colors, Visual C# .NET won't update the colors automatically when the user changes system colors; you would have to redraw the elements with the new system color. In addition, if you apply system colors to properties that aren't usually assigned system colors, you run the risk of displaying odd color combinations, such as black on black, depending on the user's color settings.



Users don't just change their system colors for aesthetic purposes. I work with a programmer who is colorblind. He has modified his system colors so that he can see things better on the screen. If you don't allow your applications to adjust to the color preferences of the user, you may make using your program unnecessarily difficult, or even impossible, for someone with color blindness or visual acuity issues.

Table 18.3. Properties of the SystemColors Class

Enumeration	Description
ActiveCaption	The color of the background of an active caption bar (title bar).
ActiveCaptionText	The color of the text of the active caption bar (title bar).
Control	The color of the background of push buttons and other 3D elements.
ControlDark	The color of shadows on a 3D element.
ControlLight	The color of highlights on a 3D element.
ControlText	The color of the text on buttons and other 3D elements.
Desktop	The color of the Windows desktop.
GrayText	The color of the text on a user-interface element when it's unavailable.
Highlight	The color of the background of highlighted text. This includes selected menu items as well as

	selected text.
HighlightText	The color of the foreground of highlighted text. This includes selected menu items as well as selected text.
InactiveBorder	The color of an inactive window border.
InactiveCaption	The color of the background of an inactive caption bar.
InactiveCaptionText	The color of the text of an inactive caption bar.
Menu	The color of the menu background.
MenuText	The color of the menu text.
ScrollBar	The color of the scrollbar background.
Window	The color of the background in the client area of a window.

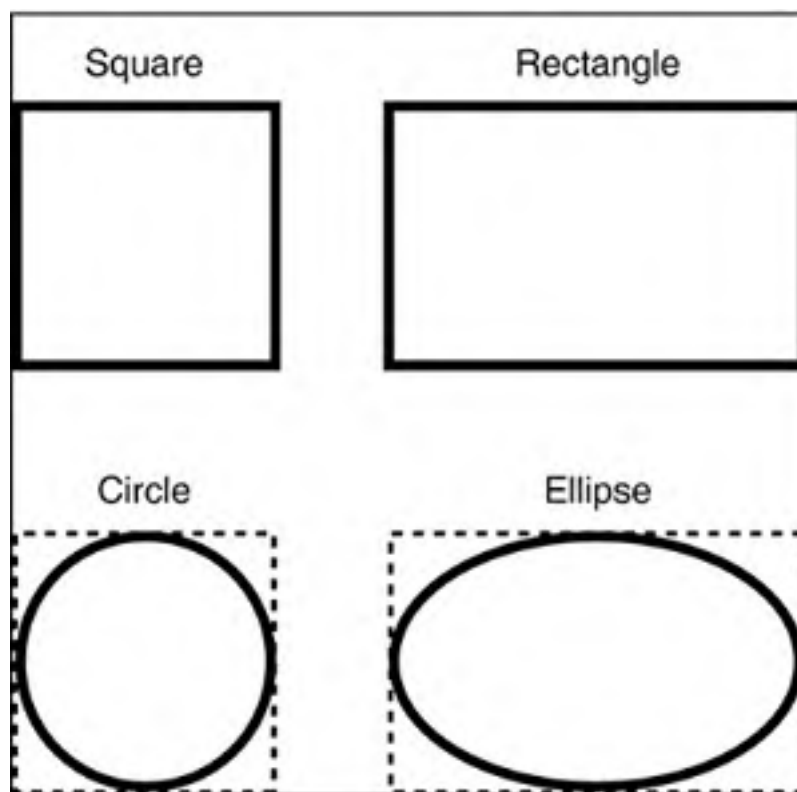
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Working with Rectangles

Before learning how to draw shapes, you need to understand the concept of a rectangle as it relates to Visual C# .NET programming. A rectangle is a structure used to hold bounding coordinates used to draw a shape. A rectangle isn't necessarily used to draw a rectangle (although it can be). Obviously, a square can fit within a rectangle. However, so can circles and ellipses. [Figure 18.3](#) illustrates how most shapes can be bound by a rectangle.

Figure 18.3. Rectangles are used to define the bounds of most shapes.



To draw most shapes, you must first have a rectangle. The rectangle you pass to a drawing method is used as a bounding rectangle; the proper shape (circle, ellipse, and so on) is always drawn. Creating a rectangle is easy. First, you set the dimensions of a variable as `Rectangle` and then you set the `X`, `Y`, `Width`, and `Height` properties of the object variable. The `X`, `Y` value is the coordinate of the upper-left corner of the rectangle—the `Height` and `Width` properties are self-explanatory. For example, the following code creates a rectangle that has its upper-left corner at coordinate 0,0, has a width of 100, and a height of 50:

```
Rectangle rectBounding = new Rectangle();  
rectBounding.X = 0;  
rectBounding.Y = 0;  
rectBounding.Width = 100;  
rectBounding.Height = 50;
```

The `Rectangle` object enables you to send the `X`, `Y`, `Height`, and `Width` values as part of its initialize construct. Using this technique, you could create the same rectangle with only a single line of code:

```
Rectangle rectBounding = new Rectangle(0,0,100,50);
```

You can do a number of things with a rectangle after it's defined. Perhaps the most useful is the ability to enlarge or shrink the rectangle with a single statement. You enlarge or shrink a rectangle using the `Inflate()` method. The most common syntax of `Inflate()` is the following:

```
object.Inflate(changeinwidth, changeinheight);
```

When called this way, the rectangle width is enlarged (the left side of the rectangle remains in place) and the height is enlarged (the top of the rectangle stays in place). To leave the size of the height or width unchanged, pass 0 as the appropriate argument. To shrink a dimension, specify a negative number.

If you're going to do much with drawing, you'll use a lot of Rectangle objects, and I strongly suggest that you learn as much about them as you can.

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Drawing Common Shapes

Now that you've learned about the Graphics object, pens, and rectangles, you'll probably find drawing shapes to be fairly simple. Shapes are drawn by calling methods of a Graphics object. Most methods require a rectangle, which is used as the bounding rectangle for the shape, as well as a pen. In this section, I'll show you what you need to do to draw different shapes.



I've chosen to discuss only the most commonly drawn shapes. The Graphics object contains many methods for drawing additional shapes.

Drawing Lines

Drawing lines is accomplished with the DrawLine() method of the Graphics object. DrawLine() is one of the few drawing methods that doesn't require a rectangle. The syntax for DrawLine() is

```
object.DrawLine(pen, x1, y1, x2, y2);
```

Object refers to a Graphics object and *pen* refers to a Pen object, both of which have already been discussed. X1, Y1 is the coordinate of the starting point of the line, whereas X2, Y2 is the coordinate of the ending point; Visual C# .NET draws a line between the two points, using the specified pen.

Drawing Rectangles

Drawing rectangles (and squares for that matter) is accomplished using the DrawRectangle() method of a Graphics object. As you might expect, DrawRectangle() accepts a pen and a rectangle. Following is the syntax for calling DrawRectangle() in this way:

```
object.DrawRectangle(pen, rectangle);
```

If you don't have a Rectangle object (and you don't want to create one), you can call DrawRectangle() using the following format:

```
object.DrawRectangle(pen, X, Y, width, height);
```

Drawing Circles and Ellipses

Drawing circles and ellipses is accomplished by calling the DrawEllipse() method. If you're familiar with geometry, you'll note that a circle is simply an ellipse that has the same height as it does width. This is why no specific method exists for drawing circles; DrawEllipse() works perfectly. Like the DrawRectangle() method, DrawEllipse() accepts a Pen and a Rectangle. The rectangle is used as a bounding rectangle—the width of the rectangle is the width of the ellipse, whereas the height of the rectangle is the height of the ellipse. DrawEllipse() has the following syntax:

```
object.DrawEllipse(pen, rectangle);
```

In the event that you don't have a Rectangle object defined (and again you don't want to create one), you can call DrawEllipse() with this syntax:

```
object.DrawEllipse(pen, X, Y, Width, Height);
```

Clearing a Drawing Surface

To clear the surface of a Graphics object, call the Clear() method, passing it the color to paint the surface, like this:

```
objGraphics.Clear(Drawing.SystemColors.Control);  
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```

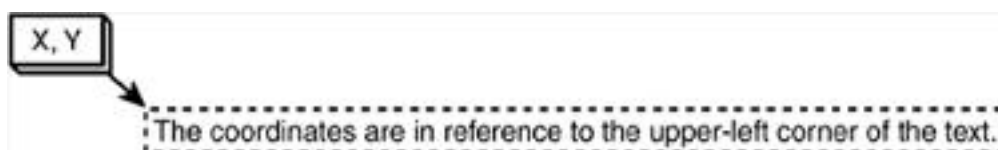
Printing Text on a Graphics Object

Printing text on a Graphics object is very similar to drawing a shape, and the method name even contains the word *Draw*, in contrast to *Print*. To draw text on a Graphics object, call the `DrawString()` method. The basic format for `DrawString()` looks like this:

```
object.DrawString(stringoftext, font, brush, topX, leftY);
```

A few of these items are probably new to you. The argument *stringoftext* is fairly self-explanatory; it's the string you want to draw on the Graphics object. The *topX* and *leftY* arguments represent the coordinate at which drawing will take place; they represent the upper-left corner of the string, as illustrated in [Figure 18.4](#).

Figure 18.4. The coordinate specified in `DrawString()` represents the upper-left corner of the printed text.



The arguments *brush* and *font* aren't so obvious. Both arguments accept objects. A brush is similar to a pen, but whereas a pen describes the characteristics of a line, a brush describes the characteristics of a fill. For example, both pens and brushes have a color, but where pens have an attribute for defining a line style, such as dashed or solid, a brush has an attribute for a fill pattern, such as solid, hatched, weave, or trellis. When you are drawing text, a solid brush is usually sufficient. You can create brushes in much the same way as you create pens, or you can use one of the standard brushes available from the `System.Drawing.Brushes` class.

A Font object defines characteristics used to format text, including the character set (Times New Roman, Courier, and so on), size (point size), and style (bold, italic, normal, underline, and so on). To create a new Font object, you could use code such as the following:

```
Font objFont;  
objFont = new System.Drawing.Font("Arial", 30);
```

The text *Arial* in this code is the name of a font installed on my computer. In fact, *Arial* is one of the few fonts installed on all Windows computers. If you supply the name of a font that doesn't exist on the machine at runtime, Visual C# .NET will use a default font. The second parameter is the point size of the text. If you want to use a style other than normal, you can provide a style value as a third parameter, like this:

```
objFont = new System.Drawing.Font("Arial Black", 30,FontStyle.Bold);
```

or

```
objFont = new System.Drawing.Font("Arial Black", 30,FontStyle.Italic);
```

In addition to creating a Font object, you can also use the font of an existing object, such as a Form. For example, the following statement prints text to a Graphics object using the font of the current form:

```
objGraphics.DrawString("This is the text that prints!",  
this.Font,System.Drawing.Brushes.Azure, 0, 0);
```

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Persisting Graphics on a Form

You'll often use the techniques discussed in this hour to draw to a form. However, you may recall from earlier hours that when you draw to a form (actually, you draw to a Graphics object that references a form), the things that you draw aren't persisted; the next time the form paints itself, the drawn elements will disappear. If the user minimizes the form or obscures the form with another window, for example, the next time the form is painted, it will be missing any and all drawn elements that were obscured. You can use a couple of approaches to deal with this behavior:

- Place all code that draws to the form in the form's Paint event.
- Draw to a memory bitmap and copy the contents of the memory bitmap to the form in the form's Paint event.

If you're drawing only a few items, placing the drawing code in the Paint event might be a good approach. However, consider a situation in which you've got a lot of drawing code. Perhaps the graphics are drawn in response to user input, so you can't re-create them all at once. In these situations, the second approach is clearly better.

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Building a Graphics Project

You're now going to build a project that uses the skills you've learned to draw to a form. In this project, you'll use the technique of drawing to a memory bitmap to persist the graphics each time the form paints itself.



The project you're about to build is perhaps the most difficult yet. I'll explain each step of the process of creating this project, but I won't spend any time explaining the objects and methods that I've already discussed.

To make things interesting, I've used random numbers to determine font size as well as the X, Y coordinate of the text you're going to draw to the form. The Random class and its Next() method will be used to generate pseudo-random numbers. To generate a random number within a specific range (such as a random number between 1 and 10), you use the following:

```
randomGenerator.Next(1,10);
```

I don't want you to dwell on the details of how the ranges of random numbers are created. However, at times, you may need to use a random number, so I thought I'd spice things up a bit and teach you something cool at the same time.

Start by creating a new Windows Application titled **Persisting Graphics**.

Change the name of the default form to **fclsMain**, set the form's Text property to **Persisting Graphics Example**, and change the entry point of the project to reference **fclsMain** instead of Form1. The interface of your form will consist of a text box and a button. When the user clicks the button, the contents of the text box will be drawn on the form in a random location and with a random font size. Add a new text box to your form and set its properties as follows:

Property	Value
Name	txtInput
Location	56,184
Size	100,20
Text	(make blank)

Add a new button to the form and set its properties as follows:

Property	Value
Name	btnDrawText
Location	160,184
Text	Draw Text

Time to let the code fly!

As I mentioned earlier, all drawing will be performed using a memory bitmap, which will then be drawn on the form. You'll reference this bitmap in multiple places, so you're going to make it a module-level variable by following these steps:

1. Double-click the Form to access its Load event.
2. Locate the statement `public class fclsMain : System.Windows.Forms.Form` and position your cursor immediately *after* the left bracket ({) on the next line.
3. Press Enter to create a new line.
4. Enter the following statement:

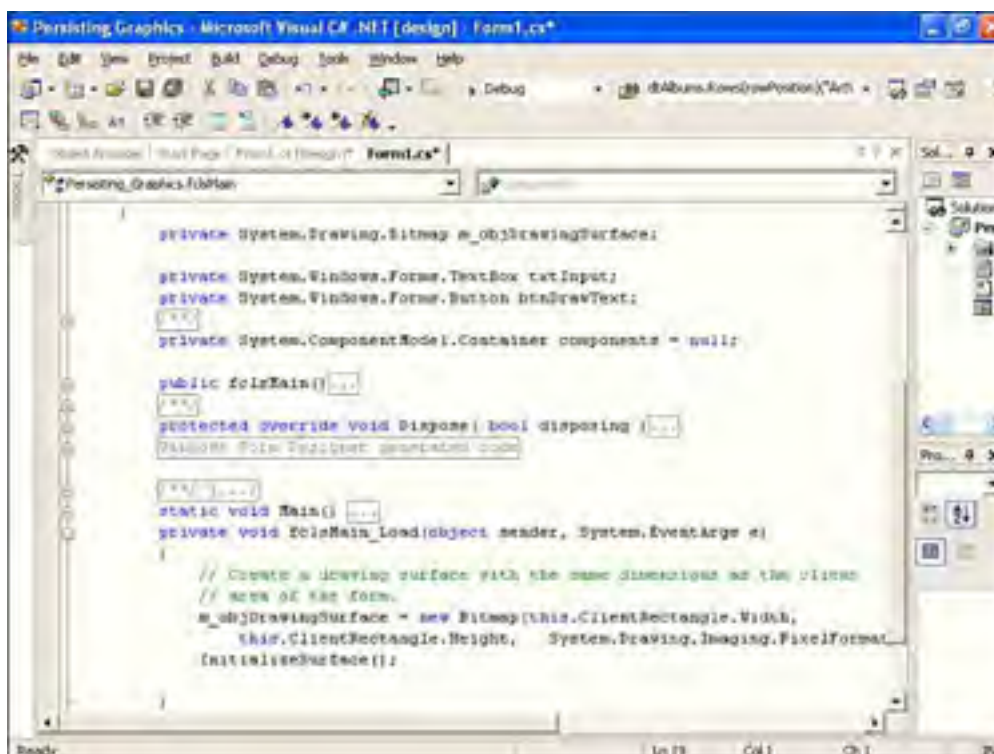
```
private System.Drawing.Bitmap m_objDrawingSurface;
```

For the bitmap variable to be used, it must reference a Bitmap object. A good place to initialize things is in the form's Load event, so put your cursor back in the Load event now and enter the following code:


```
// Create a drawing surface with the same dimensions as the client
// area of the form.
m_objDrawingSurface = new Bitmap(this.ClientRectangle.Width,
    this.ClientRectangle.Height,
    System.Drawing.Imaging.PixelFormat.Format24bppRgb);
InitializeSurface();
```

Your procedure should now look like the one shown in [Figure 18.5](#).

Figure 18.5. Make sure that your code appears as it does here.



The first statement creates a new bitmap in memory. Because the contents of the bitmap are to be sent to the form, it makes sense to use the dimensions of the client area of the form as the size of the new bitmap—which is exactly what you've done. The final statement calls a procedure that you haven't yet created.

Position the cursor after the closing bracket (}) of the fclsMain_Load event, and press Enter to create a new line. You're now going to write code to initialize the bitmap. The code will clear the bitmap to the system color named Control and then draw an ellipse that has the dimensions of the bitmap. (I've added comments to the code so that you can follow along with what's happening; all the concepts in this code have been discussed already.) Enter the following in its entirety:

```
private void InitializeSurface()
{
    Graphics objGraphics;
    Rectangle rectBounds;

    // Create a Graphics object that references the bitmap and clear it.
    objGraphics = Graphics.FromImage(m_objDrawingSurface);

    objGraphics.Clear(SystemColors.Control);

    //Create a rectangle the same size as the bitmap.
    rectBounds = new Rectangle(0, 0,
        m_objDrawingSurface.Width,m_objDrawingSurface.Height);
    //Reduce the rectangle slightly so the ellipse won't appear on the border.
    rectBounds.Inflate(-1, -1);

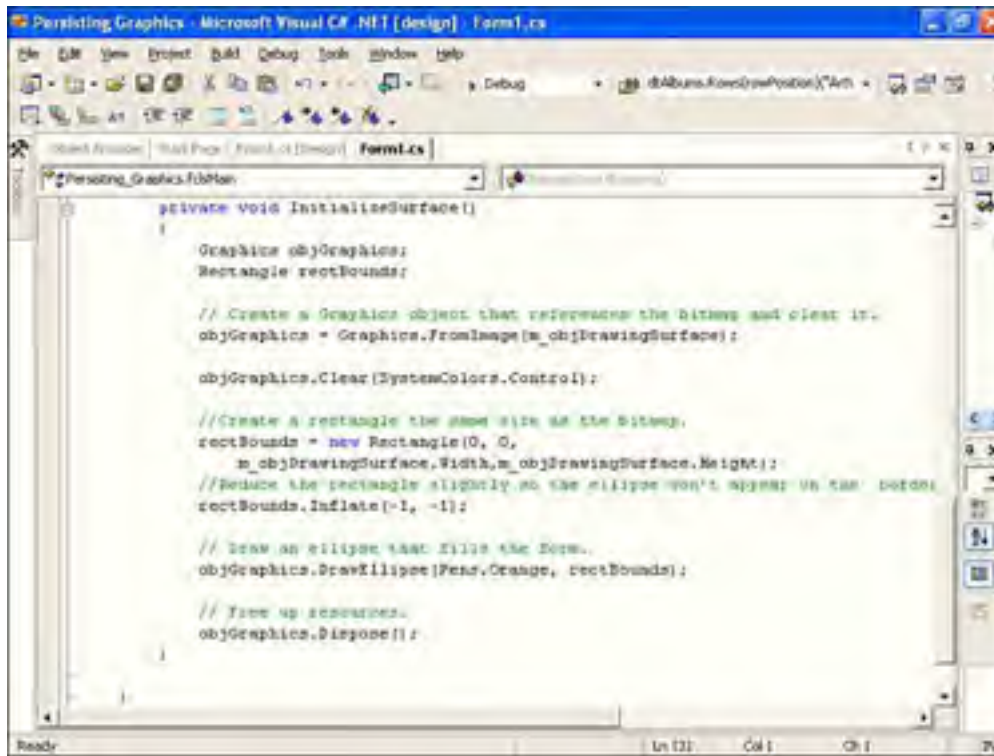
    // Draw an ellipse that fills the form.
    objGraphics.DrawEllipse(Pens.Orange, rectBounds);

    // Free up resources
```

```
// Free up resources.  
objGraphics.Dispose();  
}
```

Your procedure should now look like the one shown in [Figure 18.6](#).

Figure 18.6. Again, verify that your code is entered correctly.



If you run your project now, you'll find that nothing is drawn to the form. This is because the drawing is being done to a bitmap in memory, and you haven't yet added the code to copy the bitmap to the form. The place to do this is in the form's Paint event so that the contents of the bitmap are sent to the form every time the form paints itself. This ensures that the items you draw always appear on the form.

Create an event handler for the form's Paint event by first returning to the form designer and selecting the form. Click the Event icon (the lightning bolt) in the Properties window and then double-click Paint to create a Paint event. Add the following code to the Paint event:

```
Graphics objGraphics ;  
//You can't modify e.Graphics directly.  
objGraphics = e.Graphics;  
// Draw the contents of the bitmap on the form.  
objGraphics.DrawImage(m_objDrawingSurface, 0,0,  
    m_objDrawingSurface.Width,  
    m_objDrawingSurface.Height);  
objGraphics.Dispose();
```

By the Way

The previous code can be rewritten as follows when utilizing the `using` statement mentioned earlier in this chapter; notice how the `Dispose()` method is not required any more.

```
using (Graphics objGraphics = e.Graphics)  
{  
    objGraphics.DrawImage(m_objDrawingSurface,0,0,  
        m_objDrawingSurface.Width, m_objDrawingSurface.Height);  
}
```

The `e` parameter of the Paint event has a property that references the Graphics object of the form. You can't, however, modify the Graphics object using the `e` parameter (it's read-only), which is why you've created a new Graphics object to work with and then set the object to reference the form's Graphics object. The method `DrawImage()` draws the image in a bitmap to the surface of a Graphics object, so the last statement is simply sending the contents of the bitmap that exists in memory to the form.

If you run the project now, you'll find that the ellipse appears on the form. Furthermore, you can cover the form with another window, or even minimize it, and the ellipse will always appear on the form when it's displayed again—the graphics persist.

The last thing you're going to do is write code that draws the contents entered into the text box on the form. The text will be drawn with a random size and location. Return to the form designer and double-click the button to access its `Click` event. Add the following code:

```
Graphics objGraphics;
Font objFont;
int intFontSize, intTextX, intTextY;

Random randomGenerator = new Random();

// If no text has been entered, get out.
if (txtInput.Text == "") return;

// Create a graphics object using the memory bitmap.
objGraphics = Graphics.FromImage(m_objDrawingSurface);

// Create a random number for the font size. Keep it between 8 and 48.
intFontSize = randomGenerator.Next(8,48);
// Create a random number for the X coordinate of the text.
intTextX = randomGenerator.Next(0,this.ClientRectangle.Width);
// Create a random number for the Y coordinate of the text.
intTextY = randomGenerator.Next(0,this.ClientRectangle.Height);

// Create a new font object.
objFont = new System.Drawing.Font("Arial", intFontSize, FontStyle.Bold);
// Draw the user's text.
objGraphics.DrawString(txtInput.Text, objFont,
System.Drawing.Brushes.Red, intTextX, intTextY);
// Clean up.
objGraphics.Dispose();
// Force the form to paint itself. This triggers the Paint event.
this.Invalidate();
```

The comments I've included should make the code fairly self-explanatory. However, the last statement bears discussing. The `Invalidate()` method of a form invalidates the client rectangle. This operation tells Windows that the appearance of the form is no longer accurate and that the form needs to be repainted. This, in turn, triggers the Paint event of the form. Because the Paint event contains the code that copies the contents of the memory bitmap to the form, invalidating the form causes the text to appear. If you don't call `Invalidate()` here, the text won't appear on the form (but it is still drawn on the memory bitmap).



If you draw elements that are based on the size of the form, you'll need to call `Invalidate()` in the `Resize` event of the form; resizing a form doesn't trigger the form's Paint event.

The last thing you need to do is make sure you free up the resources used by your module-level `Graphics` object. Using the Properties window, add an event handler for the `Closed` event of the form now, and enter the following statement:

```
m_objDrawingSurface.Dispose();
```

Your project is now complete! Click `Save All` on the toolbar to save your work, and then press `F5` to run the project. You'll notice immediately that the ellipse is drawn on the form. Type something into the text box and click the button. Click it again. Each time you click the button, the text is drawn on the form using the same brush, but with a different size and location (see [Figure 18.7](#)).

Figure 18.7. Text is drawn on a form, much like ordinary shapes.



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Summary

You won't need to add drawing capabilities to every project you create. However, when you need the capabilities, *you need the capabilities*. In this hour, you learned the basic skills for drawing to a graphics surface, which can be a form, control, memory bitmap, or one of many other types of surfaces. You learned that all drawing is done using a Graphics object, and you now know how to create a Graphics object for a form or control and even how to create a Graphics object for a bitmap that exists in memory.

Most drawing methods require a pen and a rectangle, and you can now create rectangles and pens using the techniques you learned in this hour. After learning about pens and rectangles, you've found that the drawing methods themselves are pretty easy to use. Even drawing text is a fairly simple process when you've got a Graphics object to work with.

Persisting graphics on a form can be a bit complicated, and I suspect this will confuse a lot of new Visual C# .NET programmers who try to figure it out on their own. However, you've now built an example that persists graphics on a form, and you'll be able to leverage the techniques involved when you have to do this in your own projects.

I don't expect you to be able to sit down for an hour and create an Adobe Photoshop knock-off. However, you now have a solid foundation on which to build. If you're going to attempt a project that performs a lot of drawing, you'll want to dig deeper into the Graphics object.

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Q&A

Q1: *What if I need to draw a lot of lines, one starting where another ends? Do I need to call `DrawLine()` for each line?*

A1: The Graphics object has a method called `DrawLines()`, which accepts a series of points. The method draws lines connecting the sequence of points.

Q2: *Is there a way to fill a shape?*

A2: The Graphics object includes methods that draw filled shapes, such as `FillEllipse()` and `FillRectangle()`.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** What object is used to draw to a surface?
- 2:** To set a Graphics object to draw to a form directly, you call what method of the form?
- 3:** What object defines the characteristics of a line? A fill pattern?
- 4:** How do you make a color property adjust with the user's Windows settings?
- 5:** What object is used to define the bounds of a shape to be drawn?
- 6:** What method do you call to draw an irregular ellipse? A circle?
- 7:** What method do you call to print text on a Graphics surface?
- 8:** To ensure that graphics persist on a form, the graphics must be drawn on the form in what event?

Exercises

- 1:** Modify the example in this hour to use a font other than Arial. If you're not sure what fonts are installed on your computer, open the Start menu and choose Settings and then Control Panel. You'll have an option on the Control Panel for viewing your system fonts.
- 2:** Create a project that draws an ellipse that fills the form, much like the one you created in this hour. However, draw the ellipse directly to the form in the Paint event. Make sure that the ellipse is redrawn when the form is sized. (Hint: Invalidate the form in the form's Resize() event.)

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Part IV: Working with Data

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HOOR 20 [Controlling Other Applications Using Automation](#)

HOOR 21 [Working with a Database](#)

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Hour 19. Performing File Operations

It's very difficult to imagine any application other than a tiny utility program that doesn't make use of the file system. In this hour, you'll learn how to use the controls to make it easy for a user to browse and select files. In addition, you'll learn how to use the `System.IO.File` and `System.IO.Directory` objects to manipulate the file system. Using these objects, you can delete files and directories, move them, rename them, and more. These objects are powerful, but please remember: Play nice!

The highlights of this hour include the following:

- Using the Open File Dialog and Save File Dialog controls
- Manipulating files with `System.IO.File`
- Manipulating directories with `System.IO.Directory`

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Using the Open File Dialog and Save File Dialog Controls

In [Hour 1](#), "Jumping in with Both Feet: A Visual C# .NET Programming Tour," you used the Open File Dialog control to enable a user to browse for pictures to display in your Picture Viewer program. In this section, you'll move beyond those basics to learn important details about working with the Open File Dialog control, as well as its sister control, the Save File Dialog.

You're going to build a project to illustrate most of the file-manipulation concepts discussed in this hour. Before continuing, create a new Windows Application titled **Manipulating Files**. Change the name of the default form to **fclsManipulatingFiles**, set its Text property to **Manipulating Files**, and then set the entry point of the project to **fclsManipulatingFiles**.

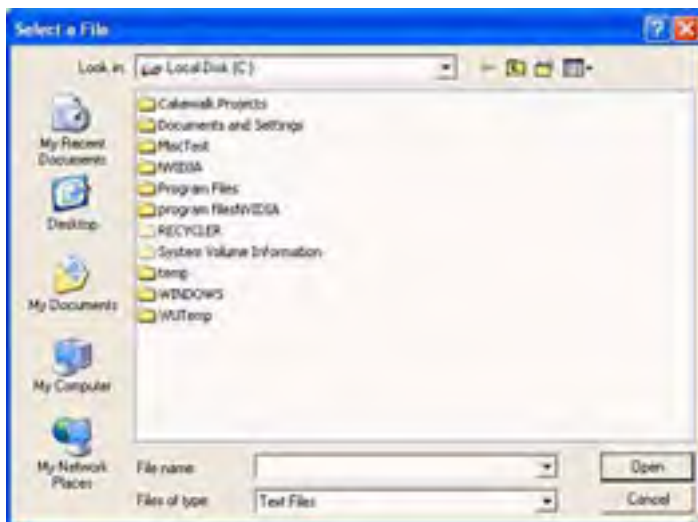
Add a new text box to the form and set its properties as shown in the following table:

Property	Value
Name	txtSource
Location	95,8
Size	184,20
Text	(make blank)

Using the Open File Dialog Control

The Open File Dialog control is used to display a dialog box that enables the user to browse and select a file (see [Figure 19.1](#)). It's important to note that usually the Open File Dialog doesn't actually open a file, but it allows a user to select a file that is then opened by code within the application.

Figure 19.1. The Open File dialog box is used to browse and select files.



Follow these steps to start building the project:

1. Add a new Open File Dialog to your project now by double-clicking the OpenFileDialog item in the toolbox. The Open File Dialog doesn't have an interface per se, so it appears in the area below the form rather than on it. For the user to browse for files, you have to manipulate the Open File Dialog using its properties and methods.

You're going to add a button to the form that, when clicked, enables a user to locate and select a file. If a user selects a file, the filename is placed in the text box you've created.

2. Add a button to the form now, and set its properties as follows:

Property	Value
Name	btnOpenFile

Location	8,8
Size	80,23
Text	Source

3. Double-click the button and add the following code to its Click event:

```
openFileDialog1.InitialDirectory = @"C:\";  
openFileDialog1.Title = "Select a File";
```

The first statement specifies the directory to display when the dialog box is first shown. If you don't specify a directory for the `InitialDirectory` property, the active system directory is used (for example, the last directory browsed to with a different Open File dialog box).

The `Title` property of the Open File Dialog determines the text displayed in the title bar of the Open File dialog box. If you don't specify text for the `Title` property, Visual C# .NET displays the word `Open` in the title bar.

Different types of files have different extensions. The `Filter` property determines what types of files appear in the Open File dialog box (refer to [Figure 19.1](#)). A filter is specified in the following format:

*Description**.*extension*

The text that appears before the pipe symbol (`|`) is the descriptive text of the file type to filter on, whereas the text after the pipe symbol is the pattern used to filter files. For example, to display only Windows bitmap files, you could use a filter such as the following:

```
control.Filter = "Windows Bitmaps|*.bmp";
```

You can specify more than one filter type. To do so, add a pipe symbol (`|`) between the filters, like this:

```
control.Filter = "Windows Bitmaps|*.bmp|JPEG Files|*.jpg";
```

You're going to restrict your Open File dialog box to show only text files, so enter the following statement in your `btnOpenFile_Click` code:

```
openFileDialog1.Filter = "Text Files|*.txt";
```

When you have more than one filter, you can use the `FilterIndex` property to specify the default for which the filter appears selected. Although you've specified only one filter type in this example, it's still a good idea to designate the default filter, so add this statement to your code:

```
openFileDialog1.FilterIndex = 1;
```



The `FilterIndex` property is 1-based, not 0-based like most other properties and collections.

Finally, you need to show the Open File dialog box and take action based on whether the user selects a file. The `ShowDialog()` method of the Open File Dialog control acts much like the method of forms by the same name, returning a result that indicates the user's selection on the dialog box. Enter the following statements into your procedure:

```
if (openFileDialog1.ShowDialog() != DialogResult.Cancel)  
    txtSource.Text = openFileDialog1.FileName;  
else  
    txtSource.Text = "";
```

This code just places the selected filename into the text box `txtSource`. If the user clicks `Cancel`, the contents of the text box are cleared.

Press `F5` to run the project and click the button. You'll get the same dialog box shown in [Figure 19.1](#) (with different files and directories, of course). Select a text file, click `Open`, and Visual C# .NET places the name of the file into the text box.

Did you Know?

By default, the Open File Dialog won't allow the user to enter a filename that doesn't exist. You can override this behavior by setting the `CheckFileExists` property of the Open File Dialog to `false`.

By the way

The Open File Dialog control has the capability to allow the user to select multiple files. It's rare that you need to do this (I don't recall ever needing this capability in one of my projects), so I won't go into the details here. If you're interested, take a look at the `Multiselect` property of the Open File Dialog in the Help text.

The Open File Dialog control makes enabling a user to browse and select a file almost trivial. Without this code, you would have to write an astounding amount of very difficult code and probably still would not come up with all the functionality supported by this control.

Using the Save File Dialog Control

The Save File Dialog control is very similar to the Open File Dialog control, but it's used to enable a user to browse directories and specify a file to save, rather than open. Again, it's important to note that the Save File Dialog control doesn't actually save a file; it is used to enable a user to specify a filename to save. You'll have to write code to do something with the filename returned by the control.

You're going to use the Save File Dialog control to let the user specify a filename. This filename will be the target of various file operations you'll learn about later in this hour. Follow these steps:

1. Create a new text box on your form and set its properties as follows:

Property	Value
Name	<code>txtDestination</code>
Location	<code>95,40</code>
Size	<code>184,20</code>
Text	<i>(make blank)</i>

2. You're now going to create a button that, when clicked, enables the user to specify a filename to save a file. Add a new button to the form and set its properties as shown in the following table:

Property	Value
Name	<code>btnSaveFile</code>
Location	<code>8,40</code>
Size	<code>80,23</code>
Text	<code>Destination</code>

3. Of course, none of this will work without adding a Save File dialog box. Double-click the `SaveFileDialog` item in the toolbox to add a new control to the project.
4. Double-click the new button you just created (`btnSaveFile`) and add the following code to its Click event:

```
saveFileDialog1.Title = "Specify Destination Filename";  
saveFileDialog1.Filter = "Text Files|.txt";  
saveFileDialog1.FilterIndex = 1;  
saveFileDialog1.OverwritePrompt = true;
```

The first three statements set properties that are identical to those of the Open File Dialog. The `OverwritePrompt` property, however, is unique to the Save File Dialog. When this property is set to `true`, Visual C# .NET asks users to confirm their selections when they choose a file that already exists, as shown in [Figure 19.2](#). I highly recommend that you prompt the user about replacing files by ensuring that the `OverwritePrompt` property is set to `true`.

Figure 19.2. It's a good idea to get confirmation before replacing an existing file.



**Did you
Know?**

If you want the Save File dialog box to prompt users when the file they specify *oesn't* exist, set the CreatePrompt property of the Save File Dialog control to **true**.

The last bit of code you need to add shows the dialog box and places the selected filename in the txtDestination text box. Enter the code as shown here:

```
if (saveFileDialog1.ShowDialog() != DialogResult.Cancel)  
    txtDestination.Text = saveFileDialog1.FileName;
```

Press F5 to run the project, and then click each of the buttons and select a file. When you're satisfied that your selections are being sent to the appropriate text box, stop the project and save your work. If your selected filenames aren't being sent to the proper text box, verify that your code is correct.

The Open File Dialog and Save File Dialog controls are very similar in their design and appearance, but each serves a specific purpose. You'll be using the interface you've just created throughout the rest of this hour.

[[Team LiB](#)]

Manipulating Files with the File Object

Visual C# .NET includes a powerful namespace called System.IO (the IO object acts like an object property of the System namespace). Using various properties, methods, and object properties of System.IO, you can do just about anything you can imagine with the file system. In particular, the System.IO.File and System.IO.Directory objects provide you with extensive file and directory (folder) manipulation.

In the following sections, you'll continue to expand the project that you've created. You'll write code that manipulates the selected filenames by using the Open File Dialog and Save File Dialog controls.



The code you'll write in the following sections is "the real thing." For instance, the code for deleting a file really deletes a file. Don't forget this as you test your project; the files selected as the source and as the destination will be affected by your actions. I provide the cannon; it's up to you not to shoot yourself in the foot.

Determining Whether a File Exists

Before attempting any operation on a file, such as copying or deleting it, it's a good idea to make certain the file exists. If the user doesn't click the Source button to select a file, but instead types the name and path of a file into the text box, for example, the user could type an incorrect filename. Attempting to manipulate a nonexistent file could result in an exception—which you don't want to happen. Because you're going to work with the source file selected by the user in many routines, you're going to create a central function that can be called to determine whether the source file exists. The function uses the Exists() method of the System.IO.File object to determine whether the file exists.

Add the following method to your Form class:

```
bool SourceFileExists()
{
    if (!System.IO.File.Exists(txtSource.Text))
    {
        MessageBox.Show("The source file does not exist!");
        return false;
    }
    else
        return true;
}
```

The Exists() method accepts a string containing the filename (with path) of the file to verify. If the file exists, Exists() returns true; otherwise, it returns false.

Copying a File

Copying files is a common task. For instance, you may want to create an application that backs up important data files by copying them to another location. For the most part, copying is pretty safe—as long as you use a destination filename that doesn't already exist. Copying files is accomplished using the Copy() method of the System.IO.File class.

You're now going to add a button to your form. When the user clicks this button, the file specified in the source text box will be copied to a new file with the name given in the destination text box. Add a button to your form now and set its properties as shown in the following table:

Property	Value
Name	btnCopyFile
Location	96,80
Size	75,23
Text	Copy

Double-click the Copy button and add the following code:

```
if (!SourceFileExists()) return;  
System.IO.File.Copy(txtSource.Text, txtDestination.Text);  
MessageBox.Show("The file has been successfully copied.");
```

The Copy() method has two arguments. The first is the file that you want to copy, and the second is the name and path of the new copy of the file. In this example, you're using the filenames in the two text boxes.

Press F5 to run the project and test your copy code now by following these steps:

1. Click the Source button and select a text file.
2. Click the Destination button to display the Save File dialog box. Don't select an existing file. Instead, type a new filename into the File Name text box and click Save. If you are asked whether you want to replace a file, click No and change your filename; don't use the name of an existing file.
3. Click Copy to copy the file.

After you get the message box telling you the file was copied, you can use Explorer to locate the new file and open it. Stop the project and save your work before continuing.

Moving a File

When you move a file, it's taken out of its current directory and placed in a new one. You can specify a new name for the file or use its original name. Moving a file is accomplished with the Move() method of the System.IO.File object. You're now going to create a button on your form that moves the file selected as the source to the path and the filename selected as the destination.



I recommend that you use Notepad to create a text file, and use this temporary text file when testing from this point forward. This code, as well as the rest of the examples in this hour, can permanently alter or destroy a file.

Add a new button to the form and set its properties as follows:

Property	Value
Name	btnMove
Location	96,112
Size	75,23
Text	Move

Double-click the Move button and add the following code to its Click event:

```
if (!SourceFileExists()) return;  
System.IO.File.Move(txtSource.Text, txtDestination.Text);  
MessageBox.Show("The file has been successfully moved.");
```

Go ahead and press F5 to test your project. Select a file to move (I recommend you create a dummy file in Notepad), and supply a destination filename. When you click Move, the file will be moved to the new location and be given the new name. Remember, if you specify a name for the destination that isn't the same as that of the source, the file will be given the new name when it's copied.

Deleting a File

Deleting a file can be a risky proposition. The Delete() method of System.IO.File deletes a file permanently—it doesn't send the file to the Recycle Bin. For this reason, you should take great care when deleting files. First and foremost, this means testing your code. When you write a routine to delete a file, be sure to test it under various conditions. For example, if you reference the wrong text box in this code, you could inadvertently delete the wrong file! Users aren't forgiving of such mistakes.

You're now going to add a button to your project that deletes the source file when clicked. Remember: Be careful when testing this code. Add a button to the form now and set its properties as follows:

Property	Value
Name	btnDelete
Location	96,144
Size	75,23
Text	Delete

Next, double-click the button and add the following code to its Click event:

```
if (!SourceFileExists()) return;  
  
if (MessageBox.Show("Are you sure you want to delete the source file?",  
    "Delete Verification", MessageBoxButtons.YesNo,  
    MessageBoxIcon.Question) == DialogResult.Yes)  
{  
    System.IO.File.Delete(txtSource.Text);  
    MessageBox.Show("The file has been successfully deleted.");  
}
```

Notice that you've included a message box to confirm the user's intentions. It's a good idea to do this whenever you're about to perform a serious action that can't be undone. In fact, the more information you can give, the better. For example, I suggest that if this were production code (code meant for end users), you should include the name of the file in the message box, so that the user knows without a doubt what the program intends to do.

If you're feeling brave, press F5 to run the project, and then select a file and delete it. Again, I highly recommend you use a dummy text file created in Notepad for these experiments.

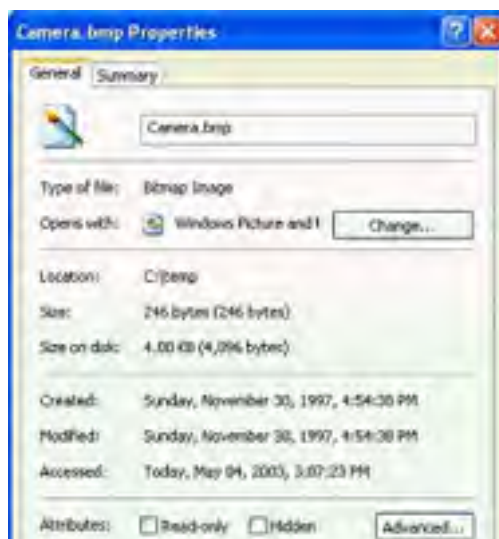
Renaming a File

When you rename a file, it remains in the same directory and nothing materially happens to the contents of the file—the name is changed to something else. Because the original file isn't altered, renaming a file isn't as risky as performing an action such as deleting the file. Nevertheless, it is frustrating trying to determine what happened to a file when it was mistakenly renamed. To rename a file, use the Move() method of System.IO.File, specifying a new filename but keeping the same path.

Retrieving a File's Properties

Although many people don't realize it, files have a number of properties—such as the date the file was last modified. The easiest way to see these properties is to use Explorer. View the attributes of a file now by starting Explorer, right-clicking any file displayed in Explorer, and choosing Properties. Explorer shows the File Properties window with information about the file (see [Figure 19.3](#)).

Figure 19.3. Visual C# .NET provides a means to easily obtain most file properties.





The System.IO.File object provides ways to get at most of the data displayed on the General tab of the File Properties dialog box shown in [Figure 19.3](#). Some of this data is available directly from the File object, whereas other data is accessed using a FileAttributes object.

Getting Date and Time Information About a File

Getting the last created, last accessed, and last modified dates of a file is easy; the System.IO.File object supports a method for each of these dates. [Table 19.1](#) lists the applicable methods and what they return.

Table 19.1. File Object Methods to Retrieve Data Information

Property	Description
<code>GetCreationTime</code>	Returns the date and time the file was created
<code>GetLastAccessTime</code>	Returns the date and time the file was last accessed
<code>GetLastWriteTime</code>	Returns the date and time the file was last modified

Getting the Attributes of a File

The attributes of a file (refer to the bottom of the dialog box shown in [Figure 19.3](#)) aren't available as properties or methods of the System.IO.File object. How you determine an attribute's value is a bit complicated. The `GetAttributes()` method of System.IO.File returns a FileAttributes enumeration. This, in turn, acts as a set of flags for the various attributes. The method used to store these values is called *bit packing*. Bit packing is pretty complicated and has to do with the binary method in which values are stored in memory and on disk. Teaching bit packing is beyond the scope of this book—what I want to show you is how to determine whether a certain flag is set in a value that is bit packed.

The first step in determining the attributes is to get the file attributes. To do this, create a FileAttributes variable and call `GetAttributes()`, like this:

```
System.IO.FileAttributes objfileAttributes ;  
IntAttributes = System.IO.File.GetAttributes(txtSource.Text);
```

After you have the flags in the variable, by `&`ing the variable with one of the flags shown in [Table 19.2](#) and then testing whether the result equals the flag, you can determine whether a particular attribute is set. For example, to determine whether a file's `ReadOnly` flag is set, you could use a statement like the following:

```
(objfileAttributes &  
System.IO.FileAttributes.ReadOnly == System.IO.FileAttributes.ReadOnly)
```

When you `&` a flag value with a variable, you'll get the flag value back if the variable contains the flag; otherwise, you'll get a zero back.

Table 19.2. File Attribute Flags

Attribute	Meaning
<code>Archive</code>	The file's archive status. Applications use this attribute to mark files for backup and removal.
<code>Directory</code>	The file is a directory.
<code>Hidden</code>	The file is hidden and therefore not included in an ordinary directory listing.
<code>Normal</code>	The file is normal and has no other attributes set.
<code>ReadOnly</code>	The file is a read-only file.
<code>System</code>	The file is part of the operating system or is used exclusively by the operating system.
<code>Temporary</code>	The file is a temporary file.

Writing Code to Retrieve a File's Properties

Now that you know how to retrieve the properties of an object, you're going to use that knowledge to display the properties of the file specified in the source text box on your form. Begin by adding a new button to your form and setting its properties as shown in the following table:

Property	Value
Name	btnGetFileProperties
Location	8,176
Size	80,56
Text	Get Properties of Source File

Next, add a text box to the form and set its properties as follows:

Property	Value
Name	txtProperties
Location	96,176
Multiline	True
ScrollBars	Vertical
Size	184,88
Text	(make blank)

The code you enter into the Click event of this button will be a bit longer than most of the code you've entered so far. Therefore, I'll show the code in its entirety, and then I'll explain what the code does. Double-click the button and add the following code to the button's Click event:

```
System.Text.StringBuilder stbProperties = new System.Text.StringBuilder("");
System.IO.FileAttributes fileAttributes ;

if (!SourceFileExists()) return;
// Get the dates.
stbProperties.Append("Created: ");
stbProperties.Append(System.IO.File.GetCreationTime(txtSource.Text));

stbProperties.Append("\r\n");

stbProperties.Append("Accessed: ");
stbProperties.Append(System.IO.File.GetLastAccessTime(txtSource.Text));

stbProperties.Append("\r\n");

stbProperties.Append("Modified: ");
stbProperties.Append(System.IO.File.GetLastWriteTime(txtSource.Text));
// Get File Attributes
fileAttributes = System.IO.File.GetAttributes(txtSource.Text);

stbProperties.Append("\r\n");

stbProperties.Append("Normal: ");
stbProperties.Append(
    Convert.ToBoolean((fileAttributes & System.IO.FileAttributes.Normal)
        == System.IO.FileAttributes.Normal));

stbProperties.Append("\r\n");

stbProperties.Append("Hidden: ");
```

```
stbProperties.Append(  
    Convert.ToBoolean((fileAttributes & System.IO.FileAttributes.Hidden)  
        == System.IO.FileAttributes.Hidden));  
  
stbProperties.Append("\r\n");  
  
stbProperties.Append("ReadOnly: ");  
stbProperties.Append(  
    Convert.ToBoolean((fileAttributes & System.IO.FileAttributes.ReadOnly)  
        == System.IO.FileAttributes.ReadOnly));  
  
stbProperties.Append("\r\n");  
  
stbProperties.Append("System: ");  
stbProperties.Append(  
    Convert.ToBoolean((fileAttributes & System.IO.FileAttributes.System)  
        == System.IO.FileAttributes.System));  
  
stbProperties.Append("\r\n");  
  
stbProperties.Append("Temporary File: ");  
stbProperties.Append(  
    Convert.ToBoolean((fileAttributes & System.IO.FileAttributes.Temporary)  
        == System.IO.FileAttributes.Temporary));  
  
stbProperties.Append("\r\n");  
  
stbProperties.Append("Archive: ");  
stbProperties.Append(  
    Convert.ToBoolean((fileAttributes & System.IO.FileAttributes.Archive)  
        == System.IO.FileAttributes.Archive));  
  
txtProperties.Text = stbProperties.ToString();
```

All the various properties of the file are appended to the StringBuilder variable `stbProperties`. The `"\r\n"` denotes a carriage return and a newline, and appending this into the string ensures that each property appears on its own line.

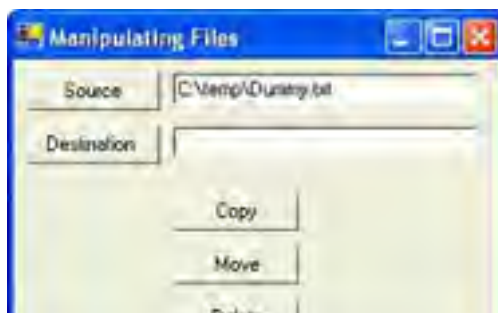
The first statement declares an empty StringBuilder variable called `stbProperties`. The StringBuilder object was designed for optimizing string concatenation. You'll be using the append method of the StringBuilder class to create the file properties text. The second set of statements simply call the `GetCreateTime()`, `GetLastAccessTime()`, and `GetLastWriteTime()` methods to get the values of the date-related properties. Next, the attributes are placed in a variable by way of the `GetAttributes()` method, and the state of each attribute is determined. The `Convert.ToBoolean()` method is used so that the words True and False appear. Lastly, you assign the `txtProperties.Text` value to the created StringBuilder string.

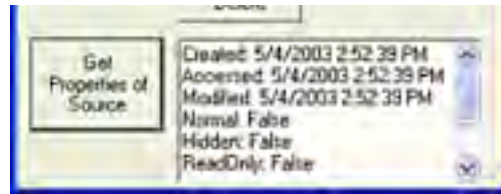
Watch Out!

You've previously used the `+` to concatenate strings, and this will also work. But, when concatenating a large number of strings, you should use the StringBuilder object. The reason for this is that strings are immutable in .NET—they can never be changed. So every concatenation operation creates an entirely new string object, discarding both of the other strings. This can have a negative effect on performance.

Press F5 to run the project, click Source to select a file, and then click the button to get and display the attributes. If you entered the code exactly as shown, the attributes of the file should appear in the text box as they do in [Figure 19.4](#).

Figure 19.4. The System.IO.File object enables you to look at the properties of a file.





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Manipulating Directories with the Directory Object

Manipulating directories (folders) is very similar to manipulating files. However, rather than using `System.IO.File`, you use `System.IO.Directory`. Notice that when you specify a directory path, double slashes are used instead of just one. If any of these method calls confuse you, see the previous section on `System.IO.File` for more detailed information. Following are the method calls:

- `System.IO.Directory.CreateDirectory()`— Used to create a directory. You must pass it the name of the new folder as shown here (note that, as discussed in [Hour 11](#), you must preference literal strings containing slashes with the `@` character):

```
System.IO.Directory.CreateDirectory(@"c:\my new directory");
```

- `System.IO.Directory.Exists()`— Used to determine whether a directory exists. Pass the method the directory name in question, like this:

```
MessageBox.Show(Convert.ToString(System.IO.Directory.Exists(@"c:\temp")));
```

- `System.IO.Directory.Move()`— Used to move a directory. The `Move()` method takes two arguments. The first is the current name of the directory, and the second is the new name and path of the directory. When you move a directory, the contents of it are moved as well. The following illustrates a call to `Move()`:

```
System.IO.Directory.Move(@"c:\current directory name",  
    @"d:\new directory name");
```

- `System.IO.Directory.Delete()`— Used to delete a directory. Note, however, that deleting directories is even more perilous than deleting files; when you delete a directory, you also delete all files and subdirectories within the directory. When you call `Delete()`, pass it the name of the directory to delete. I can't tell you often enough that you have to be careful when calling this method; it can get you into a lot of trouble. The following statement illustrates deleting a directory:

```
System.IO.Directory.Delete(@"c:\temp");
```

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Summary

The Open File Dialog and Save File Dialog controls, coupled with System.IO, enable you to do many powerful things with a user's file system. In this hour, you learned how to let a user browse and select a file for opening, and how to let a user browse and select a file for saving. Determining a user's file selection is only the first part of the process, however. You also learned how to manipulate files and directories, including renaming, moving, and deleting, by using System.IO. Finally, you learned how to retrieve the properties and attributes of a file.

With the techniques shown in this hour, you should be able to do most of what you'll need to do with files and directories. None of this material is very difficult, but don't be fooled by the simplicity; use care whenever manipulating a user's file system.

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Q&A

Q1: *What if I want to perform an operation on a file, but something is preventing the operation, for example, the file may be open or I don't have rights to the file?*

A1: All the method calls have one or more exceptions that can be thrown in the event that the method fails. These method calls are listed in the online Help. You can use the techniques discussed in [Hour 15](#), "Debugging Your Code," to trap the exceptions.

Q2: *What if a user types a filename into one of the file dialog boxes, but the user doesn't include the extension?*

A2: By default, both file dialog controls have their AddExtension properties set to `true`. When this property is set to `true`, Visual C# .NET automatically appends the extension of the currently selected filter.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** True or False: The Open File dialog box automatically opens a file.
- 2:** What symbol is used to separate a filter description from its extension?
- 3:** What object is used to manipulate files?
- 4:** What arguments are required by `System.IO.File.Copy()`?
- 5:** How would you rename a file?
- 6:** True or False: Files deleted with `System.IO.File.Delete()` are sent to the Recycle Bin.
- 7:** What objects are used to manipulate folders?

Exercises

- 1:** Create a project that enables a user to select a file with the Open Dialog control. Store the filename in a text box. Provide another button that, when clicked, creates a backup of the file by making a copy of it with the extension `.bak`.
- 2:** Create a project with a text box on a form in which the user can type in a three-character file extension. Include a button that shows an Open File dialog box when clicked, with the filter set to the extension entered by the user.

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Hour 20. Controlling Other Applications Using Automation

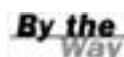
In [Hour 16](#), "Designing Objects Using Classes," you learned how to use classes to create objects. In that hour, I mentioned that objects could be exposed to outside applications. Excel, for example, exposes most of its functionality as a set of objects. The process of using objects from another application is called **Automation**. The externally accessible objects of an application compose its **object model**. Using Automation to manipulate a program's object model enables you to reuse components. For instance, you can use Automation with Excel to perform complex mathematical functions using the code that's been written and tested within Excel, rather than writing and debugging the complex code yourself.

Programs that expose objects are called **servers**, and the programs that consume those objects are called **clients**. Creating automation servers requires advanced skills, including a very thorough understanding of programming classes. Creating clients to use objects from other applications, on the other hand, is relatively simple. In this hour, you'll learn how to create a client application that uses objects of an external server application.

The highlights of this hour include the following:

- Creating a reference to an automation library
- Creating an instance of an automation server
- Manipulating the objects of an automation server

To understand Automation, you're going to build a Microsoft Excel client—a program that automates Excel via Excel's object model.



This exercise is designed to work with Excel 97, Excel 2000, or Excel 2002.

Create a new Windows Application named **Automate Excel**. Change the name of the default form to **fclsMain**, set its Text property to **Automate Excel**, and then set the entry point in Main() to reference **fclsMain** instead of Form1. Next, add a button to the form by double-clicking the Button item in the toolbox and set the button's properties as follows:

Property	Value
Name	btnAutomateExcel
Location	96,128
Size	104,23
Text	Automate Excel

Creating a Reference to an Automation Library

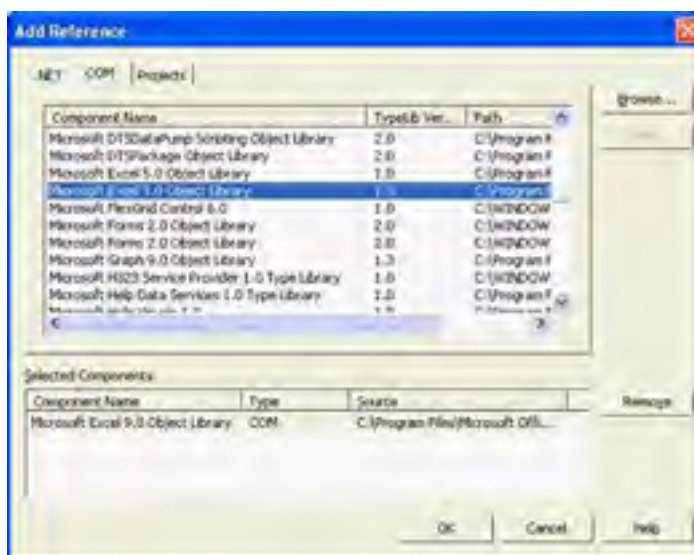
To use the objects of a program that supports Automation (a server), you have to reference the program's type library. A program's **type library** (also called its **object library**) is a file containing a description of the program's object model. After you've referenced the type library of an automation server (also called a component), you can access the objects of the server as though they were internal Visual C# .NET objects.

Many types of components support automation. Of course, .NET is the latest technology, but in the case of Excel, we're interested in the COM components. COM stands for Component Object Model, and it's been *the* technology for working with objects within Windows for many years. Microsoft's .NET platform is designed to replace COM, but this isn't going to happen overnight. Literally thousands of objects are built on COM technology. In fact, all the Microsoft Office products up to and including Office XP are based on COM.

To create a reference to a type library, follow these steps:

1. Display the Add Reference dialog box by choosing Project, Add Reference.
2. Click the COM tab to display the available COM components (programs that have a type library) on your computer.
3. Scroll the list and locate the Microsoft Excel X Object Library (where X is the version of Excel installed on your computer). Double-click the Excel item to add it to the list of selected components at the bottom of the Add Reference dialog box (see [Figure 20.1](#)).

Figure 20.1. To use an object library, you need to reference it first.



By the Way

If you don't see an entry for Microsoft Excel, you probably don't have Excel installed on your computer; therefore, this code won't work. If you have multiple Excel entries, choose version 9 if it's listed.

4. Click OK to add the reference to your project.

By the Way

Visual C# .NET doesn't work directly with COM components. Instead, it interacts through a *wrapper*, a set of code and objects that works as an intermediary between Visual C# .NET and a COM component. When you add the reference to a COM component, Visual C# .NET automatically creates the wrapper for you.

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Creating an Instance of an Automation Server

Referencing a type library allows Visual C# .NET to integrate the available objects of the type library with its own internal objects. After this is done, you can create object variables based on object types found in the type library. Excel has an object called Application, which acts as the primary object in the Excel object model. In fact, most Office programs have an Application object. How do you know what objects an automation server supports? The only sure way is to consult the documentation of the program in question or use the Object Browser, which is discussed in [Hour 3](#), "Understanding Objects and Collections."

**By the
Way**

In this example, you'll be using about a half-dozen members of an Excel object. This doesn't even begin to scratch the surface of Excel's object model, nor is it intended to. What you should learn from this example is the mechanics of working with an automation server. If you choose to automate a program in your own projects, you should consult the program's developer documentation to learn as much about its object model as you can—you're sure to be surprised at the functionality available to you.

Double-click the button to access its Click event, and then enter the following code, which creates a new Excel Application:

```
Excel.Application objExcel = new Excel.Application();
```

Notice that Visual C# .NET included Excel in its IntelliSense drop-down list of available objects. It was able to do this because you referenced Excel's type library. Excel is the reference to the server and Application is an object supported by the server. This statement creates a new Application object based on the Excel object model.

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Manipulating the COM Server from the Client Code

After you have an instance of an object from an automation server, manipulating the server (creating objects, setting properties, calling methods, and so forth) is accomplished by manipulating the object. In the following sections, you'll manipulate the new Excel object (by setting properties and calling methods), and in so doing you will be manipulating Excel itself.

Forcing Excel to Show Itself

When Excel is started using Automation, it's loaded but not shown. Keeping Excel hidden enables the developer to use Excel's functionality and then close it without the user knowing what happened. For instance, you could create an instance of an Excel object, perform a complicated formula to obtain a result, close Excel, and return the result to the user—all without the user ever seeing Excel. In this example, you want to see Excel so that you can see what your code is doing. Fortunately, showing Excel couldn't be easier. Add the following statement to make Excel visible:

```
objExcel.Visible = true;
```

Creating an Excel Workbook and Worksheet

In Excel, a workbook is the file in which you work and store your data; you can't manipulate data without a workbook. When you first start Excel from the Start menu, an empty workbook is created for you. When you start Excel via Automation, however, Excel doesn't create a workbook; you have to do it yourself. To create a new workbook, you use the Add method of the workbooks collection. After the workbook has been created, you need to set up a worksheet. Enter the following statements:

```
//start a new workbook and a worksheet.  
Excel.Workbook objBook =  
    objExcel.Workbooks.Add(System.Reflection.Missing.Value);  
Excel.Worksheet objSheet = (Excel.Worksheet)objBook.Worksheets.get_Item(1);
```



Notice how `System.Reflection.Missing.Value` is being passed into the `Add()` method. This is because the `Add()` method supports a default parameter and Visual C# .NET does not support default parameters. Using the `System.Reflection.Missing.Value` as the parameter in the `Add()` method enables the COM's late-binding service to use the default value for the indicated parameter value.

Working with Data in an Excel Workbook

In this section, you're going to manipulate data in the worksheet.

The following describes what you'll do:

1. Add data to four cells in the worksheet.
2. Select the four cells.
3. Total the selected cells and place the sum into a fifth cell.
4. Bold all five cells.

To manipulate cells in the worksheet, you manipulate the Range object, which is an object property of the Worksheet object. Entering data into a cell involves first selecting a cell and then passing data to it. Selecting a cell is accomplished by setting a range object by calling the `get_Range()` method of the Worksheet object; the `get_Range()` method is used to select one or more cells. The `get_Range()` method accepts a starting column and row and an ending column and row. If you want to select only a single cell, as we do here, you can substitute the ending column and row with the `System.Reflection.Missing.Value` parameter. After the range is set, you pass data to the selected range by using the `set_Value()` method on the Range object. Sound confusing? Well, it is to some extent. Programs that support Automation are often vast and complex, and programming them is usually far from intuitive.

Did you Know?

If the program you want to automate has a macro builder (as most Microsoft products do), you can save yourself a lot of time and headache by creating macros of the tasks you want to automate by using the Macro recording tools found in the server application (such as Excel). The "macros" are actually code, and in the case of Microsoft products, they're VBA (Visual Basic for Applications) code. VBA code doesn't translate directly to .NET, but it will give you a good idea of the objects, properties, and methods involved with accomplishing certain automation tasks.

The following section of code uses the techniques just described to add data to four cells. Enter this code into your procedure:

```
Excel.Range objRange;  
  
objRange = objSheet.get_Range("A1", System.Reflection.Missing.Value);  
objRange.Value = 75;  
  
objRange = objSheet.get_Range("B1", System.Reflection.Missing.Value);  
objRange.Value = 125;  
  
objRange = objSheet.get_Range("C1", System.Reflection.Missing.Value);  
objRange.Value = 255;  
  
objRange = objSheet.get_Range("D1", System.Reflection.Missing.Value);  
objRange.Value = 295;
```

The next step is to have Excel total the four cells. You'll do this by using the Range object to select the cells, activating a new cell in which to place the total, and then using FormulaR1C1 to create the total by passing it a formula, rather than a literal value. Enter the following code into your procedure:

```
objRange = objSheet.get_Range("E1", System.Reflection.Missing.Value);  
objRange.set_Value(System.Reflection.Missing.Value, "=SUM(RC[-4]:RC[-1])" );
```

Next, you'll select all five cells and bold them. Enter the following statements to accomplish this:

```
objRange = objSheet.get_Range("A1", "E1");  
objRange.Font.Bold=true;
```

The last thing you need to do is destroy the object reference by setting the object variable to null. Excel remains open even though you've destroyed the Automation instance (not all servers do this). Add this last statement to your procedure:

```
objExcel=null;
```

To help you ensure that everything is entered correctly, [Listing 20.1](#) shows the procedure in its entirety.

Listing 20.1 Code to Automate Excel

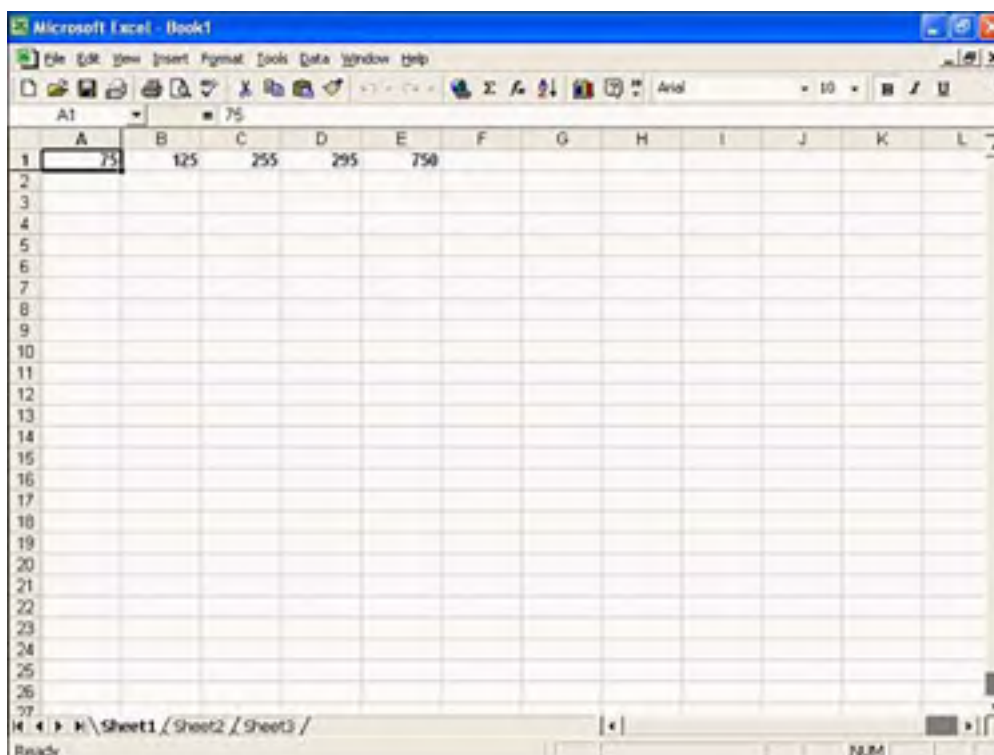
```
private void btnAutomateExcel_Click(object sender, System.EventArgs e)  
{  
    Excel.Application objExcel = new Excel.Application();  
    objExcel.Visible = true;  
  
    //start a new workbook and a worksheet.  
    Excel.Workbook objBook =  
        objExcel.Workbooks.Add(System.Reflection.Missing.Value);  
  
    Excel.Worksheet objSheet =  
        (Excel.Worksheet)objBook.Worksheets.get_Item(1);  
  
    Excel.Range objRange;  
  
    objRange = objSheet.get_Range("A1", System.Reflection.Missing.Value);  
    objRange.Value = 75;
```

```
objRange = objSheet.get_Range("B1", System.Reflection.Missing.Value);  
objRange.Value = 125;  
  
objRange = objSheet.get_Range("C1", System.Reflection.Missing.Value);  
objRange.Value = 255;  
  
objRange = objSheet.get_Range("D1", System.Reflection.Missing.Value);  
objRange.Value = 295;  
  
objRange = objSheet.get_Range("A1", "E1");  
objRange.Font.Bold=true;  
  
objExcel=null;  
}
```

Testing Your Client Application

Now that your project is complete, press F5 to run it and then click the button to automate Excel. If you entered the code correctly, Excel will start, data will be placed into four cells, the total of the four cells will be placed into a fifth cell, and all cells will be made bold (see [Figure 20.2](#)).

Figure 20.2. You can control almost every aspect of Excel using its object model.



By the Way

Automating applications, particularly Office products such as Excel and Word, requires a lot of system resources. If you intend to perform a lot of automation, you should use the fastest machine with the most memory that you can afford. Also, be aware that in order for automation to work, the client application (Excel is this case) has to be installed on the user's computer in addition to your application.

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Summary

In this hour, you learned how a program can make available an object model that client applications can use to manipulate the program. You learned that the first step in automating a program (server) is to reference the type library of the server. After the type library is referenced, the objects of the server are available as though they were internal Visual C# .NET objects. As you have seen, the mechanics of automating a program aren't that difficult—they build on the object-programming skills you've already learned in this book. The real challenge comes in learning the object model of a given server and in making the most productive use of the objects available.

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Q&A

Q1: *What are some applications that support Automation?*

A1: All the Microsoft Office products, as well as Microsoft Visio, support Automation. You can create a useful application by building a client that makes use of multiple Automation servers. For instance, you could calculate data in Excel and then format and print the data in Word.

Q2: *Can you automate a component without creating a reference to a type library?*

A2: Yes, but this is considerably more complicated than when using a type library. First, you can't early-bind to objects, because Visual C# .NET knows nothing about the objects without a type library. This means you have no IntelliSense drop-down list to help you navigate the object model; the chances for bugs in this situation are almost unbearably large. To use late binding in Visual C# .NET, use the `System.Type.InvokeMember` method.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Quiz Answers."

Quiz

- 1:** Before you can early-bind objects in an automation server, you must do what?
- 2:** What is the most likely cause of not seeing a type library listed in the Add References dialog box?
- 3:** For Visual C# .NET to use a COM library, it must create a:
- 4:** To manipulate a server via Automation, you manipulate:
- 5:** To learn about the object library of a component, you should:

Exercises

- 1:** Modify the Excel example to save the workbook. Hint: Consider the SaveAs() method of the Workbooks collection.
- 2:** If you have Word installed, add the Word type library to a new project, create an object variable that holds a reference to Word's Application object, create a new document, and send some text to the document. You'll probably need to reference the VBA help file that ships with Word.

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Hour 21. Working with a Database

You've heard it so many times that it's almost a cliché: This is the information age. Information is data, and managing information means working with databases. Database design is a skill unto itself, and entire books are devoted to database design and management. In this hour, you'll learn the basics of working with a database using ADO.NET, Microsoft's newest database technology.

By the Way

Although high-end solutions are built around advanced database technologies such as Microsoft's SQL Server, the Microsoft Jet database (used by Microsoft Access) is more readily available and easier to learn, so you'll build working examples that use a Jet database. Be aware, however, that 95% of what you learn here is directly applicable to working with SQL Server as well.

The highlights of this hour include the following:

- Introduction to ADO.NET
- Connecting to a database
- Understanding DataTables
- Creating a DataAdapter
- Referencing fields in a DataRow
- Navigating records
- Adding, editing, and deleting records
- Building an ADO.NET example

By the Way

You'll learn a lot in this hour, but realize that this material is really the "tip of the iceberg." Database programming can be, and often is, very complex. This hour is intended to get you writing database code as quickly as possible, but if you plan to do a lot of database programming, you'll want to consult a dedicated book (or two) on the subject.

Start by creating a new Windows Application named **Database Example**. Change the name of the default form to **fclsMain** and set its Text property to **Database Example**. Next, click the View Code button on the Solution Explorer window to access the form's code, scroll down and locate the procedure Main(), and change the reference of Form1 to **fclsMain**. Finally, click the Form1.cs tab to return to the form designer.

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Introduction to ADO.NET

ADO.NET is the .NET platform's new database technology, and it builds on ADO (Active Data Objects). ADO.NET provides DataSet and DataTable objects that are optimized for moving disconnected sets of data across the Internet and intranets, including through firewalls. At the same time, ADO.NET includes the traditional Connection and Command objects, as well as an object called a DataReader (which resembles a forward-only, read-only ADO recordset, in case you're familiar with ADO). Together these objects provide the very best performance and throughput for retrieving data from a database.

In short, you'll learn about the following objects as you progress through this hour:

- OleDbConnection Used to establish a connection to an OLEDB data source.
- SqlConnection Used to establish a connection to a SQL Server data source.
- DataSet A memory-resident representation of data. There are many ways of working with a DataSet, such as through DataTables.
- DataTable Holds a result set of data for manipulation and navigation.
- OleDbDataAdapter Used to populate a DataReader or a DataSet, and can hold commands for updating the database.
- DataReader Used to read through a result set only one time—Data Readers are very fast.

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Connecting to a Database

To access data in a database, you must first establish a connection using an ADO.NET connection object. Two connection objects are included in the .NET Framework: the `OleDbConnection` object (for working with the same OLE DB data providers you would access through traditional ADO) and the `SqlConnection` object (for optimized access to Microsoft SQL Server). Because these examples connect to the Microsoft Jet Database, you'll be using the `OleDbConnection` object. To create an object variable of type `OleDbConnection` and initialize the variable to a new connection, you could use a statement such as the following:

```
OleDbConnection cnADONetConnection = new OleDbConnection();
```

To use ADO.NET, the first step that you need to take is to add the proper Namespace to your project. Double-click the form now to access its events. Scroll to the top of the class and add the following `using` statement on the line below the other `using` statements:

```
using System.Data.OleDb;
```

You're going to create a module-level variable to hold the connection, so place the cursor below the left bracket (`{`) that follows the statement `public class fclsMain : System.Windows.Forms.Form` and press Enter to create a new line. Enter the following statement:

```
OleDbConnection m_cnADONetConnection = new OleDbConnection();
```

Before using this connection, you must specify the data source to which you want to connect. This is done through the `ConnectionString` property of the ADO.NET connection object. The `ConnectionString` contains connection information such as the name of the provider, username, and password. The `ConnectionString` might contain many connection parameters; the set of parameters available varies depending on the source of data that you're connecting to. Some of the parameters used in the OLE DB `ConnectionString` are listed in [Table 21.1](#). If you specify multiple parameters, separate them with a semicolon.

Table 21.1. Possible Parameters for ConnectionString

Parameter	Description
<code>Provider=</code>	The name of the data provider (Jet, SQL, and so on) to use.
<code>Data Source=</code>	The name of the data source (database) to connect to.
<code>UID=</code>	A valid username to use when connecting to the data source.
<code>PWD=</code>	A password to use when connecting to the data source.
<code>DRIVER=</code>	The name of the database driver to use. This isn't required if a DSN is specified.
<code>SERVER=</code>	The network name of the data source server.

The `Provider=` parameter is one of the most important at this point and is governed by the type of database you're accessing. For example, when accessing a SQL Server database, you specify the provider information for SQL Server; when accessing a Jet database, you specify the provider for Jet. In this example, you'll be accessing a Jet (Microsoft Access) database, so you'll use the provider information for Jet.

In addition to specifying the provider, you're also going to specify the database. I've provided a sample database at the Web site for this book. This code assumes that you've placed the database in a folder called `C:\Temp`. If you are using a different folder, you'll need to change the code accordingly.

To specify the `ConnectionString` property of your ADO.NET connection, place the following statement in the Load event of your form:

```
m_cnADONetConnection.ConnectionString =  
@"Provider=Microsoft.Jet.OLEDB.4.0;Data Source=C:\temp\contacts.mdb";
```

When the connection string is defined, a connection to a data source is established by using the `Open()` method of the connection object. Add the following statement to the Load event, right after the statement that sets the connection string:

```
m_cnADONetConnection.Open();
```



Refer to the online documentation for information on the connection strings for providers other than Jet.

When you attach to an unsecured Jet database, it's not necessary to provide a username and password. When attaching to a secured Jet database, however, you must provide a username and a password. This is done by passing the username and password as parameters in the `ConnectionString` property. The sample database I've provided isn't secured, so it's not necessary to provide a username and password.

Closing a Connection to a Data Source

You should always explicitly close a connection to a data source. That means you shouldn't rely on a variable going out of scope to close a connection. Instead, you should force an explicit disconnect via code. This is accomplished by calling the `Close()` method of the connection object.

You're now going to write code to explicitly close the connection when the form is closed. Follow these steps:

1. Start by clicking the `Form1.cs` tab to return to the form designer.
2. Click the Events button on the Properties window (the lightning bolt) to access the list of events for the form.
3. Double-click the Closed event to create a new event handler. Enter the following statement in the Closed event:

```
m_cnADONetConnection.Close();
```

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Manipulating Data

The easiest way to manipulate data using ADO.NET is to create a `DataTable` object containing the resultset of a table, query, or stored procedure. Using a `DataTable` object, you can add, edit, delete, find, and navigate records. The following sections explain how to use `DataTables`.

Understanding Data Tables

DataTables contain a snapshot of data in the data source. You generally start by filling a `DataTable`, manipulating its results, and finally sending the changes back to the data source. The `DataTable` is populated using the `Fill()` method of a `DataAdapter` object, and changes are sent back to the database using the `Update()` method of a `DataAdapter`. Any changes made to the `DataTable` appear only in the local copy of the data until you call the `Update()` method. Having a local copy of the data reduces contention by preventing users from blocking others from reading the data while it's being viewed. If you're familiar with ADO, you'll note that this is similar to the Optimistic Batch Client Cursor in ADO.

Creating a DataAdapter

To populate a `DataTable`, you must create a *DataAdapter*, an object that provides a set of properties and methods to retrieve and save data between a `DataSet` and its source data. The `DataAdapter` you're going to create will use the connection you've already defined to connect to the data source and then execute a query you'll provide. The results of that query will be pushed into a `DataTable`.

Just as two ADO.NET connection objects are in the .NET Framework, there are two ADO.NET `DataAdapter` objects as well: the `OleDbDataAdapter` and the `SqlDataAdapter`. Again, you'll be using the `OleDbDataAdapter` because you aren't connecting to Microsoft SQL Server.

The constructor for a `DataAdapter` optionally takes the command to execute when filling a `DataTable` or `DataSet`, as well as a connection specifying the data source. (You could have multiple connections open in a single project.) This constructor has the following syntax:

```
OleDbDataAdapter cnADONetAdapter = new  
OleDbDataAdapter([CommandText],[Connection]);
```

To add the `DataAdapter` to your project, first add the following statement immediately below the statement you entered to declare the `m_cnADONewConnection` object.

```
OleDbDataAdapter m_daDataAdapter = new OleDbDataAdapter();
```

Next, add the following statement at the bottom of the Load event of the form, (immediately following the statement that opens the connection):

```
m_daDataAdapter =  
new OleDbDataAdapter("Select * From Contacts",m_cnADONetConnection);
```

Because you're going to use the `DataAdapter` to update the original data source, you must specify the `insert`, `update`, and `delete` statements to use to submit changes from the `DataTable` to the data source. ADO.NET lets you customize how updates are submitted by enabling you to manually specify these statements as database commands or stored procedures. In this case, you're going to have ADO.NET automatically generate these statements for you by creating a `CommandBuilder` object. Enter the following statement to create the `CommandBuilder`:

```
OleDbCommandBuilder m_cbCommandBuilder =  
new OleDbCommandBuilder(m_daDataAdapter);
```

The `CommandBuilder` is an interesting object in that after you initialize it, you no longer work with it directly: It works behind the scenes to handle the updating, inserting, and deleting of data. To make this work, you have to attach the `CommandBuilder` to a `DataAdapter`. You do so by passing a `DataAdapter` to the `CommandBuilder`. The `CommandBuilder` then registers for update events on the `DataAdapter` and provides the `insert`, `update`, and `delete` commands as needed.



When using a Jet database, the `CommandBuilder` object can create the dynamic SQL code only if the table in question has a primary key defined.

Creating and Populating DataTables

You're going to create a module-level DataTable in your project. First, create the DataTable variable by adding the following statement on the line below the statement you entered previously to declare a new module-level m_daDataAdapter object:

```
DataTable m_dtContacts = new DataTable();
```

You are going to use an integer variable to keep track of the user's current position within the DataTable. To do this, add the following statement immediately below the statement you just entered to declare the new DataTable object:

```
int m_rowPosition = 0;
```

Next, add the following statement to the end of the Load event of the form, immediately following the statement that creates the CommandBuilder:

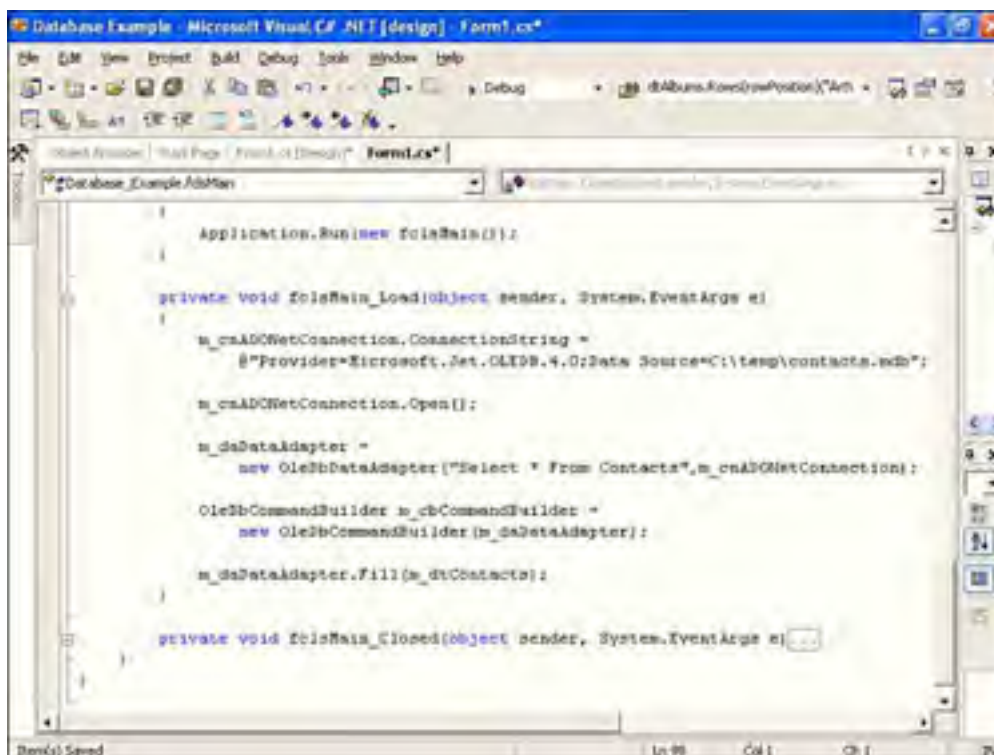
```
m_daDataAdapter.Fill(m_dtContacts);
```



Because the DataTable doesn't hold a connection to the data source, it's not necessary to close it when you're finished.

Your class should now look like the one in [Figure 21.1](#).

Figure 21.1. This code accesses a database and creates a DataTable that can be used anywhere in the class.



Referencing Fields in a DataRow

DataTables contain a collection of DataRows. To access a row within the DataTable, you specify the ordinal (index) of that DataRow. For example, you could access the first row of your DataTable like this:

```
DataRow m_rwContact = m_dtContacts.Rows[0];
```

Data elements in a DataRow are called *columns*. In the Contacts table I've created, for example there are two columns, ContactName and State. To reference the value of a column, you can pass the column name to the DataRow like this:

```
m_rwContact["ContactName"] = "Bob Brown";
```

or

```
Debug.WriteLine(m_rwContact["ContactName"]);
```



If you spell a column name incorrectly, an exception occurs when the statement executes at runtime; no errors are raised at compile time.

You're now going to create a procedure that's used to display the current record in the data table.

Position the cursor after the right bracket that ends the fclsMain_Closed() event and press Enter a few times to create some blank lines. Next, enter the following procedure in its entirety:

```
private void ShowCurrentRecord()
{
    if (m_dtContacts.Rows.Count==0)
    {
        txtContactName.Text = "";
        txtState.Text = "";
        return;
    }
    txtContactName.Text =
        m_dtContacts.Rows[m_rowPosition]["ContactName"].ToString();
    txtState.Text = m_dtContacts.Rows[m_rowPosition]["State"].ToString();
}
```

Ensure that the first record is shown when the form loads by adding the following statement to the end of the Load event, after the statement that fills the DataTable:

```
this.ShowCurrentRecord();
```

You've now ensured that the first record in the DataTable is shown when the form first loads.

To display the data, you need to add a few controls to the form. Create a new text box and set its properties as follows (you'll probably need to click the Properties button on the Properties window to view the text box's properties rather than its events):

Property	Value
Name	txtContactName
Location	48,112
Size	112,20
Text	(make blank)

Add a second text box to the form and set its properties according to the following table:

Property	Value
Name	txtState

Location 168,112
Size 80,20
Text (make blank)

Press F5 to run the project and you'll see the first contact in the database displayed in the text box (see [Figure 21.2](#)).

Figure 21.2. It takes quite a bit of prep work to display data.



Navigating and Modifying Records

The ADO.NET DataTable object supports a number of methods that can be used to access its DataRow's. The simplest of these is the ordinal accessor that you used in your ShowCurrentRecord() method. Because the DataTable has no dependency on the source of the data, this same functionality is available regardless of where the data comes from.

You're now going to create buttons that the user can click to navigate the DataTable.

The first button is used to move to the first record in the DataTable. Add a new button to the form and set its properties as follows:

Property	Value
Name	btnMoveFirst
Location	16,152
Size	32,23
Text	<<

Double-click the button and add the following code to its Click event:

```
// Move to the first row and show the data.  
m_rowPosition = 0;  
this.ShowCurrentRecord();
```

A second button is used to move to the previous record in the DataTable. Add another button to the form and set its properties as shown in the following table:

Property	Value
Name	btnMovePrevious
Location	56,152
Size	32,23
Text	<

Double-click the button and add the following code to its Click event:

```
// If not at the first row, go back one row and show the record.  
if (m_rowPosition != 0)  
{  
    m_rowPosition = m_rowPosition-1;  
    this.ShowCurrentRecord();  
}
```

A third button is used to move to the next record in the DataTable. Add a third button to the form and set its properties as shown in the following table:

Property	Value
Name	btnMoveNext
Location	96,152
Size	32,23
Text	>

Double-click the button and add the following code to its Click event:

```
// If not on the last row, advance one row and show the record.  
if (m_rowPosition < m_dtContacts.Rows.Count-1)  
{  
    m_rowPosition = m_rowPosition + 1;  
    this.ShowCurrentRecord();  
}
```

A fourth button is used to move to the last record in the DataTable. Add yet another button to the form and set its properties as shown in the following table:

Property	Value
Name	btnMoveLast
Location	136,152
Size	32,23
Text	>>

Double-click the button and add the following code to its Click event:

```
// If there are any rows in the data table,  
// move to the last and show the record.  
If (m_dtContacts.Rows.Count != 0)  
{  
    m_rowPosition = m_dtContacts.Rows.Count-1;  
    this.ShowCurrentRecord();  
}
```

Editing Records

To edit records in a DataTable, you change the value of a particular column in the desired DataRow. Remember though, that changes aren't made to the original data source until you call Update() on the DataAdapter, passing in the DataTable containing the changes.

You're now going to add a button that the user can click to update the current record. Add a new button to the form now and set its properties as follows:

Property	Value
Name	btnSave
Location	176,152

Size	40,23
Text	Save

Double-click the Save button and add the following code to its Click event:

```
// If there is existing data, update it.  
if (m_dtContacts.Rows.Count !=0)  
{  
    m_dtContacts.Rows[m_rowPosition]["ContactName"]= txtContactName.Text;  
    m_dtContacts.Rows[m_rowPosition]["State"] = txtState.Text;  
    m_daDataAdapter.Update(m_dtContacts);  
}
```

This code checks to make sure that there is an active row. If there is, the data entered on the form is written to the underlying recordset using the DataAdapter.

Creating New Records

Adding records to a DataTable is performed very much like editing records. However, to create a new row in the DataTable, you must first call the NewRow method. After creating the new row, you can set its column values. The row isn't actually added to the DataTable, however, until you call the Add method on the DataTable's RowCollection.

You're now going to modify your interface so that the user can add new records. You'll use one text box for the contact name and a second text box for the state. When the user clicks the button you'll provide, the values in these text boxes will be written to the Contacts table as a new record.

Start by adding a group box to the form and set its properties as shown in the following table:

Property	Value
Name	grpNewRecord
Location	16,192
Size	264,64
Text	New Contact

Next, add a new text box to the group box and set its properties as follows:

Property	Value
Name	txtNewContactName
Location	8,24
Size	112,20
Text	(make blank)

Add a second text box to the group box and set its properties as shown:

Property	Value
Name	txtNewState
Location	126,24
Size	80,20
Text	(make blank)

Finally, add a button to the group box and set its properties as follows:

Property	Value
Name	btnAddNew
Location	214,24

Size	40,23
Text	Add

Double-click the Add button and add the following code to its Click event:

```
DataRow drNewRow = m_dtContacts.NewRow();  
drNewRow["ContactName"] = txtNewContactName.Text;  
drNewRow["State"] = txtNewState.Text;  
m_dtContacts.Rows.Add(drNewRow);  
m_daDataAdapter.Update(m_dtContacts);  
m_rowPosition = m_dtContacts.Rows.Count-1;  
this.ShowCurrentRecord();
```

Notice that after the new record is added, the position is set to the last row and the ShowCurrentRecord() procedure is called. This causes the new record to appear in the text boxes you created earlier.

Deleting Records

To delete a record from a DataTable, you call the Delete() method on the DataRow to be deleted. Add a new button to your form (not to the group box) and set its properties as shown in the following table.

Property	Value
Name	btnDelete
Location	224,152
Size	56,23
Text	Delete

Double-click the Delete button and add the following code to its Click event:

```
// If there is data, delete the current row.  
if (m_dtContacts.Rows.Count !=0)  
{  
    m_dtContacts.Rows[m_rowPosition].Delete();  
    m_daDataAdapter.Update(m_dtContacts);  
    m_rowPosition=0;  
    this.ShowCurrentRecord();  
}
```

Your form should now look like that in [Figure 21.3](#).

Figure 21.3. A basic data-entry form.



Running the Database Example

Press F5 to run the project. If you entered all the code correctly, and you placed the Contacts database into the C:\Temp folder (or modified the path used in code), the form should display without errors, and the first record in the database will appear. Click the navigation buttons to move forward and backward. Feel free to change the information of a contact; click the Save button, and your changes will be made to the underlying database. Next, enter your name and state into the New Contact section of the form and click Add. Your name will be added to the database and displayed in the appropriate text boxes.

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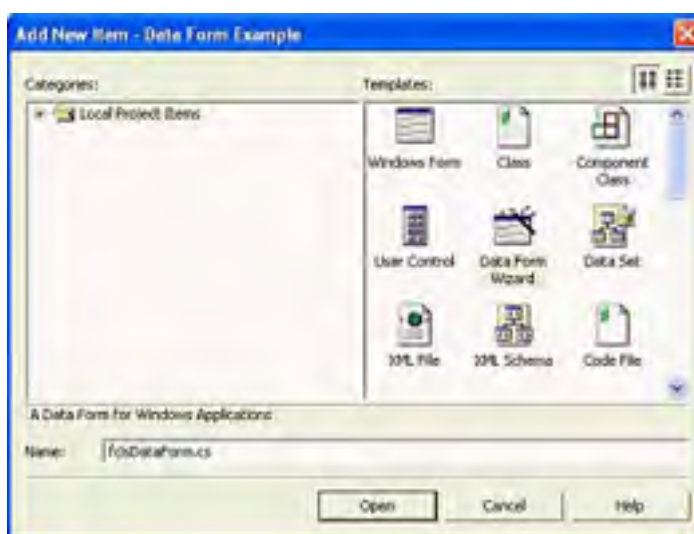
Using the Data Form Wizard

Visual C# .NET includes a tool to help introduce you to ADO.NET—the Data Form Wizard. In this section, you're going to use the Data Form Wizard to create a form that's bound to the same database you used in the previous example. This form will show the records in the database, and provide for updating the underlying data as well.

Start by creating a new Windows Application titled **Data Form Example**. The Data Form Wizard is run by adding it to your project as a form template. Follow these steps:

1. Choose Project, Add Windows Form to display the Add New Item dialog box.
2. Click the Data Form Wizard icon.
3. Change the name to **fclsDataForm.cs** (see [Figure 21.4](#)), and click Open to start the wizard.

Figure 21.4. The Data Form Wizard as a form template.



The first page of the wizard is simply an introduction. Click Next to get to the first real page. This next page is used to choose the dataset you want to bind to the form. ADO.NET datasets hold a collection of DataTables (in case you're familiar with ADO).

4. Enter **AllContacts** into the text box (see [Figure 21.5](#)) and click Next to continue.

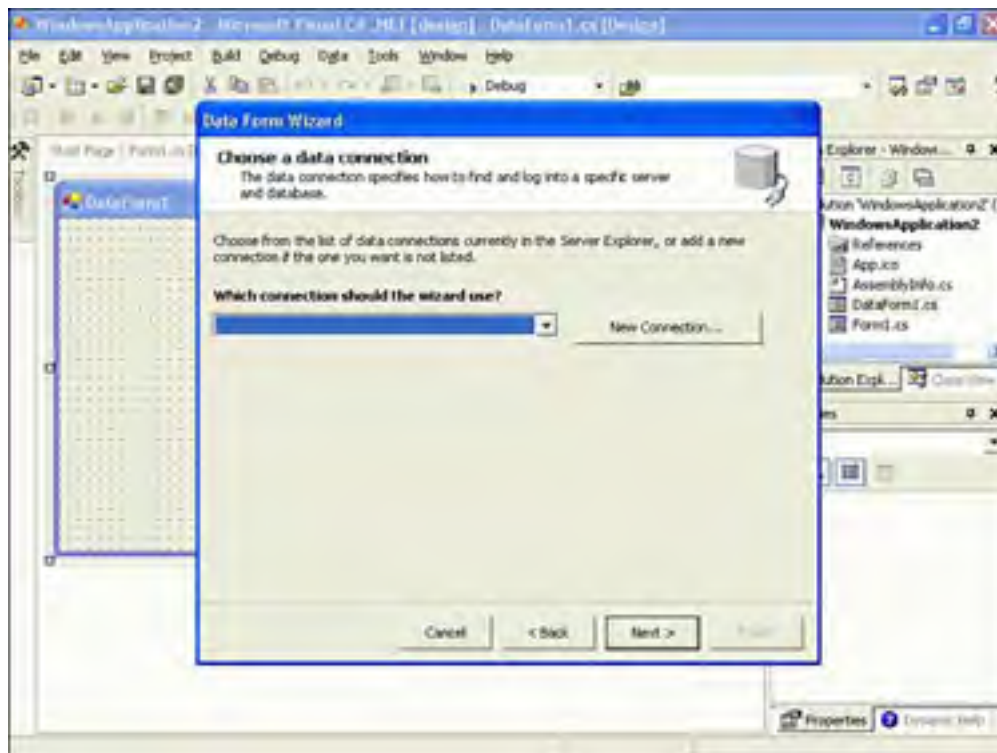
Figure 21.5. A DataTable is similar to an ADO recordset.





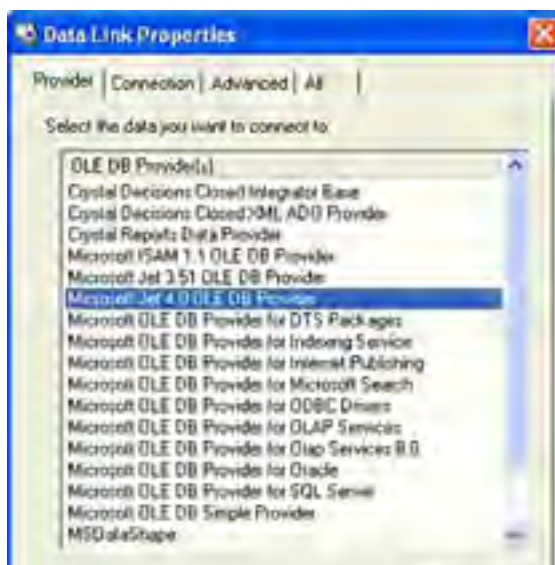
The next page of the wizard is used to specify a connection to a data source (see [Figure 21.6](#)). Because you haven't previously defined a connection to the Contacts database, your drop-down list will be empty.

Figure 21.6. Use this page to specify a data source.



5. Click the New Connection button to display the Data Link Properties dialog box. Notice that this dialog box opens with the Connection page visible.
6. Click the Provider tab to see the list of installed providers on your computer (see [Figure 21.7](#)), choose Microsoft Jet 4.0 OLE DB Provider to select it, and then click the Connection tab to return once more to the connection information.

Figure 21.7. You must specify the appropriate provider for the type of data source to which you're connecting.





7. Now that you've selected the provider, you need to locate and select the data source (your Jet database). Click the Build button next to the database name text box, and then locate and select the contacts.mdb database.
8. Next, click Test Connection to make sure the information you've supplied creates a valid connection to the database. If the test succeeded, click OK to close the Data Link Properties dialog box.

The database should now appear in the Connection drop-down list. Click Next to continue.

The next step in completing the wizard is to choose the table or tables you want to use (see [Figure 21.8](#)). The tables you choose here will be used to supply the data that is bound to your form.

Figure 21.8. Use this page to choose the data to bind to the form.



9. Double-click the Contacts table to add it to the Selected items list and click Next to continue.

This page shown in [Figure 21.9](#) is used to specify the columns that you want bound on the form. The two columns in your Contacts table are already selected by default, so click Next to continue.

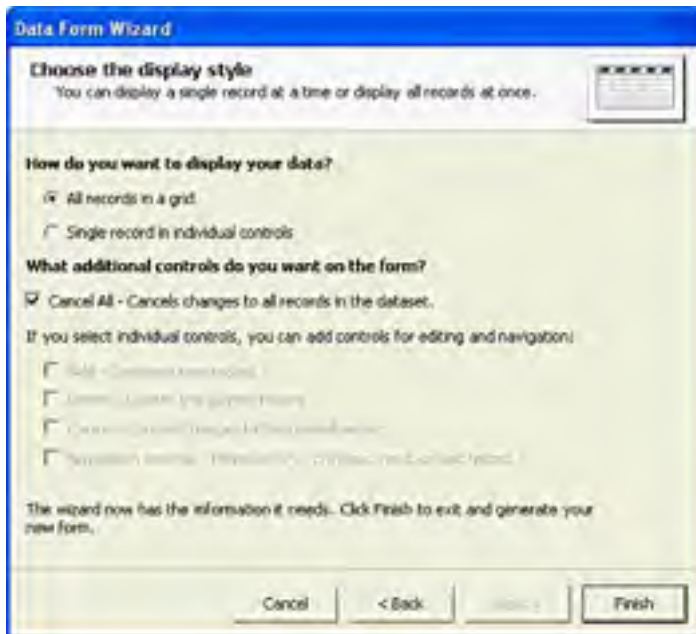
Figure 21.9. You can choose which columns you want from the table.





10. The last step of the wizard is specifying the style in which you want the data to appear (see [Figure 21.10](#)). Because the previous example had you work with individual controls for each column, leave the All records in a grid radio button selected (this will create a data grid).

Figure 21.10. The Data Form Wizard gives you a number of choices for displaying your data.



11. Click Finish to create your new data form, which will appear in the form designer (see [Figure 21.11](#)). Visual C# .NET might ask you if you want the password included in the connection string. If so, choose to include it (you haven't supplied a password anyway, so this isn't important at this time).

Figure 21.11. This bound grid was created by the Data Form Wizard.



To test your form, you'll have to display it, so follow these steps:

1. Click Form1.cs to display the designer for the default form in your project and add a new button to the form. Set the button's properties as follows:

Property	Value
Name	btnShowDataForm
Location	96,120
Size	104,23
Text	Show Data Form

2. Double-click the button to access its Click event and add the following code:

```
fclsDataForm objDataForm = new fclsDataForm ();  
objDataForm.Show();
```

3. Press F5 to run the project, and then click the button and your bound form will appear. To load the grid with records, click the Load button (see [Figure 21.12](#)).

Figure 21.12. This grid is bound to the record source.



Stop the running project, click `fclsDataForm.cs` in the Solution Explorer, and then click the View Code button on the Solution Explorer to view the class. Notice that the Data Form Wizard created all the ADO.NET code for you, and even included rudimentary error handling.

The Data Form Wizard is a great way to get started with ADO.NET, but it'll take you only so far. To create robust ADO.NET applications, you'll need to find one or more dedicated resources that focus on the intricacies of ADO.NET.

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Summary

Most commercial applications use some sort of database. Becoming a good database programmer requires extending your skills beyond being just a good programmer. There's so much to know about optimizing database and database code, creating usable database interfaces, creating a database schema—the list goes on and on. Writing any database application, however, begins with the basic skills you learned in this hour. You learned how to connect to a database, create and populate a DataTable, and navigate the records in the DataTable. In addition, you learned how to edit records and how to add and delete records. Finally, you learned how to use the Data Form Wizard to create a basic ADO.NET bound form. You're now prepared to write simple, yet functional, database applications.

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Q&A

Q1: *If I want to connect to a data source other than Jet, how do I know what connection string to use?*

A1: Not only is different connection information available for different types of data sources, but also for different versions of different data sources. The best way of determining the connection string is to consult the documentation for the data source to which you want to attach.

Q2: *What if I don't know where the database will be at runtime?*

A2: For file-based data sources such as Jet, you can add an Open File Dialog control to the form and let the user browse and select the database. Then, concatenate the filename with the rest of the connection information (such as the provider string).

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Quiz Answers."

Quiz

- 1:** What is the name of the data access components used in the .NET Framework?
- 2:** What is the name given to a collection of DataRow's?
- 3:** How do I get data into and out of a DataTable?
- 4:** What object is used to connect to a data source?
- 5:** What argument of a connection string contains information about the type of data being connected to?
- 6:** What object provides update, delete, and insert capabilities to a DataAdapter?
- 7:** What two .NET data providers are supplied as part of the .NET Framework?
- 8:** What method of a DataTable object do you call to create a new row?

Exercises

- 1:** Create a new project that connects to the same database used in this example. Rather than displaying a single record in two text boxes, put a list box on the form and fill the list box with the names of the people in the database.
- 2:** Further extend the project you built in exercise 1 by adding a Name text box below the list. When the user clicks a name in the list, show the name in the text box. If the user clicks another name, update the database with any changes made in the text box to the newly selected name.

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Part V: Deploying Solutions and Beyond

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HOOR 23 [Introduction to Web Development](#)

HOOR 24 [Build a Real-World Application](#)

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Hour 22. Deploying a Visual C# .NET Solution

Now you've learned how to create a Visual C# .NET application, and you're probably just itching to create some project and send it to the world. Fortunately, Visual Studio .NET includes the tools you need to create a setup program for an application. In this hour, you'll learn how to use these tools to create a setup program that a user can run to install an application you've developed. In fact, you'll be creating a setup program for the Picture Viewer application you created in [Hour 1](#), "Jumping in with Both Feet: A Visual C# .NET Programming Tour."

The highlights of this hour include the following:

- Creating a custom setup program
- Installing the output of a project
- Changing the installation location of a file
- Specifying build options
- Adding files to an installation
- Creating a custom folder on installation
- Creating a shortcut on the Start menu

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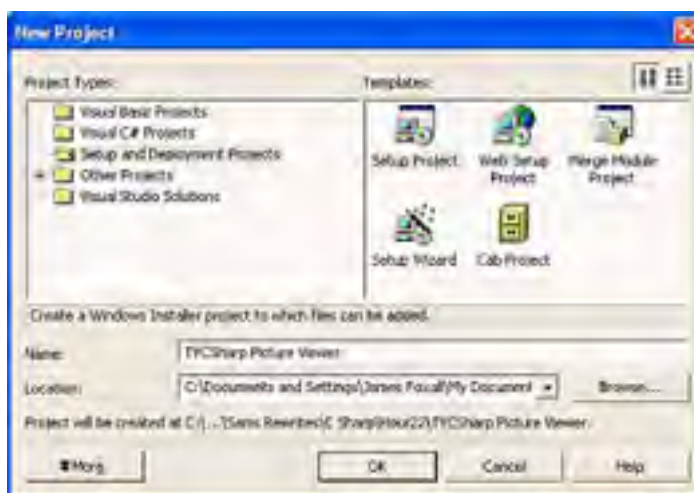
Creating a Custom Setup Program

A custom setup program (the program the user runs to install a program) is the result of building a special type of project in Visual C# .NET. Throughout most of this book, you've created projects of the type Windows Application. To create a custom setup program, you start with a special type of .NET project.

Follow these steps:

1. Start Visual Studio .NET and choose to create a new project now.
2. In the New Project dialog box, click the Setup and Deployment Projects item to display its contents, and then click Setup Project (see [Figure 22.1](#)). This is the project type to use when you distribute Windows Applications; use the Web Setup Project item when distributing Web projects.

Figure 22.1. Create a Setup Project to distribute Windows Applications.



3. Enter the name **TYCSharp Picture Viewer**.
4. Click OK to create the project.

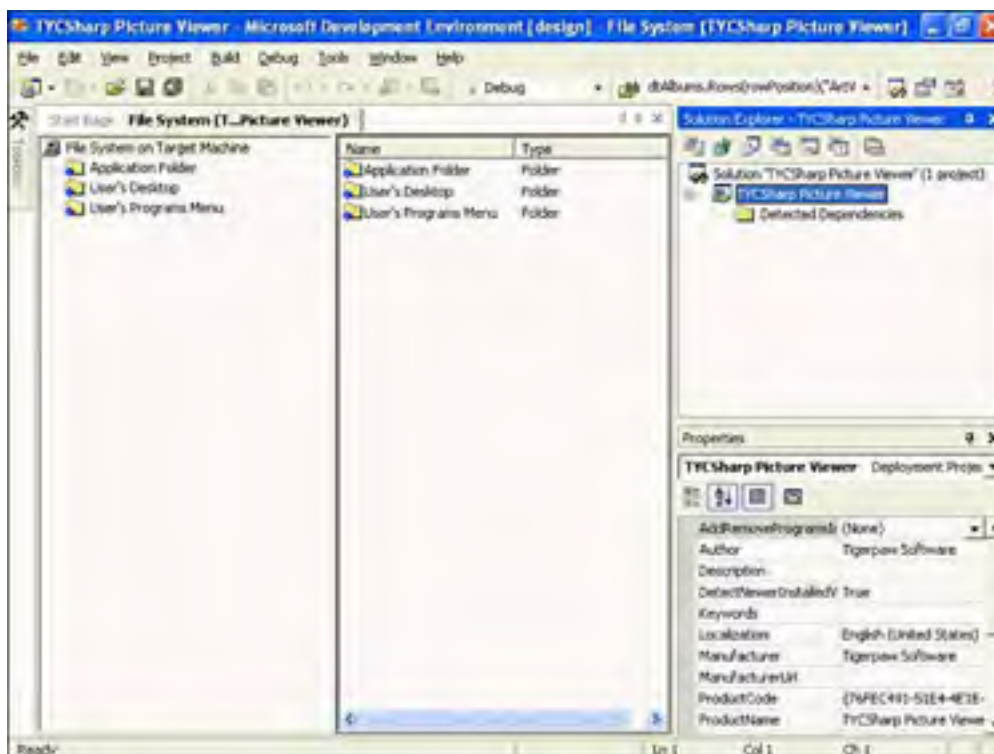
By the Way

The name you give your Setup Project is the name that appears in the setup wizard when the user installs your program. Unfortunately, the name you use for this project can't be the same as the one you used for the project whose output you are distributing (for reasons you'll learn shortly). This is why I had you use **TYCSharp** (for Teach Yourself Visual C# .NET) as the project name.

The interface for a Setup Project consists primarily of two panes. The pane on the left side represents the file system of the target machine (the computer on which the software is being installed).

The pane on the right shows the contents of the selected item in the left pane (see [Figure 22.2](#)). You really can do a lot when creating custom setup programs, but as you'll see, accessing the features to modify your setup program isn't all that intuitive.

Figure 22.2. The interface for creating a setup program isn't intuitive.

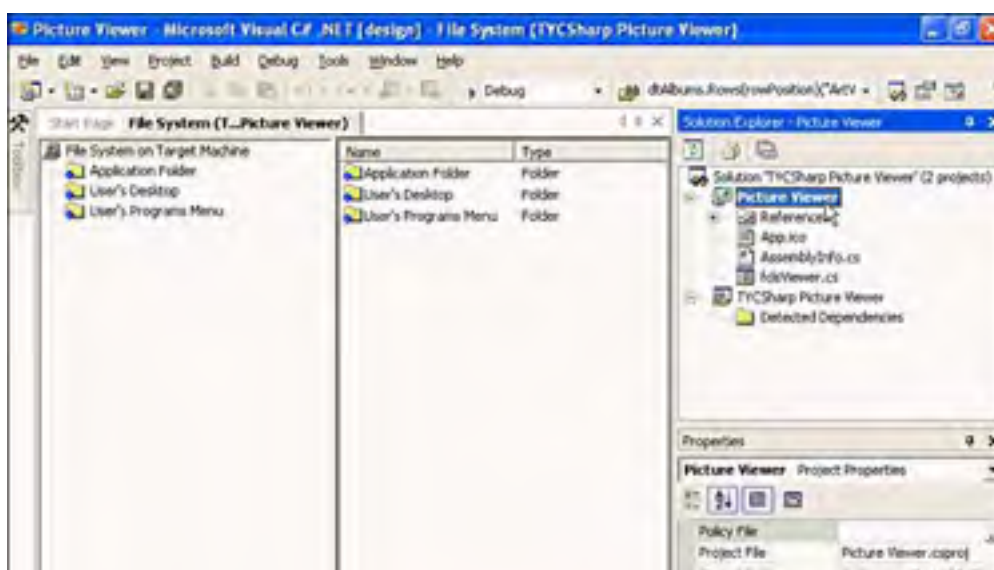


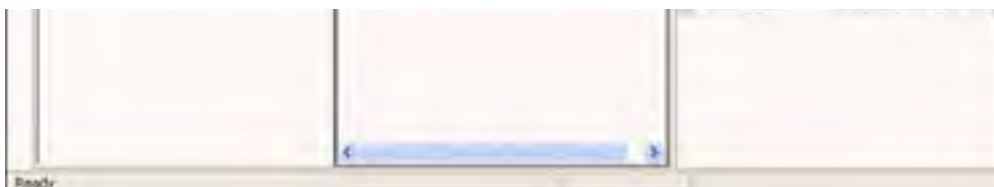
Adding the Output of a Project

For the purposes of creating a setup program, the final file (EXE, DLL, and so on) produced in building a Visual C# .NET project is called the *output* of the project. The setup program is used to install the output of a project on the user's computer. At this point, the setup program doesn't install anything; you must add the output of another project. The first step to including a project's output is to add the project to the setup program project. Because you're creating a setup program for the Picture Viewer you created in [Hour 1](#), you need to add the Picture Viewer project to the current solution.

Add the project to the solution now by right-clicking the solution name in the Solution Explorer window and then choosing Add, Existing Project. Use the Add Existing Project dialog box to locate your Picture Viewer project (look for the file named `Picture Viewer.csproj`) and add it to the current solution. The Picture Viewer project should now appear in the Solution Explorer (see [Figure 22.3](#)).

Figure 22.3. To distribute the output of a project, the project must be part of the solution.



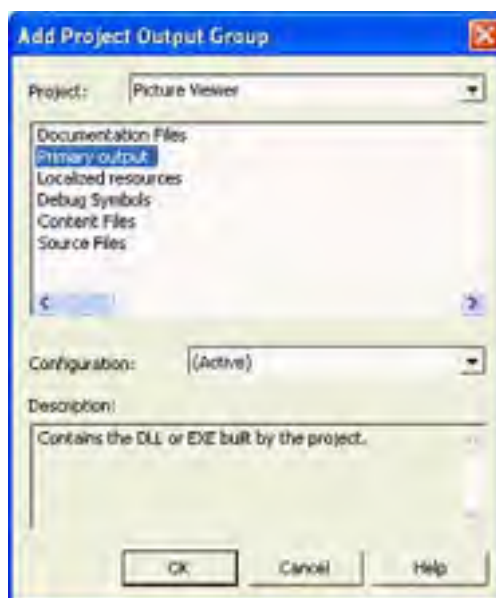


Now that the Picture Viewer project is part of the solution, you have to tell the setup program to install the output of the Picture Viewer project. This is where things get a bit odd because the Project menu changes according to what project you have selected in the Project Explorer. What you're going to do next is have the Setup Project install the final executable of your Picture Viewer project.

Follow these steps:

1. Click the TYCSharp Picture Viewer project (not the solution) in the Solution Explorer before continuing. If you don't do this, you won't find the appropriate menu items when you open the Project menu.
2. Open the Project menu and then open the Add submenu.
3. Choose Project Output to display the Add Project Output Group dialog box shown in [Figure 22.4](#). Make sure that the project selected is Picture Viewer and that Primary output is selected as well.

Figure 22.4. Choosing Primary output ensures that the distributable file of the project is installed on the user's machine.



4. Click OK to commit your selections.
5. Next, click the Application Folder in the left pane to view its contents. Notice that it now contains the primary output from the Picture Viewer project. This means that the .EXE file built by the Picture Viewer project will be installed in whatever folder the user designates as the application folder.

Changing the Installation Location of a File

You have complete control over where a file is installed on the user's computer. Most program files (such as the output of the Picture Viewer project) are installed in an application folder. The Application Folder has the following default path:

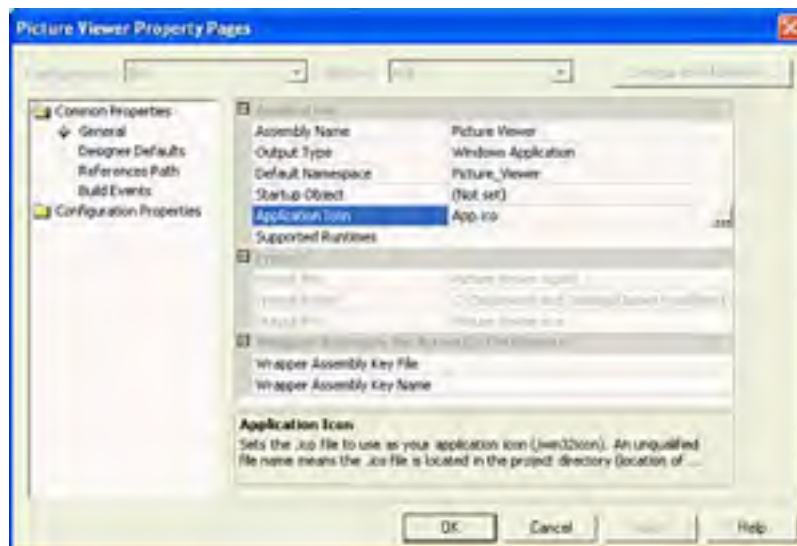
`[ProgramFilesFolder][Manufacturer][ProductName]`

Users can change this when they run your setup program. Right-click the Application Folder icon in the left pane and choose Properties Window from its context menu. In the Properties window, notice that the DefaultLocation property contains the information that defines the default installation location. The items in brackets are tokens that get replaced when the user runs the setup program. The *Manufacturer* token pulls its value from the company name you entered when you installed Visual C# .NET. To change your default installation folder, you'd change this property (don't do this right now).

Specifying the Build Options of a Project's Output

At this point, the setup program installs the final output of the Picture Viewer program, which is an .EXE file. However, you have more control over the output of a project than just the file type. For example, you can specify the icon assigned to the .EXE file. Right-click the Picture Viewer project in the Solution Explorer and choose Properties from its context menu to display the Picture Viewer Property Pages dialog box. Next, click General in the list on the left to display the General options for the project (see [Figure 22.5](#)).

Figure 22.5. Use this dialog box to tailor the output of a project.



The icon specified appears wherever a shortcut is created for your program. Remember, the default icon assigned to executables isn't all that attractive (and even less meaningful), so you should assign a custom icon to all of your projects. Because you did this in [Hour 1](#), there's no need to change the icon now. Click OK to close the Property Pages dialog box.

Adding a File to the Install

You aren't limited to installing the output of a project; you can install any file that you choose. For example, you might want to include sample data or support files with your program. You're now going to install a bitmap with your application so that the user has something to view.

Again, select the TYCSharp Picture Viewer project in the Solution Explorer, or you won't have the appropriate items on the Project menu. Next, add a file by opening the Project menu and then choosing Add, File. Locate a BMP or JPG on your system, click it to select it, and then click Open to add the file to the install project.

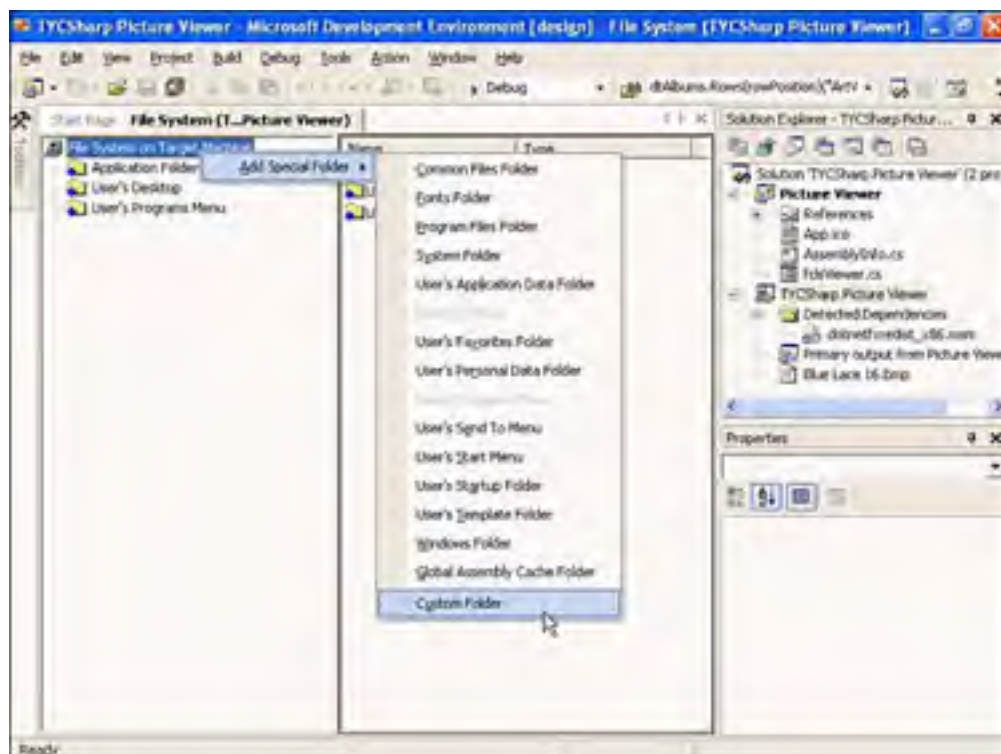
Adding a Custom Folder to the Install

The pane on the left lists folders that correspond to folders on the user's computer. You can add other folders to this list. These folders may already exist on the user's computer (such as the user's Favorites folder) or may be a brand-new folder that your install now by right-clicking the File System on Target Machine item in the left pane (the first item) and choosing Add Special Folder from its context menu. As you can see, you can select from a number of folders that already exist on the user's computer.

Now, however, you're going to create a custom folder, so follow these steps:

1. Choose Custom Folder (see [Figure 22.6](#)). The new folder is added to the left pane.

Figure 22.6. It's easy to select existing folders and create new ones.



2. Change the name of the new folder to Pictures.
3. Click Application Folder again. Notice that the BMP file you selected for installation appears in the Application Folder.
4. Drag the bitmap to the Pictures folder you just created. Now, when the picture is installed, it will be installed in the Pictures folder.

Creating a Shortcut on the Start Menu

The setup program doesn't automatically create shortcuts for your application—you have to create them yourself. Most applications create a shortcut in the Programs folder on the Start menu (or in a subfolder of the Programs folder). You're going to create a shortcut for the Picture Viewer program that will be placed in the Programs folder on the Start menu.

Follow these steps:

1. Click the Application Folder to view its contents.
2. Right-click the Primary Output from Picture Viewer item and choose Create Shortcut to Primary Output from Picture Viewer. Visual C# .NET creates the shortcut item and places it in the Application Folder.
3. Drag the shortcut to the User's Programs Menu item in the left pane.

Now, when the user installs your program, a shortcut will be placed in the Programs folder on the user's Start menu.

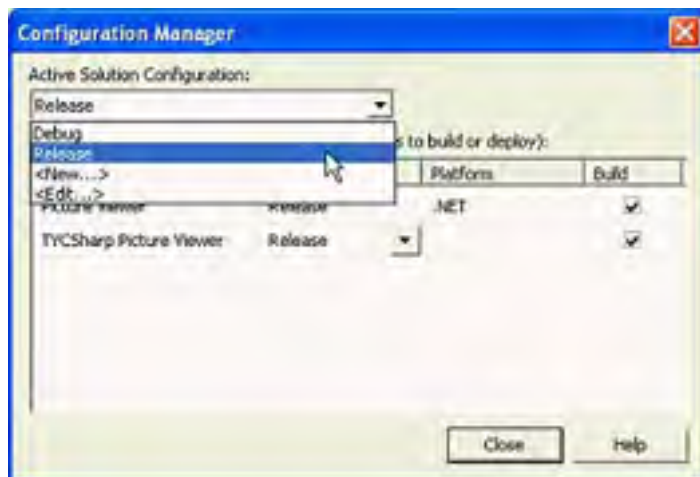


Apparently, an issue with .NET prohibits the user from moving the shortcuts for .NET applications after they're installed. Hopefully, Microsoft will eventually correct this. As it stands, however, if the user moves the shortcuts, Windows will move them back. For this reason alone, you should pick a good name for your folder.

Defining the Build Configuration for the Setup Program

When you create a setup program, you can choose to include debug information. This information enables you to perform advanced debugging using techniques beyond the scope of this book. When distributing to other machines, you may want to leave out this debugging information and instead create a Release build. Release builds are smaller and faster than Debug builds. Change your installation to a Release build by choosing Build, Configuration Manager, and selecting Release from the drop-down list (see [Figure 22.7](#)). Click Close to save your changes.

Figure 22.7. Release builds are smaller and faster than Debug builds.



The Common Language Runtime

The common language runtime (discussed in detail in [Appendix A](#), "The 10,000-Foot View") allows any Visual Studio .NET language (Visual C# .NET, Visual Basic .NET, and so on) to run on a computer. For a user to run your Visual C# .NET application, the common language runtime must exist on the user's computer. You cannot include the common language runtime in your install. Instead, either it must exist on the user's machine, or you must distribute the Microsoft common language runtime installation file, *Dotnetfx.exe*. There are license restrictions to distributing the common language runtime, so for this example we'll operate under the assumption that the .NET Framework (the common language runtime) exists on the target machine. For more information about distributing *Dotnetfx.exe*, including licensing restrictions, please refer to Visual C# .NET's documentation.

Building the Setup Program

That's it, you're done! The only thing left is to actually build the program. Choose Build, Build Solution to create the distributable file. As Visual Studio .NET is building the file (three files actually), a small animation appears in the status bar. This occurs because it can take some time to build a file, especially for large solutions compiling on slower machines with minimum RAM. When Visual Studio .NET is done building the setup program, the status bar will read Build Succeeded. The setup program can be found in the Release subfolder of the TYCSharp Picture Viewer project folder. The file has the extension of MSI, which indicates that the file is a Windows Installer Package.

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Running a Custom Setup Program

You should always test your setup programs before distribution. (I recommend that you test your setup wizard on a separate machine when possible.) You're now going to run the custom setup program that you've built, but you'll just do it on your current machine.

Shut down Visual C# .NET now, saving your work if prompted to do so. Double-click the installation program in the Release folder to start your custom setup program (the file with the .MSI extension is the Windows Installer file that runs your custom setup program). The setup program is a wizard (see [Figure 22.8](#)), so installation is pretty simple for an end user. Click Next to pass the Welcome page.

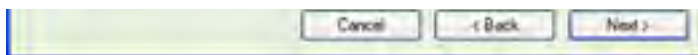
Figure 22.8. Your final setup program is in the form of a wizard.



The second page of your setup program is where the user can specify the installation folder. Notice that the default path is what you specified when you created the setup program (see [Figure 22.9](#)). The wizard even enables the user to install the application for shared use; you don't have to worry about the details. Clicking Disk Cost shows all installed drives, their disk space, and the disk space required by the setup program. Click Next to accept the default path and continue.

Figure 22.9. The user can change your default installation path.





The last important page of your setup wizard is used to get confirmation before installing the files (see [Figure 22.10](#)). You can add a lot more functionality to your setup program, and doing so might create additional pages in the final setup wizard. However, this example is pretty straightforward, so there's not much to the wizard. Click Next to install the Picture Viewer program. After the program is installed, the user will get one last wizard page telling them the installation is complete (see [Figure 22.11](#)).

Figure 22.10. Clicking Next from here causes your program to be installed.

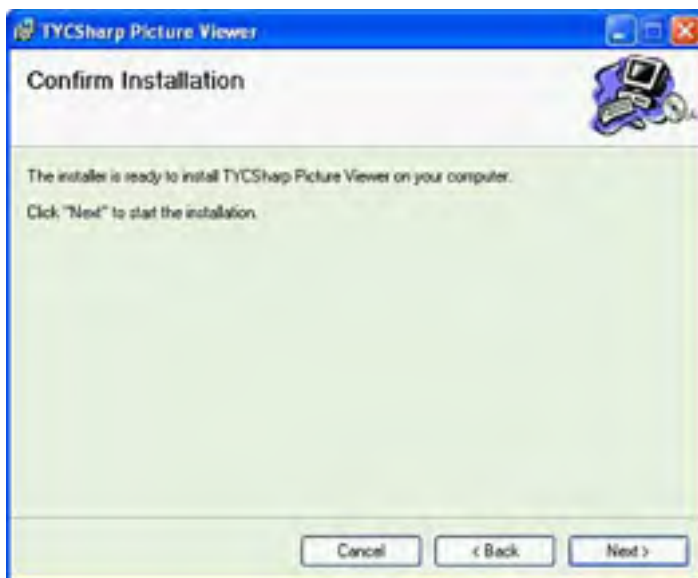


Figure 22.11. A successful installation!

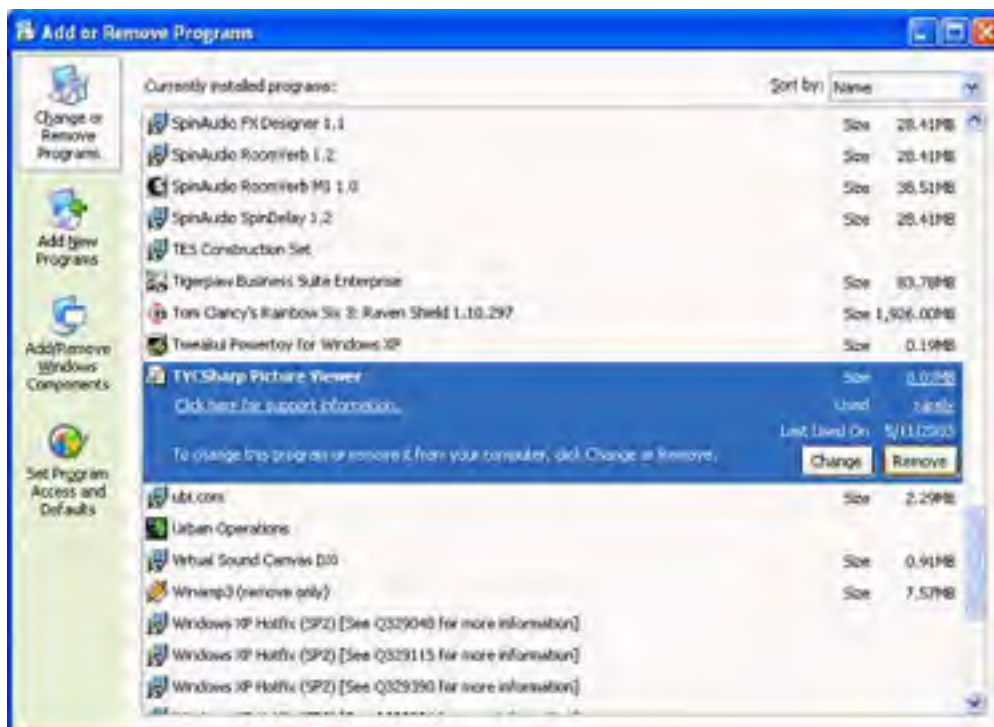


Open the Start menu and look at the contents of your Programs folder; you should see the shortcut to your Picture Viewer program. Click the shortcut to start your program. That's it! You've just created an installation program that installs the Picture Viewer program, and you can now distribute your program to other computers if they have the .NET Framework installed. Refer to Visual C# .NET's documentation if you need to distribute *Dotnetfx.exe* to machines that don't have the .NET Framework installed.

Uninstalling an Application

All Windows applications should provide a facility for easy removal from the user's computer. Most applications provide this functionality in the Add/Remove Programs dialog box, and yours is no exception. Open the Start menu and choose Control Panel. Next, locate the Add or Remove Programs icon and click it. Scroll down in your Add/Remove programs dialog box until you find the Picture Viewer program (see [Figure 22.12](#)). To uninstall the program, click it to select it and then click Remove.

Figure 22.12. Your program can be uninstalled using the Add/Remove Programs dialog box.



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Summary

In this hour, you learned how to create a custom setup program to distribute an application you've built using Visual C# .NET. You learned how to work with folders on the user's computer, how to create shortcuts, how to install files, and how to install the output of a Visual C# .NET project. Custom setup programs can become quite complex, but even the most advanced ones build on the foundation of skills you learned in this hour. Creating a useful program is a very rewarding experience. Nevertheless, your level of satisfaction will increase dramatically the first time a user runs your creation on his computer.

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Q&A

Q1: *Should I assume that the user will always have the .NET Framework on his or her computer?*

A1: Generally, no. When distributing updates to your project, it's probably a safe bet that the user has installed the .NET Framework. However, you should either distribute [Dotnetfx.exe](#) or include instructions for the user on where they can obtain the file from Microsoft.

Q2: *Can I install multiple applications in a single setup program?*

A2: Yes. Just add each project as you did the Picture Viewer project, and be sure to include the output of each.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Quiz Answers."

Quiz

- 1:** To create a custom setup program, you start by creating what type of Visual Studio project?
- 2:** The final build file of a project (EXE, DLL, and so on) is referred to as the what?
- 3:** True or False: To include the output of a project, the project must be added to the solution containing the setup program.
- 4:** Which build option creates smaller and faster builds?
- 5:** How do you add a file to an installation?
- 6:** If the Project menu doesn't have the menu options for creating a setup program, what might be wrong?
- 7:** How do you add folders to the custom setup program?
- 8:** How do you create a shortcut for a file in a setup program?

Exercises

- 1:** Modify the setup program you created in this hour so that the shortcut created appears on the Start menu with the name *Picture Viewer*, rather than its current default name. Also, give the shortcut the same icon you assigned to the *Picture Viewer* program.
- 2:** Modify the setup program that you created in this hour so that it creates a custom folder within the *Programs* folder on the Start menu. Install the shortcut to this folder.

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Hour 23. Introduction to Web Development

Visual Studio .NET, more than any previous Microsoft technology, offers incredible Web development tools and functionality. In fact, .NET is very much about programming for the Web. Creating Web applications requires a thorough understanding of all the skills you've acquired in this book—and more. In addition to the complexities of programming that you've dealt with so far, such as creating forms, writing code, and so on, additional concerns exist—such as Web protocols, firewalls, Web servers, and scalability. Teaching you how to create Web applications is beyond the scope of this book. However, it's important for you to be at least a little familiar with the concepts and technologies involved with Microsoft's .NET Internet programming strategy. This hour gives you an overview of the .NET Web programming technologies.

The highlights of this hour include the following:

- ASP.NET
- Web Forms
- XML Web services
- XML
- SOAP (Simple Object Access Protocol)

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Understanding ASP.NET

ASP.NET is the next evolution of ASP (Active Server Pages). ASP.NET is a framework for creating applications that reside on a Web server and that are run from within a client browser. ASP.NET enables you to program Web-based client-server applications using tools and methodologies much like those used to create traditional applications.

ASP.NET solutions execute on a Web server running Microsoft Internet Information Server (IIS). Therefore, to create ASP.NET solutions, you'll need to have some knowledge of IIS.

In a nutshell, ASP.NET is the Web technology of .NET used to create Web Services and to dynamically generate Web pages by serving up Web Forms (both are discussed shortly). For example, you can create an e-commerce site where a user can choose to view all products by category. Using ASP.NET, you could dynamically build and display a Web page containing an appropriate list of products. The server would execute the code to build the new Web page and then send the page to the user's browser as an HTML document.

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Creating Dynamic Web Content with Web Forms

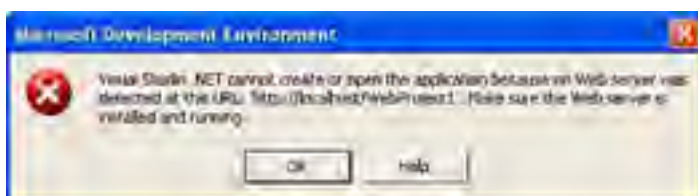
Web Forms are similar to Windows Forms applications (which you've been creating and programming throughout this book). However, Web Forms are designed specifically to run in a browser over the Web. Although Web Forms are designed to run within *any* browser by default, you can target deployment to a specific browser to take advantage of a particular browser's features.

To create a Web Forms application, you choose ASP.NET Web Application on the New Project dialog box (see [Figure 23.1](#)). Be aware that to create and test a Web Forms application, you must have a Web server installed. If you don't have a Web server installed and configured, you'll receive a message similar to that shown in [Figure 23.2](#), and you'll be prevented from creating the project.

Figure 23.1. A Web Forms project is different from a Windows Forms project.



Figure 23.2. To create a Web Forms application, you must install and configure a Web server.



Comparing Windows Forms to Web Forms

Creating a Web Forms application can offer many advantages. For example, to deploy a Web Forms application, you have to deploy only to a Web server (not to all client machines). After the program is set up on the server, users can run it simply by pointing their browsers to the proper URL. Contrast this with the need to deploy a Windows Application to hundreds or thousands of users' computers. Another benefit of Web Forms is that applications are essentially platform independent because the code runs on the server and the browser is the only thing running on the client side. When deciding whether to base your application on Windows Forms or on Web Forms, consider the issues discussed in the following sections.

Deployment

As mentioned previously, Windows applications built on Windows Forms are installed and executed on the user's machine. Web Forms, however, run within a browser and therefore don't require deployment to a client machine. Rather than having to install updates on every client as you do with a Windows Forms application, with a Web Forms application you need to update only the server (which must be running the .NET Framework).

Graphics

Windows Forms include the capability to interact with the Windows graphics device interface (refer to [Hour 18](#), "Working with Graphics," for information about the GDI) to create intricate graphics with excellent performance. Web Forms can access the GDI on a Web server. However, round-trips are required for screen updates, which can negatively affect the performance of drawing graphics.

Responsiveness

When an application requires a high degree of interactivity with the user (such as screen updates, lots of event code, and data validation), Windows Forms provide the best performance because they run on the client machine. Most interactive processes with Web Forms require round-trips to the server, which again can negatively affect the responsiveness of an application.

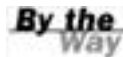
Text Formatting and Control Positioning

Windows Forms provide an exceptional capability to place controls. Displaying text on a Windows Form, however, requires using controls such as a label or a text box. Making text flow on a Windows Form (such as flowing around other controls when adjusting to the sizing of a form) can be very difficult to accomplish. In addition, formatting text can be problematic because most controls support only one font at a time.

Web Forms, on the other hand, are served to clients as HTTP Web pages, which excel at formatting and flowing text. Web Forms aren't as precise as Windows Forms when it comes to placing controls, however.

.NET Platform Installation

To run a Windows Forms application, users must have the .NET Framework installed on their computer. Web Forms, however, are installed on the server; therefore, the .NET Framework must be installed on the server, but isn't needed on the client. The client needs only a Web browser.



Future service packs of Windows will probably include the latest .NET Framework—but don't depend on this.

Security and System Resources

Windows Forms applications can have complete control over system resources such as the Registry and also can be restricted by using the operating system's security features. Web Forms have very limited access to system resources because they are restricted by the user's browser security settings.

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Understanding XML Web Services

The technology that Microsoft is perhaps most excited about in .NET is XML Web services. Microsoft describes an XML Web service as "a unit of application logic providing data and services to other applications." It's easiest to think of XML Web services as applications that reside on a server without a user interface, providing objects to clients. The following are a few practical examples of what can be done with XML Web services:

- A company could create stock quote XML Web services that clients could use to get real-time stock quotes.
- A doctor's office could expose scheduling functions so that clients could use their mobile devices to schedule appointments.
- A government office could expose tax-related objects, which businesses could use to get accurate tax rates.
- A company could expose data that is paid for by subscription. When clients access the data via the Web service's objects, a billing system could track the number of accesses.
- An auction company, such as eBay, could expose its bidding system as authenticated XML Web services, and third-party vendors could create their own front ends to placing bids on the auction site.

Obviously, this list just scratches the surface. Microsoft ambitiously envisions everyone exposing application logic as XML Web services. Although this may not become a reality in the near future (indeed, XML Web services might never take off the way Microsoft hopes), many companies are generating a lot of excitement about this technology.

Understanding the Technology Behind Web Services

Many of the details of programming XML Web services are handled for you by .NET. For example, SOAP and XML are used to marshal objects and method calls across the Web so that you don't have to worry about the details of the plumbing. Because a standard protocol is used to marshal this information, you don't have to worry about the language or the platform used to implement the XML Web services—almost any type of client can consume an XML Web service (Visual C# .NET, Visual Basic .NET, Java, and so on). Clients don't have to be Windows-based or even be PCs; Web-enabled phones and other wireless devices can consume XML Web services. Although you don't have to understand the technical details, it's good to have a general understanding of the technology involved.

XML (Extensible Markup Language)

XML (Extensible Markup Language) is a universal format for transferring data across the Internet. On the surface, XML files are simply text files. This is oversimplifying things, however. The beauty in XML is that XML files themselves contain not only data, but also self-describing information about the data (called **metadata**). The fact that XML files are text makes it relatively easy to move them across boundaries (such as firewalls) and platforms.

Semantic tags are used to describe data in an XML file, and starting and ending tags are used to define an **element**. The data between a starting and ending tag is the value of the element. The tags are similar to HTML tags and have the following format:

```
<tagname> data </tagname>
```

For example, you could store a color in an element titled BackColor, like this:

```
<BackColor>Blue</BackColor>
```

XML tags are case sensitive; therefore, BackColor is not the same as backcolor, and both elements could exist in the same XML file.

Elements can be nested as long as the starting and ending tags of elements don't overlap. For example, two customers could be stored in an XML file like this:


```
<Customer>
  <Name>John Smith</Name>
  <OrderItemID>Elder Scrolls: Morrowind</OrderItemID>
  <Price>$20.00</Price>
</Customer>
<Customer>
  <Name>Jane Aroogala</Name>
  <OrderItemID>Ultima VII: The Black Gate</OrderItemID>
  <Price>$62.00</Price>
</Customer>
```

XML files can be much more complex, but this simple example should suffice to show you that XML documents are text documents that can store just about any type of data you can think of. In fact, Microsoft is using XML in just about everything, from ADO.NET to XML Web services.

SOAP (Simple Object Access Protocol)

To pass structured data across the Web (such as passing objects or calling methods on objects), the sender and receiver must agree on how the data will be transmitted. SOAP (Simple Object Access Protocol) is a new protocol used to exchange structured data in an XML format, and provides a mechanism for making remote procedure calls across the Internet. SOAP is lightweight (that is, it doesn't consume a lot of resources or bandwidth) and makes use of the widely accepted HTTP protocol. SOAP is fundamental to Microsoft's .NET strategy because it allows different applications on multiple platforms to share structured data and interoperate across the Web.

Consuming Web Services

Writing code to consume an XML Web service is actually similar to writing code to access an Automation server. First you create a Web reference, which is much like creating a reference to an Automation library such as Excel or Word. After you've got a reference to the XML Web service, the XML Web service's objects become available in code, and you can browse them as you would traditional objects.

To create an XML Web service, you must have a sound understanding of creating objects by programming classes, and you have to have an understanding of ASP.NET—the Web development technology of .NET. The .NET Framework handles the details of using SOAP to enable clients to interact with your XML Web service, so you can focus most of your attention on creating useful objects rather than on details of the underlying plumbing.

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Summary

Programming for the Web is an exciting proposition, and one that can't be entered into lightly. To create robust Web applications requires an understanding of many technologies, including Web servers, protocols, firewalls, security, object-oriented programming concepts, and much more. By completing this book, you're gaining a solid understanding of application development with Visual C# .NET, and you're building a set of skills that you can use to move into Web programming.

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Q&A

Q1: *Can I use XML files within my applications?*

A1: Yes, you can design your own XML files and use them any way you see fit. For example, you could save a configuration file in an XML file with a scheme you've designed. For more information, look at the documentation on [System.XML](#) in the online Help.

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Workshop

The Workshop is designed to help you anticipate possible questions, review what you've learned, and get you thinking about how to put your knowledge into practice. The answers to the quiz are in [Appendix B](#), "Answers to Quizzes."

Quiz

- 1:** What does XML stand for?
- 2:** An element is designated in an XML document using what?
- 3:** True or False: XML tag names are case sensitive.
- 4:** What is the name of the protocol used by .NET to marshal object requests across the Web?
- 5:** What forms engine is used to create forms that run over the Internet?
- 6:** Which forms engine provides for faster response to user interaction?
- 7:** Where is the .NET Framework installed for Windows Forms applications? For Web Forms applications?
- 8:** What is the name of the ASP.NET technology used to expose application logic as objects over the Web?

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Hour 24. Building a Real-World Application

As you've worked through this book, you've progressively added to your development skill set. You've covered a lot of material so far, and you might be wondering what's next—how do you put it all together? In this hour, you'll do just that; put everything together. This hour is unique in that I'm really not going to teach you anything new (well, maybe a few things). Instead, you're going to follow explicit instructions to build a working, real-world application.

The application you're about to build is the CD/Album Catalog program. It's a database application that stores basic information about a CD/album collection, including title, artist name, and associated artwork such as cover art. You'll create forms with toolbars, menus, list views, and much more. All the code you create here follows accepted standards, including using naming conventions and having exception handling. There's nothing in this example that wasn't discussed in a previous hour, but if you get stuck or need more information on a topic than can be found in a corresponding lesson, please visit www.jamesfoxall.com/forums and I'll be happy to provide you with the additional information you need.

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Building the Interface

Start by creating a new Windows application titled **Album Catalog**, and follow these steps:

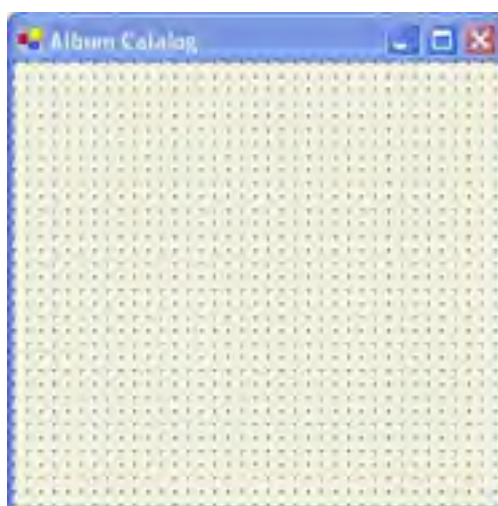
1. Change the Name of the default form to **fclsMain**.
2. Change the Text property of fclsMain to **Album Catalog**.
3. Right-click the default form in the Solution Explorer, choose Rename, and change the name of the file to **fclsMain.cs**.
4. Click the View Code button in the Solution Explorer, scroll down and find the reference to Form1 and change it to **fclsMain**.

Designing the Main Window

The interface for the main form will contain a List View control that lists the albums in the database. This List View will show the album title and artist name. In addition, it will display a picture of a camera if artwork is attached to the album information. The form will also have menus and a toolbar for accessing its functionality.

Add an Image List control to the form now and name it **imgMain**. Before adding images to the Images collection, open the TransparentColor property of the Image List control and choose Silver on the Web tab as shown in [Figure 24.1](#).

Figure 24.1. Use this shade of gray to give the buttons a transparent background.



Add the following images —in the order listed—to the Image List's Images collection (I've supplied the images with the sample code for this book at both www.samspublishing.com and www.jamesfoxall.com):

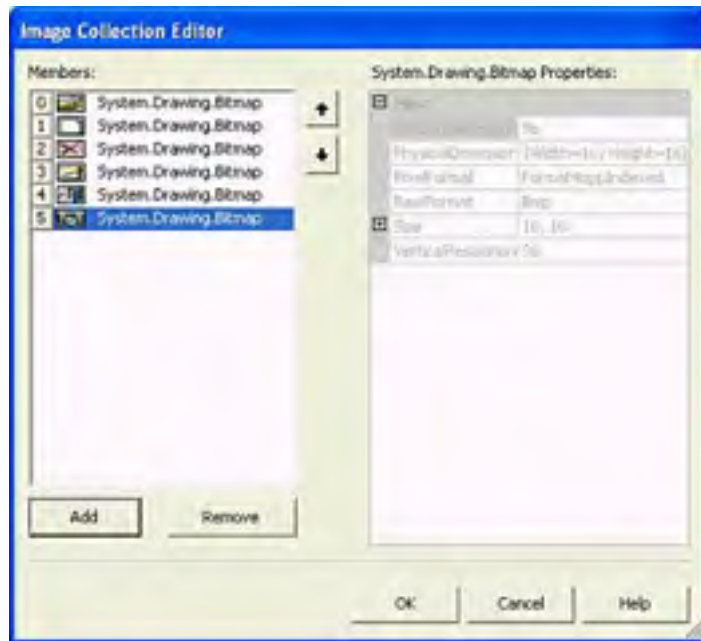
1. [Open.bmp](#)
2. [New.bmp](#)
3. [Delete.bmp](#)
4. [Edit.bmp](#)
5. [Quit.bmp](#)
6. [Camera.bmp](#)

By the Way

Be sure to add the images to the Images collection in the same order in which they appear in the preceding list. If you don't, the images won't appear on the proper menu or toolbar items.

When you've added all the images, the Image Collection Editor should look like the one shown in [Figure 24.2](#).

Figure 24.2. Be sure that the order of your images matches the order shown here.



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Building the Main Menu

Users are accustomed to using menus. In fact, when someone first starts using a program, the menus are an easy way for them to explore the functions provided in the application.

Follow these steps to create a menu on your form:

1. Add a new Main Menu control to the form and name it **mmuMain**.
2. Create a new menu item on the menu bar by entering the text **&File** in the Type Here box. Change the name of the new item to **mnuFile**. Remember, the text you enter to create the menu item becomes the Text property value, not the name.
3. Click the Type Here box *below* File and enter the text **&New Album**. Change the Name of this item to **mnuNewAlbum**. Set its Shortcut property to **CtrlN**.
4. Click the Type Here box below New Album and enter the text **&Delete Album**. Change the name of this item to **mnuDeleteAlbum**.
5. Right-click the Type Here box immediately beneath the Delete Album item and choose Insert Separator from the shortcut menu (see [Figure 24.3](#)).

Figure 24.3. Use separators to group menu items.



6. Click the Type Here box below Separator and enter the text **&Quit**. Change the name of the new item to **mnuQuit** and set its Shortcut property to **CtrlQ**.
7. Click the Type Here box directly *to the right* of the File menu item and enter **&Edit**. This creates a new top-level menu item; name it **mnuEdit**.
8. Click the Type Here box below Edit and enter the text **&Edit Album**. Change the name of the new item to **mnuEditAlbum**.

The menu is now complete.

Building the Toolbar

Toolbars are used to access the most common functions in a program. Although they usually aren't as comprehensive as menus, they are just as important.

Follow these steps to add a toolbar to your form:

1. Add a new Toolbar control to the form and name it **tbMain**.
2. Set the toolbar's ImageList property to **imgMain**.
3. Using the Buttons collection, create the following toolbar buttons:

Button 1:

Property	Value
Name	tbbOpenDatabase
ImageIndex	0
Text	<i>(make blank)</i>
ToolTipText	Open Database

Button 2:

Property	Value
Name	tbbSeparator1
Style	Separator

Button 3:

Property	Value
Name	tbbNewAlbum
ImageIndex	1
Text	<i>(make blank)</i>
ToolTipText	New Album

Button 4:

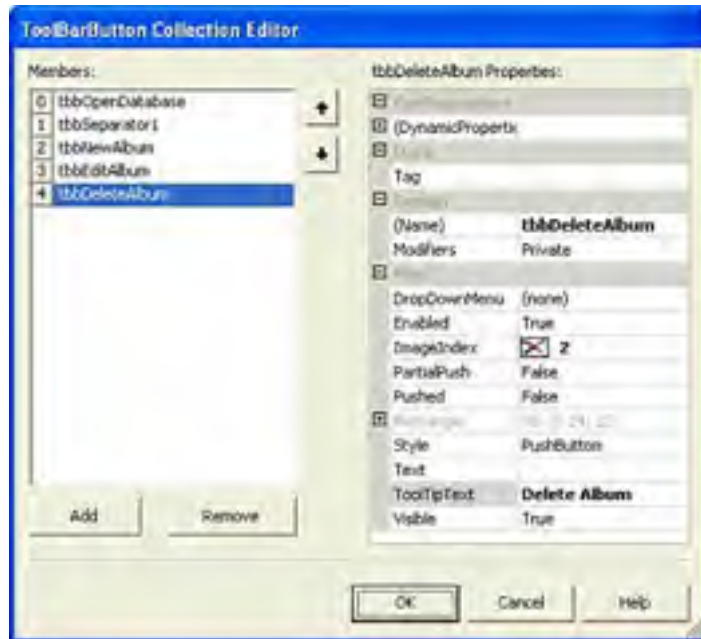
Property	Value
Name	tbbEditAlbum
ImageIndex	3
Text	<i>(make blank)</i>
ToolTipText	Edit Album

Button 5:

Property	Value
Name	tbbDeleteAlbum
ImageIndex	2
Text	<i>(make blank)</i>
ToolTipText	Delete Album

Your ToolBarButton Collection Editor should now look like the one in [Figure 24.4](#).

Figure 24.4. The toolbar will contain four buttons and a separator.



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Adding the List View to Display Albums

You're going to use a list view to display albums. The reason that you'll use a list view instead of a regular list box is that list view controls allow you to display pictures and multiple columns—both of which you'll be doing.

Follow these steps to add the list view to your form:

1. Add a new List View control to the form and set its properties as follows:

Property	Value
Name	lvwAlbums
Anchor	Top, Bottom, Left, Right
FullRowSelect	True
HideSelection	False
Location	6,32
MultiSelect	False
Size	277,224
SmallImageList	imgMain
Sorting	Ascending
View	Details

2. Add the following three columns to the Columns collection of the List View control:

Column 1:

Property	Value
Name	colAlbumName
Text	Album
Width	160

Column 2:

Property	Value
Name	colArtistName
Text	Artist
Width	100

Column 3:

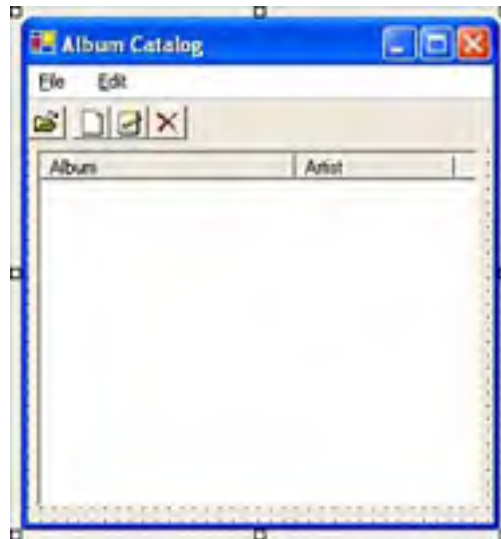
Property	Value
Name	colArtWorkFileName
Text	ArtWorkFileName
Width	0



Note that specifying a column width of 0 creates a hidden column. This is very useful in situations where you want to store data in the list, but don't necessarily want the user to see the data.

The interface of your main form is now complete, and should look like [Figure 24.5](#).

Figure 24.5. This form will serve as the main window in your program.



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Adding the Browse For Database OpenFileDialog Control

You're going to let the user browse for a database at runtime, so add a new OpenFileDialog control and set its properties as follows:

Property	Value
Name	ofdChooseDatabase
Filter	Microsoft Access Databases *.mdb
Title	Open Database

Designing the Album Dialog Box

The secondary form you'll create is the Album dialog box, which will be used to create and edit albums in the database. Choose Project, Add Windows Form and create a new Windows form with the name **fclsAlbum.cs**. Set the form's properties as follows:

Property	Value
FormBorderStyle	FixedDialog
Icon	Album.ico
MaximizeBox	False
MinimizeBox	False
Size	298,264
Text	Album Maintenance

1. Add a new label control to the form and set its properties as follows:

Property	Value
Name	lblTitle
Location	8,20
Size	40,16
Text	Title:

2. Add a new Text Box control to the form and set its properties as follows:

Property	Value
Name	txtTitle
Location	56,16
Size	144,20
Text	(make blank)

3. Add another label control to the form and set its properties as follows:

Property	Value
Name	lblArtistName
Location	8,44
Size	40,16
Text	Artist:

4. Add another Text Box control to the form and set its properties as follows:

Property	Value
Name	txtArtistName
Location	56,40
Size	144,20
Text	(make blank)

5. Add a PictureBox control to the form and set its properties as follows:

Property	Value
Name	picArtWork
BorderStyle	FixedSingle
Location	56,72
Size	144,144
SizeMode	StretchImage

6. Add a Button control to the form and set its properties as follows:

Property	Value
Name	btnChooseCoverArt
Location	8,72
Size	40,23
Text	Art

7. Add another Button control to the form and set its properties as follows:

Property	Value
Name	btnOK
Location	208,16
Size	75,23
Text	OK

8. Add a third Button control to the form and set its properties as follows:

Property	Value
Name	btnCancel
Location	208,46
Size	75,23
Text	Cancel

9. Change the AcceptButton property of the form to **btnOK**.

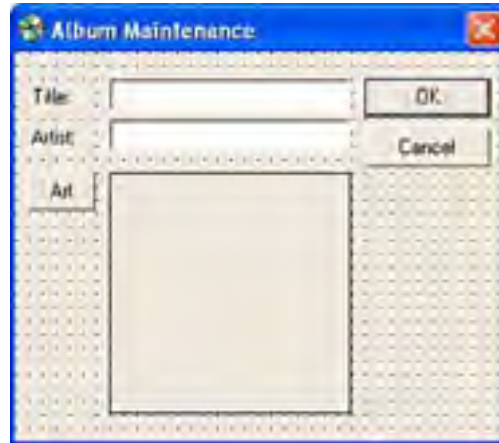
10. Change the CancelButton property of the form to **btnCancel**.

11. You're going to let the user browse their hard drives for artwork files, so add an OpenFileDialog control to the form and set its properties as follows:

Property	Value
Name	ofdChooseArtWork
Filter	Windows Bitmaps *.BMP JPEG Files *.JPG
Title	Choose Artwork

Your form should now look like the one in [Figure 24.6](#).

Figure 24.6. This form will be used to create and edit album info.



The image shows a Windows-style dialog box titled "Album Maintenance". It has a blue title bar with a standard Windows icon on the left and a close button (X) on the right. The main area of the dialog is light gray and contains three input fields on the left and two buttons on the right. The first input field is labeled "Title:" and is empty. The second input field is labeled "Artist:" and is also empty. The third input field is labeled "Art:" and is a larger, empty rectangular area. To the right of the "Title:" field is an "OK" button. To the right of the "Artist:" field is a "Cancel" button. The dialog box has a standard Windows border and a grid-like pattern on the background.

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Writing the Code for the CD Cataloger

Now that your forms are complete, it's time to add the code behind them. As you know by now, this involves creating module-level variables as well as code procedures and event procedures.

Writing Code for the Main Window

The interface of the main window is now complete. Follow these steps to add the necessary code behind the interface:

1. Click the `fclsMain.cs` [Design] tab to view the main form in the designer.
2. Click the View Code button in the Solution Explorer to access the form's code.
3. Add the following **using** statement just below the other using statements at the top of the class:

```
using System.Data.OleDb;
```

4. Position the cursor just in front of the text **static void** (toward the bottom of the code listing) and press Enter a few times.
5. Enter the following procedure:

```
void ShowAlbums()
{
    OleDbConnection cnADONetConnection = new OleDbConnection();
    OleDbDataAdapter daDataAdapter = new OleDbDataAdapter();
    OleDbCommandBuilder cbCommandBuilder;
    DataTable dtAlbums = new DataTable();
    int rowPosition = 0;

    try
    {
        // Open the database.
        cnADONetConnection.ConnectionString =
            @"Provider=Microsoft.Jet.OLEDB.4.0;Data Source=" + m_strDatabase;

        cnADONetConnection.Open();

        // Get all albums.
        daDataAdapter =
            new OleDbDataAdapter("Select * From tblCDs",
                cnADONetConnection);

        daDataAdapter.Fill(dtAlbums);

        // Set up the command builder for navigation.
        cbCommandBuilder =
            new OleDbCommandBuilder(daDataAdapter);

        // Clear the list.
        lvwAlbums.Items.Clear();

        // Go through the recordset and show all of the CDs/albums
        ListViewItem objListItem;

        while (rowPosition < dtAlbums.Rows.Count)
        {
            // Create a new list item for the album.
            objListItem = lvwAlbums.Items.Add(
                dtAlbums.Rows[rowPosition]["Title"].ToString(), 0);

            objListItem.SubItems.Add(
                dtAlbums.Rows[rowPosition]["ArtistName"].ToString());

            objListItem.SubItems.Add(
```



```
dtAlbums.Rows[rowPosition]["ArtWorkFileName"].ToString());

// If artwork is present, indicate this with an icon.
if (dtAlbums.Rows[rowPosition]["ArtWorkFileName"].
    ToString().Length > 0)
{
    // Show the image of the camera to denote there is
    // an image for this album.
    objListItem.ImageIndex = 5;
}
else
    objListItem.ImageIndex = -1;

    rowPosition = rowPosition + 1;
} // End While

// Close the connection.
cnADONetConnection.Close();
}
catch (Exception ex)
{
    MessageBox.Show("An error has occurred! Error: " + ex.Message,
        "Album Catalog", MessageBoxButtons.OK,
        MessageBoxIcon.Error);
}
}
}
```

6. Enter the following statement immediately below the set of `private System` statements toward the top of the class. This variable will hold the path and filename of the open database.

```
string m_strDatabase;
```

7. Place the cursor after the closing brace of the `ShowAlbums()` procedure and press Enter a few times. Next, enter the following procedure:

```
void NewAlbum()
{
    try
    {
        // Make sure a database is loaded.
        if (m_strDatabase == "")
        {
            MessageBox.Show("No database has been opened.",
                "Album Catalog", MessageBoxButtons.OK,
                MessageBoxIcon.Exclamation);
            return;
        }

        // Load the album maintenance form and let it know
        // the user is entering a new album
        fclsAlbum frmAlbum = new fclsAlbum();
        frmAlbum.Database = m_strDatabase;
        frmAlbum.ShowDialog();

        // Refresh the album list.
        ShowAlbums();
    }
    catch (Exception ex)
    {
        MessageBox.Show("An error has occurred! Error: " + ex.Message,
            "Album Catalog", MessageBoxButtons.OK, MessageBoxIcon.Error);
    }
}
```

8. Place the cursor after the closing brace of the procedure you just created and press Enter a few times. Next, enter the following procedure:

```
void EditAlbum()
{
    try
    {
        // Make sure an album has been selected.
        if (lvwAlbums.SelectedItems.Count == 0)
        {
            MessageBox.Show("There is no album selected.",
                "Album Catalog", MessageBoxButtons.OK,
                MessageBoxIcon.Information);
            return;
        }

        // Load the album maintenance form and let it know
        // which album is being edited.
        fclsAlbum frmAlbum = new fclsAlbum();
        frmAlbum.Database = m_strDatabase;
        frmAlbum.ShowAlbum(lvwAlbums.SelectedItems[0].Text,
            lvwAlbums.SelectedItems[0].SubItems[1].Text,
            lvwAlbums.SelectedItems[0].SubItems[2].Text);
        frmAlbum.ShowDialog();

        // Refresh the album list.
        ShowAlbums();
    }
    catch (Exception ex)
    {
        MessageBox.Show("An error has occurred! Error: " + ex.Message,
            "Album Catalog", MessageBoxButtons.OK,
            MessageBoxIcon.Error);
    }
}
```

9. Place the cursor after the curly brace of the EditAlbum() procedure you just created and press Enter a few times. Next, enter the following procedure:

```
void DeleteAlbum()
{
    OleDbConnection cnADONetConnection = new OleDbConnection();
    OleDbDataAdapter daDataAdapter = new OleDbDataAdapter();
    DataTable dtAlbums = new DataTable();
    OleDbCommandBuilder cbCommandBuilder;

    try
    {
        // Make sure an album has been selected.
        if (lvwAlbums.SelectedItems.Count == 0)
        {
            MessageBox.Show("There is no album selected.",
                "Album Catalog", MessageBoxButtons.OK,
                MessageBoxIcon.Information);
            return;
        }

        // Open the database.
        cnADONetConnection.ConnectionString =
            @"Provider=Microsoft.Jet.OLEDB.4.0;Data Source=" + m_strDatabase;
        cnADONetConnection.Open();

        // Find the album in the database.
        daDataAdapter = new OleDbDataAdapter("SELECT * From tblCDs " +
            "WHERE Title = '" + lvwAlbums.SelectedItems[0].Text +
            "' AND " + "ArtistName = '" +
            lvwAlbums.SelectedItems[0].SubItems[1].Text +
            "'", cnADONetConnection);
        daDataAdapter.Fill(dtAlbums);

        // Set up the command builder so we can delete a record.
        cbCommandBuilder = new OleDbCommandBuilder(daDataAdapter);

        // Delete the album.
        dtAlbums.Rows[0].Delete();
        // Commit the changes to the actual data source.
        sdaDataAdapter.Update(dtAlbums);
    }
}
```

```
// Remove the album from the list.
lvwAlbums.Items.Remove(lvwAlbums.SelectedItems[0]);
}
catch (Exception ex)
{
    MessageBox.Show("An error has occurred! Error: " + ex.Message,
        "Album Catalog", MessageBoxButtons.OK,
        MessageBoxIcon.Error);
}
}
```

- 10.** Click fclsMain.cs [Design] to return to design view. Open the File menu and double-click the New Album menu item. Add the following code to its Click event:

```
NewAlbum();
```

- 11.** Click fclsMain.vb [Design] to return to Design view. Open the Edit menu and double-click the Edit Album menu item. Add the following code to its Click event:

```
EditAlbum();
```

- 12.** Click fclsMain.cs [Design] to return to Design view. Open the File menu and double-click the Delete Album menu item. Add the following code to its Click event:

```
DeleteAlbum();
```

- 13.** Click fclsMain.cs [Design] to return to design view. Open the File menu and double-click the Quit menu item. Add the following code to its Click event:

```
this.Close();
```

- 14.** Next you'll add the code for the toolbar. Click fclsMain.cs [Design] to return to design view. Double-click the Toolbar control and add the following code to the ButtonClick event:

```
try
{
    if (e.Button == tbbOpenDatabase)
        OpenDatabase();
    else if (e.Button == tbbNewAlbum)
        NewAlbum();
    else if (e.Button == tbbDeleteAlbum)
        DeleteAlbum();
    else if (e.Button == tbbEditAlbum)
        EditAlbum();
}
catch (Exception ex)
{
    MessageBox.Show("An error has occurred! Error: " + ex.Message,
        "Album Catalog", MessageBoxButtons.OK,
        MessageBoxIcon.Error);
}
```

- 15.** Create the following new procedure in fclsMain.cs:

```
void OpenDatabase()
{
    try
    {
        // Let the user browse for and select a database.
        ofdChooseDatabase.ShowDialog();
        if (ofdChooseDatabase.FileName != "")
        {
            m_strDatabase = ofdChooseDatabase.FileName;
            ShowAlbums();
        }
    }
    catch (Exception ex)
    {

```

```
        MessageBox.Show("An error has occurred! Error: " + ex.Message,  
            "Album Catalog", MessageBoxButtons.OK,  
            MessageBoxIcon.Error);  
    }  
}
```

16. The last procedure you'll create in `fclsMain.cs` will enable a user to double-click an album in the list to edit it. Click `fclsMain.cs` [Design] to display the form in Design view and then click the List view to select it; be sure you have the list view selected before continuing.
17. Click the Events button in the Properties window to access the events of the List View control.
18. Locate the `DoubleClick` event in the list and then double-click it to create an event handler. Enter the following code:

```
    EditAlbum();
```

Writing Code for the Album Maintenance Dialog Box

The Album Maintenance form (`fclsAlbum`) will be used to add and edit albums. It will have two methods: `ShowAlbum` will initiate editing an album and `SaveAlbum` will save your changes. In addition, it will have a property titled `Database` that will accept the full path and filename of the chosen database.

The `ShowAlbum` method will accept the information for the album being edited so that it knows the record to edit, and it won't have to look up the information in the database. Follow these steps to create the code:

1. Click the `fclsAlbum.cs` [Design] tab to show the Album Maintenance form.
2. Click the View Code button in the Solution Explorer to access the code behind the form.
3. Add the following **using** statement just below the other using statements at the top of the class:

```
using System.Data.OleDb;
```

4. Add the following *below* the existing private statements in the class header:

```
private string m_strAlbumTitle = "";  
private string m_strArtistName = "";  
private string m_strArtWorkFileName = "";  
private string m_strDatabase = "";
```

5. Add the following property procedure (right below the Windows Form Designer-generated Code box):

```
public string Database  
{  
    get  
    {  
        return m_strDatabase;  
    }  
    set  
    {  
        m_strDatabase = value;  
    }  
}
```

6. Next, add the following new procedure, which is used to display an album for editing:

```
public void ShowAlbum(string strAlbumTitle,  
    string strArtistName, string strArtWorkFileName)  
{  
    try  
    {  
        // Keep the original information to know what gets changed.  
        m_strAlbumTitle = strAlbumTitle;  
        m_strArtistName = strArtistName;  
        m_strArtWorkFileName = strArtWorkFileName;  
  
        // Show the fields to the user.  
        txtTitle.Text = strAlbumTitle;
```

```
txtArtistName.Text = strArtistName;

// If an artwork file has been specified,
// show the artwork.
if (strArtWorkFileName.Length > 0)
{
    // Make sure the file exists.
    if (System.IO.File.Exists(strArtWorkFileName))
    {
        picArtWork.Image = Image.FromFile(strArtWorkFileName);
    }
    else
    {
        MessageBox.Show("The artwork file " + strArtWorkFileName +
            " was not found.", "Album Catalog",
            MessageBoxButtons.OK,
            MessageBoxIcon.Information);
    }
}
}
}
catch (Exception ex)
{
    MessageBox.Show("An error has occurred! Error: " + ex.Message,
        "Album Catalog", MessageBoxButtons.OK,
        MessageBoxIcon.Error);
}
}
```

7. This next procedure will save changes made to an existing album or create a new album. If an album is being edited, its name will be stored in the module variable `m_strAlbumTitle`, and you'll use this fact to determine whether a row is being added or edited.

```
void SaveAlbum()
{
    OleDbConnection cnADONetConnection = new OleDbConnection();
    OleDbCommand objCmd = new OleDbCommand();
    OleDbTransaction objTrans = null;

    try
    {
        // Open the database.
        cnADONetConnection.ConnectionString =
            @"Provider=Microsoft.Jet.OLEDB.4.0;Data Source=" +
            m_strDatabase;
        cnADONetConnection.Open();

        // Start a new transaction. A transaction is used to ensure that
        // data is written to the disk immediately, and not held in cache.
        objTrans = cnADONetConnection.BeginTransaction();

        // Create a new Command object and attach the transaction to it.
        objCmd.Connection = cnADONetConnection;
        objCmd.Transaction = objTrans;

        // Build the query text, depending on if an album is
        // being added or edited.
        if (m_strAlbumTitle.Length == 0)
        {
            // Adding a new album.
            objCmd.CommandText = "INSERT INTO tblCDs (Title, ArtistName, " +
                "ArtWorkFileName) " +
                "VALUES (" + txtTitle.Text + ", " +
                txtArtistName.Text + ", " +
                m_strArtWorkFileName + ")";
        }
        else
        {
            // Editing an existing album.
            objCmd.CommandText = "UPDATE tblCDs SET Title = " +
                txtTitle.Text + ", ArtistName = " +
                txtArtistName.Text + ", " +
                "ArtWorkFileName = " + m_strArtWorkFileName +
                " WHERE Title = " + m_strAlbumTitle +
                " AND ArtistName = " + m_strArtistName + """;
        }
    }
}
```

```
// Execute the query.
objCmd.ExecuteNonQuery();

// Commit the transaction to the database.
objTrans.Commit();
}
catch (Exception ex)
{
    // If a transaction has been started, roll it back.
    if (objTrans != null)
    {
        objTrans.Rollback();
    }
    // Display the error to the user.
    MessageBox.Show("An error has occurred! Error: " + ex.Message,
        "Album Catalog", MessageBoxButtons.OK,
        MessageBoxIcon.Error);
}
}
```

8. Return to the design view of the form and double-click the Art button to access its Click event. Add the following code:

```
try
{
    if (ofdChooseArtwork.ShowDialog() == DialogResult.OK)
    {
        // Store the artwork file name.
        m_strArtWorkFileName = ofdChooseArtwork.FileName;

        // Show the artwork.
        picArtWork.Image = Image.FromFile(ofdChooseArtwork.FileName);
    }
}
catch (Exception ex)
{
    MessageBox.Show("An error has occurred! Error: " +
        ex.Message, "Album Catalog",
        MessageBoxButtons.OK, MessageBoxIcon.Error);
}
```

9. Return to the Design view once more and double-click the OK button to access its Click event. Enter the following code:

```
SaveAlbum();
this.Close();
```

10. You guessed it: Return to Design view again and double-click the Cancel button. Add the following code to its Click event:

```
this.Close();
```

Testing Your Application

Congratulations—the application is complete! This was a big project, and it's easy to miss steps. If you're having problems and are having a hard time debugging them, download the complete project with the sample code for this book from either the Sams Web site or from mine (www.jamesfoxall.com) and check your work.

I'm sure you know this by now, but press F5 to run your project. The main window will appear as shown in [Figure 24.7](#).

Figure 24.7. Here's your main window—ready and waiting.



Try clicking the New Album button on the toolbar. You'll receive a message stating that no database has been opened. This is a great example of how a little work on your end goes a long way for the end user. This message is much better than, say, throwing some sort of exception. Try enlarging the form—you'll find that the album list resizes with the form thanks to the magic of the Anchor property. Again, these details really make an application.

Choose File, Open Database to display the Open Database dialog box and then locate and select the Albums.mdb database provided at the Web site for this book.

When you open the database, the album list will display the albums in the database. Notice the camera icon in the list. This denotes that an artwork file has been specified for the album. The database stores only the filename, not the image, so editing this album will cause a message box to appear telling you the image couldn't be found. That's okay—feel free to click the Art button and select a file of your own (see [Figure 24.8](#)).

Figure 24.8. Providing great functionality doesn't always require a lot of work.



Hopefully, by doing this lengthy example, you've learned how all the various pieces of the development puzzle fit into place—from creating an interface and writing code on through testing and debugging. Your applications will grow in complexity and functionality, but they'll always be built with the same basic principles used in this hour.

I wish you the best of luck in your programming endeavors, and I encourage you to stop by www.jamesfoxall.com/forums to discuss your questions and share your success stories!

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Part VI: Appendices

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Appendix B [Answers to Quizzes](#)

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Appendix A. The 10,000-Foot View

You know a lot about Visual C# .NET by now. You can create projects, use forms and controls to build an interface, and you know how to add menus and toolbars to a form. You've also learned how to create modules and procedures and how to write code to make things happen. You can use variables, make decisions, perform looping, and even debug your code. The question you may be asking now is, "Where to next?"

Throughout this book, I've focused my discussions on Visual C# .NET. When it comes to Microsoft's .NET platform, however, Visual C# .NET is just part of the picture. In this appendix, I provide an overview of Microsoft's .NET platform so that you can see how Visual C# .NET relates to .NET as a whole. After you finish reading this appendix, you'll understand the various pieces of .NET and how they're interrelated. Hopefully, you'll be able to combine this information with your current personal and professional needs to determine the facets of .NET that you want to explore in more detail.

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The .NET Framework

The components and technology that make up Microsoft .NET are collectively called the .NET Framework. The .NET Framework consists of numerous classes and includes components such as the common language runtime, Microsoft Intermediate Language, and ADO.NET. In the following sections, I'll explain the various pieces that make up the .NET Framework.

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The Common Language Runtime

A language runtime is what allows an application to run on a target computer; it consists of code that is shared among all applications developed using a supported language. A runtime contains the "guts" of language code, such as code that draws forms to the screen, handles user input, and manages data. The runtime of .NET is called the *common language runtime*.

Unlike runtimes for other languages, the common language runtime is designed as a multilanguage runtime. For example, both Visual C# .NET and Visual Basic .NET use the common language runtime. In fact, currently more than a few dozen language compilers are being developed to use the common language runtime.

Because all .NET languages share the common language runtime, they share the same IDE, the same forms engine, the same exception-handling mechanism, the same garbage collector (discussed shortly), and much more. One benefit of the multilanguage capability of the common language runtime is that programmers can leverage their knowledge of a given .NET language.

For example, some developers on a team may be comfortable with Visual C# .NET, whereas others are more comfortable with Visual Basic .NET. Because both languages share the same runtime, both can be integrated to deliver a single solution. In addition, a common exception-handling mechanism is built into the common language runtime so that exceptions can be thrown from code written in one .NET language and caught in code written in another.

Code that runs within the common language runtime is called **managed code** because the code and resources used by the code (variables, objects, and so on) are fully managed by the common language runtime. Visual C# .NET is restricted to working only in managed code, but some languages (such as C++) are capable of dropping to unmanaged code—code that isn't managed by the common language runtime. One big advantage with working in managed code is that the common language runtime provides garbage collection—the automatic freeing up of unused resources. You'll learn a bit more about garbage collection later in this hour.

Another advantage of the common language runtime is that all .NET tools share the same debugging and code-profiling tools. In the past, languages such as Visual Basic were limited to their own debugging tools, whereas languages such as C++ had many third-party debugging tools available. Now, all languages share the same tools. This means that as advancements are made to the debugging tools of one product, they're made to tools of all products because the tools are shared. This aspect goes beyond debugging tools. Add-ins to the IDE (such as code managers), for example, are just as readily available to Visual C# .NET as they are to Visual Basic .NET—or any other .NET language, for that matter.

By the way

Although Microsoft hasn't announced any official plans to do so, it's *possible* that it could produce a version of the common language runtime that runs on other operating systems, such as Macintosh OS or Linux. If this occurs, the applications that you've written for Windows should run on a newly supported operating system with little or no modification.

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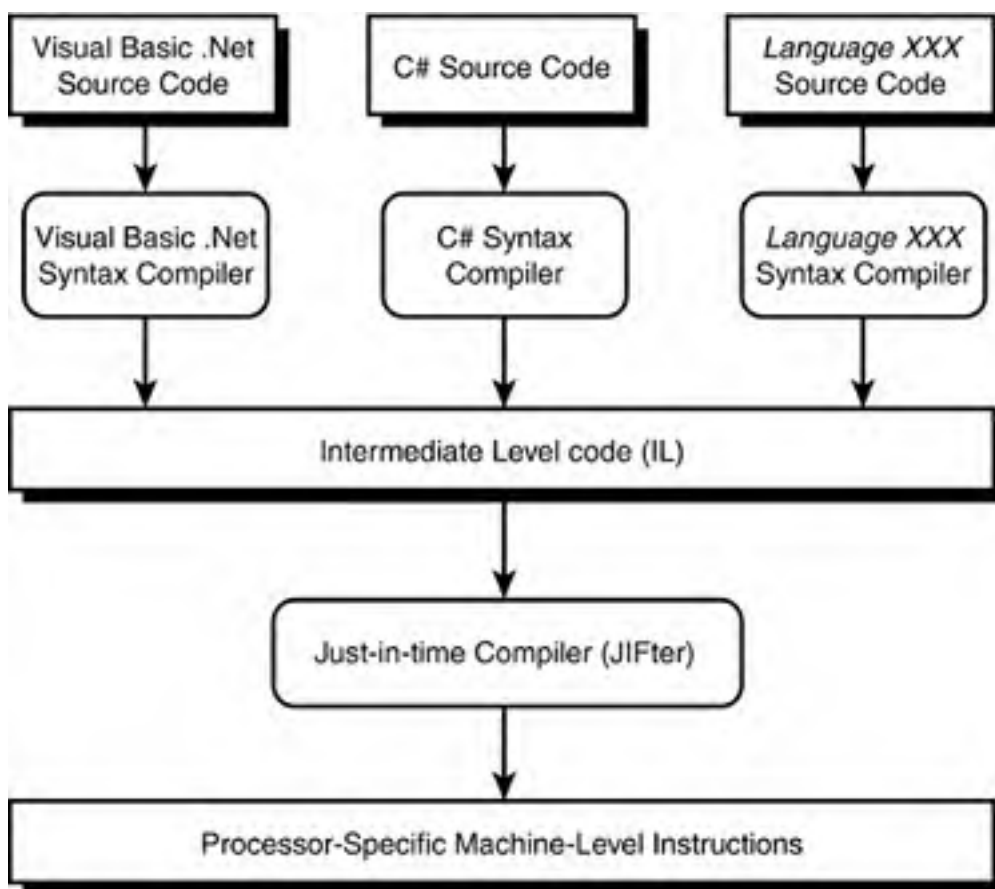
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Microsoft Intermediate Language

As you can see in [Figure A.1](#), all .NET code, regardless of the language syntax used, compiles to Intermediate Language (IL) code. IL code is the only code the common language runtime understands; it doesn't understand Visual C# .NET, Visual Basic .NET, or any other developer syntax. It's IL that gives .NET its multilanguage capabilities; as long as an original source language can be compiled to IL, it can become a .NET language. For example, people are developing a .NET compiler for COBOL—a mainframe language with a long history. This compiler will take existing COBOL code and compile it to IL so that it will run within the .NET Framework using the common language runtime. COBOL itself isn't a Windows language and doesn't support many of the features found in a true Windows language (such as a Windows Forms engine), so you can imagine the excitement of COBOL programmers at the prospect of being able to leverage their existing code and programming skills to create powerful Windows applications.

Figure A.1. These are the steps taken to turn developer code into a running component.



By the Way

One of the potential drawbacks of IL is that it may be susceptible to reverse compilation. This has many people questioning the security of .NET code and the security of the .NET Framework in general. If code security is a serious concern for you, I encourage you to research this matter on your own.

IL code isn't the final step in the process of compiling and running an application. For a processor (CPU) to execute programmed instructions, those instructions must be in *machine-language* format. When you run a .NET application, a just-in-time compiler (called a *JITter*) compiles the IL to machine-language instructions that the processor can understand. IL code is *processor independent*, which again brings up the possibility that JITters could be built to create machine code for computers that are using something other than Intel-compatible processors. If Microsoft were to offer a common language runtime for operating systems other than Windows, much of the difference would lie in the way IL would be compiled by the JITter.

As .NET evolves, changes made to the common language runtime will benefit all .NET applications. For example, if Microsoft finds a way to further increase the speed at which forms are drawn to the screen by making improvements to the common language runtime, all .NET applications will immediately benefit from the improvement. However, optimizations made to a specific syntax compiler, such as the one that compiles Visual C# .NET code to IL, are language-specific. This means that even though all .NET languages compile to IL code and use the common language runtime, it's possible for one language to have small advantages over another because of the way in which the language's code is compiled to IL.

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Namespaces and Classes in .NET

As I mentioned earlier in this book, the .NET Framework is composed of classes—many classes. Namespaces are the method used to create a hierarchical structure for all these classes, and they help prevent naming collisions. A **naming collision** occurs when two classes have the same name. Because namespaces provide a hierarchy, it's possible to have two classes with the same name as long as they exist in different namespaces. Namespaces, in effect, create a scope for classes.

The base namespace in the .NET Framework is the System namespace. The System namespace contains classes for garbage collection (discussed shortly), exception handling, data typing, and so much more. The System namespace is just the tip of the iceberg. There are literally dozens of namespaces. [Table A.1](#) lists some of the more common namespaces, many of which you've used in this book. All the controls that you've placed on forms and even the forms themselves, for example, belong to the System.Windows.Forms namespace. Use [Table A.1](#) as a guide; if a certain namespace interests you, I suggest that you research it further in the Visual Studio .NET online help.

Table A.1. Commonly Used Namespaces

Namespace	Description
Microsoft.CSharp	Contains classes that support compilation and code generation using the Visual C# .NET language.
Microsoft.VisualBasic	Contains classes that support compilation and code generation using the Visual Basic language.
System	Contains fundamental classes and base classes that define commonly used value and reference data types, event handlers, interfaces, attributes, and exceptions. This is the base namespace of .NET.
System.Data	Contains classes that constitute the ADO.NET architecture.
System.Diagnostics	Contains classes that enable you to debug your application and to trace the execution of your code.
System.Drawing	Contains classes that provide access to the Graphical Device Interface (GDI) basic graphics functionality.
System.IO	Contains classes that allow reading from and writing to data streams and files.
System.Net	Contains classes that provide a simple programming interface to many of the protocols found on the network.
System.Security	Contains classes that provide the underlying structure of the common language runtime security system.
System.Web	Contains classes that provide interfaces that enable browser/server communication.
System.Windows.Forms	Contains classes for creating Windows-based applications that take advantage of the rich user-interface features available in the Microsoft Windows operating system.
System.Xml	Contains classes that provide standards-based support for processing XML.



All Microsoft-provided namespaces begin with either System or Microsoft. Other vendors can provide their own namespaces, and it's possible for you to create your own custom namespaces as well, but that's beyond the scope of this book.

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Common Type System

The Common Type System in the common language runtime is the component that defines how data types are declared and used. The fact that the common language runtime can support cross-language integration to the level it does is largely because of the Common Type System. In the past, each language used its own data types and managed data in its own way. This made it very difficult for applications developed in different languages to communicate, because no standard way existed in which to pass data between them.

The Common Type System ensures that all .NET applications use the same data types, provides for self-describing type information (called **metadata**), and controls all the data manipulation mechanisms so that data is handled (stored and processed) in the same way among all .NET applications. This allows data (including objects) to be treated the same way in all .NET languages.

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Garbage Collection

Although I've talked a lot about objects (you can't talk about anything .NET-related without talking about objects), I've avoided discussing the underlying technical details of how .NET creates, manages, and destroys objects. Although you don't need to know the complex minutiae of how .NET works with objects, you do need to understand a few details of how objects are destroyed.

As I discussed in the rest of this book, setting an object variable to `null` or letting it go out of scope destroys the object. However, as I mentioned in [Hour 16](#), "Designing Objects Using Classes," this isn't the whole story. The .NET platform uses a **garbage collector** for destroying objects. The specific type of garbage collection implemented by .NET is called **reference-tracing garbage collection**. Essentially, the garbage collector monitors the resources used by a program, and when consumed resources reach a defined threshold, the garbage collector proceeds to look for unused objects. When the garbage collector finds an unused object, it destroys it, freeing all the memory and resources the object was using.

An important thing to remember about garbage collection is that releasing an object by setting it to `null` or letting an object variable go out of scope doesn't mean that the object will be destroyed immediately. The object won't be destroyed until the garbage collector is triggered to go looking for unused objects.

Now that you've completed this book, you should have a solid working understanding of developing applications with Visual C# .NET. Nevertheless, you've just embarked on your journey. One of the things I love about developing applications is that there is always something more to learn, and there's always a better approach to a development problem. In this appendix, I acquainted you with the "bigger picture" of Microsoft's .NET platform by exposing you to the .NET Framework and its various components. Consider the information you learned in this appendix a primer; what you do with this information and where you go from here is entirely up to you.

I wish you the best of luck in your programming endeavors!

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Appendix B. Answers to Quizzes

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Hour 1

1: What type of Visual C# project creates a standard Windows program?

A1: Windows Application project

2: What window is used to change the attributes (location, size, and so on) of a form or control in the IDE?

A2: Properties window

3: How do you access the default event (code) of a control?

A3: Double-click the control on its form designer.

4: What property of a PictureBox do you set to display an image?

A4: The Image property

5: What is the default event for a Button control?

A5: The Click event

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Hour 2

- 1:** How can you make the Visual Studio Start Page appear at startup if this feature has been disabled?
- A1:** Change the At Startup property on the Options dialog available under the Tools menu.
- 2:** Unless instructed otherwise, you are to create what type of project when building examples in this book?
- A2:** Windows Application project
- 3:** To make a docked design window appear when you hover over its tab and disappear when you move the mouse away from it, you change what setting of the window?
- A3:** Auto Hide
- 4:** How do you access the Toolbars menu?
- A4:** Choose View, Toolbars or right-click any toolbar
- 5:** What design window do you use to add controls to a form?
- A5:** The toolbox
- 6:** What design window is used to change the attributes of an object?
- A6:** The Properties window
- 7:** To modify the properties of a project, you must select the project in what design window?
- A7:** Solution Explorer
- 8:** Which Help feature adjusts the links it displays to match what it is you are doing?
- A8:** Dynamic Help

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Hour 3

Quiz

1: True or False: Visual C# .NET is a true object-oriented language.

A1: True

2: An attribute that defines the state of an object is called a what?

A2: Property

3: To change the value of a property, the property must be referenced on which side of an equal sign?

A3: The left side

4: What is the term for creating a new object from a template?

A4: Instantiation

5: An external function of an object (one that is available to code using an object) is called a what?

A5: Method

6: True or False: A property of an object can be another object.

A6: True. Such properties are called object properties.

7: A group of like objects is called what?

A7: Collection

8: What tool is used to explore the members of an object?

A8: Object Browser

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Hour 4

1: Name three things that can cause events to occur.

A1: The operating system, a user, objects

2: True or False: All objects support the same set of events.

A2: False. Each object supports a set of events specific to itself, or no events at all.

3: What is the default event type for a button?

A3: Click

4: Writing code in an event that causes that same event to be triggered, setting off a chain reaction with the event triggered again and again is called what?

A4: Recursion

5: What is the easiest way to access a control's default event handler?

A5: Double-click the control in the form designer.

6: All control events pass a reference to the control causing the event. What is the name of the parameter that holds this reference?

A6: Sender

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Hour 5

- 1:** True or False: The text displayed in the form's title bar is determined by the value in the TitleBarText property.
- A1:** False. The title bar text is determined by the Text property.
- 2:** The color named Control is what kind of color?
- A2:** A system color. System colors are determined at runtime by the user's Windows settings.
- 3:** In what three places are a form's icon displayed?
- A3:** In the form's title bar, in the taskbar when the form is minimized, and in the task list when the user presses Alt+Tab.
- 4:** A window with a smaller than normal title bar is called what?
- A4:** A tool window
- 5:** For a Minimize or Maximize button to be visible on a form, what other element must be visible?
- A5:** The ControlBox must be visible.
- 6:** What, in general, is the best value to use for the StartPosition property of a form?
- A6:** CenterParent
- 7:** To maximize, minimize, or restore a form in code, you set what property?
- A7:** The WindowState property
- 8:** True or False: To display a form, you must create a variable in code.
- A8:** True
- 9:** What property do you set to make a hidden form appear?
- A9:** The form's Visible property

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Hour 6

- 1:** True or False: The first control selected in a series is always made the active control.
- A1:** False
- 2:** How many methods are there to add a control to a form from the toolbox?
- A2:** Three: double-click, drag and drop, select and draw
- 3:** If you double-click a tool in the toolbox, where on the form is it placed?
- A3:** In the upper-left corner if it's the only control on the form, otherwise over the last control placed on the form.
- 4:** Which property fixes an edge of a control to an edge of a form?
- A4:** Anchor
- 5:** Which property do you change to hide the grid on a form?
- A5:** DrawGrid
- 6:** Which menu contains the functions for spacing and aligning controls?
- A6:** The Format menu
- 7:** Which property do you set to make a form a MDI parent?
- A7:** IsMdiContainer

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Hour 7

Quiz

- 1:** Which control would you use to display text that the user can't edit?
- A1:** A Label control
- 2:** What common property is shared by the Label control and text box and whose value determines what the user sees in the control?
- A2:** The Text property
- 3:** In order to change the Height of a text box, you must set what property?
- A3:** You must set the MultiLine property to `true`.
- 4:** What is the default event of a Button control?
- A4:** The Click event
- 5:** A button whose Click event is triggered when the user presses Enter, regardless of the control that has the focus, is called an ...?
- A5:** Accept button
- 6:** Which control would you use to display a yes/no value to a user?
- A6:** A check box
- 7:** How would you create two distinct sets of mutually exclusive option buttons?
- A7:** Place each set of option buttons on a different container control, such as a group box.
- 8:** To manipulate items in a list, you use what collection?
- A8:** The Items collection of the control
- 9:** What method adds an item to a list in a specific location?
- A9:** The Insert method of the Items collection

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Hour 8

- 1:** What increment of time is applied to the Interval property of the Timer control?
- A1:** Milliseconds
- 2:** What collection is used to add new tabs to a Tab control?
- A2:** The TabPages collection
- 3:** What property returns the index of the currently selected tab?
- A3:** The SelectedIndex property of the control
- 4:** True or False: You should use different Image List controls for storing images of different sizes.
- A4:** True
- 5:** To see columns in a List View control, the View property must be set to what?
- A5:** Detail
- 6:** The additional columns of data that can be attached to an item in a list view are stored in what collection?
- A6:** The SubItems collection
- 7:** What property of what object would you use to determine how many items are in a List View?
- A7:** The Count property of the Items collection
- 8:** Each item in a Tree View is called what?
- A8:** A node
- 9:** How do you make a node the child of another node?
- A9:** Add it to the Nodes collection of the first node.

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Hour 9

Quiz

- 1:** True or False: Form menu bars are created using the Context Menu control.
- A1:** False. They are created using the Main Menu control.
- 2:** To create an accelerator or hotkey, preface the character with a(n):
- A2:** Ampersand (&)
- 3:** If you've designed a menu using a Main Menu control, but that menu isn't visible on the form designer, how do you make it appear?
- A3:** Click the Main Menu control at the bottom of the form designer.
- 4:** To place a check mark next to a menu item, you set what property of the item?
- A4:** The Checked property
- 5:** How do you add code to a menu item?
- A5:** Double-click the item while in Edit mode.
- 6:** Toolbar items are part of what collection?
- A6:** The Buttons collection
- 7:** To create a separator on a toolbar, you create a new button and set what property?
- A7:** The Style property to Separator
- 8:** True or False: Every button on a toolbar has its own Click event.
- A8:** False. All buttons share a ButtonClick event.
- 9:** What must you do to have panels appear on a status bar?
- A9:** Set the ShowPanels property to True.

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Hour 10

Quiz

1: What are the entities that are used to house methods called?

A1: Classes

2: True or False: To access methods in a class module, you must first create an object.

A2: True

3: Data that has been passed into a method by a calling statement is called a?

A3: Parameter

4: To pass multiple arguments to a method, separate them with a?

A4: Comma

5: The situation in which a method or set of methods continue to call each other in a looping fashion is called?

A5: Recursion

6: How do you attach a task to a code statement?

A6: Click the statement, open the Edit menu, open the Bookmarks submenu, and then click Add Task List Shortcut.

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Hour 11

1: What data type would you use to hold currency values?

A1: Decimal

2: Which data type can be used to hold any kind of data and essentially serves as a generic data type?

A2: Object

3: What values does a bool hold?

A3: true or false

4: What can you create to eliminate magic numbers by defining a literal value in one place?

A4: Constant

5: What type of data element can you create in code that can have its value changed as many times as necessary?

A5: Variable

6: What are the first and last indexes of an array dimensioned using `string_strMyArray[5]`?

A6: The first index is 0, the last index is 4.

7: What word is given to describe the visibility of a constant or variable?

A7: Scope

8: In general, is it best to limit the scope of a variable or to use the widest scope possible?

A8: Limit the scope as much as possible.

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Hour 12

1: To get only the remainder of a division operation, you use which operator?

A1: %

2: Which operation is performed first in the following expression—the addition or the multiplication?

A2: $x = 6 + 5 * 4$
 $5 * 4$

3: Does this expression evaluate to `true` or to `false`?

A3: `((true || true) && false) == !true`
`true`

4: Which Boolean operator performs a logical negation?

A4: !

5: The process of appending one string to another is called?

A5: Concatenation

6: What property can be used to return the month of a given date?

A6: Month

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Hour 13

Quiz

1: Which decision construct should you use to evaluate a single expression to either **true** or **false**?

A1: **if**

2: Evaluating expressions to **true** or **false** for both types of decision constructs is accomplished using _____ logic.

A2: Boolean

3: If you want code to execute when the expression of an **if** statement evaluates to **false**, include an _____ clause.

A3: **else**

4: Which decision construct should you use when evaluating the result of an expression that may equate to one of many possible values?

A4: **switch**

5: Is it possible that more than one **case** statement may have its code execute?

A5: Yes

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Hour 14

- 1:** True or False: You have to know the start and end values of a **for** loop at design time to use this type of loop.
- A1:** False. You must know these values at runtime, but it isn't necessary to know them at design time.
- 2:** Is it possible to nest loops?
- A2:** Yes, and this is a common thing to do.
- 3:** What type of loop would you most likely need to create if you didn't have any idea how many times the loop would need to occur?
- A3:** A **do...while** loop
- 4:** If you evaluate the expression in a **do...while** on the **while** statement, is it possible that the code within the loop may never execute?
- A4:** No; when you evaluate the expression on the **while** statement, the code within the loop is guaranteed to execute at least once.
- 5:** What statement do you use to terminate a **do...while** without evaluating the expression on the **do** or **while** statements?
- A5:** The **break** statement

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Hour 15

1: What type of errors prevent Visual C# .NET from compiling and running code?

A1: Build errors

2: What is the name of a runtime error: an error that usually occurs as a result of attempting to process inappropriate data?

A2: Exception

3: What characters are used to denote a single-line comment?

A3: //

4: To halt execution at a specific statement in code, you set a what?

A4: A break point

5: Explain the yellow arrow and red circles that can appear in the gray area in the code editor.

A5: The yellow arrow denotes the next statement to be executed, and the red circle denotes a break point.

6: What IDE window would you use to poll the contents of a variable in Break mode?

A6: The Command window

7: True or False: You must always specify a `catch` section in a `try` structure.

A7: False

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Hour 16

Quiz

- 1:** To create objects, you must first create a template. This template is called a:
- A1:** Class
- 2:** One of the primary benefits of object-oriented programming is that objects contain both their data and their code. This is called:
- A2:** Encapsulation
- 3:** With static classes, public variables and routines are always available to code via the static class in other modules. Is this true with public variables and routines in classes?
- A3:** No. To access the public variables and routines, an object must be instantiated from the class.
- 4:** True or False: Each object derived from a class has its own set of class-level data.
- A4:** True
- 5:** What must you do to create a property that can be read but not changed by client code?
- A5:** Create a property procedure that includes the `get` construct, but not the `set` construct.
- 6:** What is the best way to store the internal value of a property within a class?
- A6:** As a private module-level variable.
- 7:** Which is generally superior, early binding or late binding?
- A7:** Early binding
- 8:** What is the best way to release an object you no longer need?
- A8:** Set the object variable = null.

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Hour 17

Quiz

1: What minimal argument should you supply when calling `MessageBox.Show()`?

A1: The `MessageText` argument.

2: If you don't supply a value for the *caption* parameter of `MessageBox.Show()`, what gets displayed in the title bar of the message?

A2: Nothing, which is why you should always specify a caption.

3: What type of data is always returned by the `MessageBox.Show()` method?

A3: `DialogResult`

4: Which event fires first, the `KeyUp` or `KeyPress` event?

A4: `KeyPress`

5: How do you determine which button is being pressed in a mouse-related event?

A5: Use the `Button` property of the `e` object in the event handler.

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Hour 18

1: What object is used to draw to a surface?

A1: Graphics

2: To set a Graphics object to draw to a form directly, you call what method of the form?

A2: CreateGraphics()

3: What object defines the characteristics of a line? A fill pattern?

A3: Pens define lines; brushes define fill patterns.

4: How do you make a color property adjust with the user's Windows settings?

A4: Assign a system color to the property.

5: What object is used to define the bounds of a shape to be drawn?

A5: Rectangle

6: What method do you call to draw an irregular ellipse? A circle?

A6: Ellipses and circles are both drawn using the DrawEllipse() method.

7: What method do you call to print text on a Graphics surface?

A7: DrawString()

8: To ensure that graphics persist on a form, the graphics must be drawn on the form in what event?

A8: The form's Paint() event.

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Hour 19

- 1:** True or False: The Open File dialog box automatically opens a file.
- A1:** False. The control returns the name of the file the user wants to open, but it doesn't open the file.
- 2:** What symbol is used to separate a filter description from its extension?
- A2:** The pipe (|) symbol.
- 3:** What object is used to manipulate files?
- A3:** System.IO.File
- 4:** What arguments are required by System.IO.File.Copy()?
- A4:** Two arguments are expected. The first is the name of the current file; the second is the name of the file to create as a result of the copy.
- 5:** How would you rename a file?
- A5:** Use System.IO.File.Move(), using the same path but a different filename.
- 6:** True or False: Files deleted with System.IO.File.Delete() are sent to the Recycle Bin.
- A6:** False
- 7:** What objects are used to manipulate folders?
- A7:** System.IO.Directory. Sometimes Microsoft calls them folders, sometimes directories. In .NET, however, they're usually called directories.

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Hour 20

Quiz

- 1:** Before you can early-bind objects in an automation server, you must do what?
- A1:** Create a reference to a type library.
- 2:** What is the most likely cause of not seeing a type library listed in the Add References dialog box?
- A2:** You don't have the component installed on your computer.
- 3:** For Visual C# .NET to use a COM library, it must create a:
- A3:** Wrapper
- 4:** To manipulate a server via Automation, you manipulate:
- A4:** An object variable referencing an object in the server's object model.
- 5:** To learn about the object library of a component, you should:
- A5:** Read the documentation or use the Object Browser.

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Hour 21

Quiz

1: What is the name of the data access components used in the .NET Framework?

A1: ADO.NET

2: What is the name given to a collection of DataRows?

A2: DataTable

3: How do I get data into and out of a DataTable?

A3: Use the Fill and Update methods of the DataAdapter.

4: What object is used to connect to a data source?

A4: Connection

5: What argument of a connection string contains information about the type of data being connected to?

A5: The Provider= argument

6: What object provides update, delete, and insert capabilities to a DataAdapter?

A6: CommandBuilder

7: What two .NET data providers are supplied as part of the .NET Framework?

A7: The OleDb .NET data provider and the SqlClient .NET data provider

8: What method of a DataTable object do you call to create a new row?

A8: NewRow

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Hour 22

Quiz

- 1:** To create a custom setup program, you start by creating what type of Visual Studio project?
- A1:** The project type is Setup Project, which can be found in the Setup and Deployment Projects folder.
- 2:** The final build file of a project (EXE, DLL, and so on) is referred to as the what?
- A2:** The Output of the project.
- 3:** True or False: To include the output of a project, the project must be added to the solution containing the setup program.
- A3:** True
- 4:** Which build option creates smaller and faster builds?
- A4:** Release builds are smaller and faster than debug builds.
- 5:** How do you add a file to an installation?
- A5:** Choose Project, Add, and then choose File.
- 6:** If the Project menu doesn't have the menu options for creating a setup program, what might be wrong?
- A6:** You probably have a project *other than* the setup program project selected in the Solution Explorer.
- 7:** How do you add folders to the custom setup program?
- A7:** Right-click the File System on the Target Machine item in the left pane of the setup program project.
- 8:** How do you create a shortcut for a file in a setup program?
- A8:** Right-click the file and choose the appropriate menu item.

Hour 23

Quiz

1: What does XML stand for?

A1: Extensible Markup Language

2: An element is designated in an XML document using what?

A2: Starting and ending tags

3: True or False: XML tag names are case sensitive.

A3: True

4: What is the name of the protocol used by .NET to marshal object requests across the Web?

A4: SOAP (Simple Object Access Protocol)

5: What forms engine is used to create forms that run over the Internet?

A5: Web Forms

6: Which forms engine provides for faster response to user interaction?

A6: Windows Forms

7: Where is the .NET Framework installed for Windows Forms applications? For Web Forms applications?

A7: The .NET Framework is installed on the user's computer for Windows Forms applications and on the Web server for Web Forms applications.

8: What is the name of the ASP.NET technology used to expose application logic as objects over the Web?

A8: XML Web services

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!(Not) operator 2nd
%(modulus) operator 2nd
&(ampersand)
&&(And) operator 2nd
() (parenthesis) 2nd
() parenthesis
(backslash)
*(multiplication) operator
+(addition) operator
+(concatenation) operator
-(subtraction) operator
.NET Framework
 technological components
/(division) operator
/* comment notation
// comment notation 2nd
// notation
 code comments
/// comment notation
=(equal sign)
?(question mark)
@(at symbol)
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_(underscore)
{ } (braces) 2nd 3rd
| (pipe symbol)
|| (Or) operator 2nd

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