Delphi User’s Guide

Delphi for Windows

Introduction

Copyright Agreement

Delphi represents a brand new way to develop applications for Windows. It combines the speed and ease of use of a visual development environment with the power, flexibility, and reusability of a fully object-oriented language, the world’s fastest compiler, and leading-edge database technology.

As a result, Delphi lets you build sophisticated client/server applications in record time. Delphi includes support for creating stand-alone executable (.EXE) and dynamic-link library (.DLL) files and local or networked database applications, as well as client/server applications.

Installing Delphi

Delphi and its installation program are both Windows applications, so you must already have Windows running to install Delphi. The installation program creates directories as needed and copies files from the distribution disk to your hard drive.

The installation program is largely self-explanatory. The following steps tell you all you need to know to install Delphi.

■ To install Delphi,

1. Start Windows if it is not already running on your computer.
2. Insert the Delphi CD into your CD-ROM drive.
3. Use Program Manager’s File | Run menu command or File Manager to run \INSTALL\SETUP.EXE from the Delphi CD.
4. Follow the instructions presented by the installation program.

When the installation program finishes its work, it offers you the option of reading the README.TXT file, which contains important last-minute information about Delphi. It’s a good idea to read README.TXT before running Delphi for the first time.

Documentation overview

Delphi includes complete documentation to help you learn to use the product quickly and effectively.

The Delphi documentation consists of three parts:

- Printed manuals
- Online Help
- Interactive Tutors

Using this manual

- **Part I, "Getting started with Delphi,"** introduces you to the kinds of tasks you'll perform when designing and testing applications in Delphi.
- **Part II, "Fundamental skills,"** presents concepts and techniques you'll use in developing robust and sophisticated Delphi applications. These skills are discussed in the context of creating simple but functional examples.
- **Part III, "Programming topics,"** discusses the language you'll use to write your applications, how to work with objects, and how to write robust applications by handling exceptions.
- **Part IV, "Sample applications,"** presents several complete sample applications, demonstrating most of the tasks you'll perform when writing your own applications.

Reference material on Delphi and its component library appear in online Help.

The *Delphi Component Writer's Guide* and *Database Application Developer's Guide* are also printed separately. They contain information on how to create your own components for use in Delphi, and how to create database applications, respectively.

Using Help

Delphi's online Help provides a superset of the information presented in the printed manuals. Use online Help to find

- Specific procedural information regarding programming tasks in Delphi
- The language definition of Object Pascal
- Reference material for the Visual Component Library and the Run-Time Library

Using Interactive Tutors

Delphi provides seven Interactive Tutors to help you get up and running quickly:

- A "quick tour" overview of the Delphi programming environment
- A short lesson on how to create a simple application
- A lesson on how to add components to a form
- A lesson on setting component properties
- A lesson on creating and modifying event handlers

- A lesson on creating a simple database application
- A lesson on creating a more sophisticated database application

Manual conventions

The printed manuals for Delphi use the typefaces and symbols described in Table Intro.1 to indicate special text.

Table Intro.1 Typefaces and symbols in these manuals

Typeface or symbol	Meaning
`Monospace type`	Monospaced text represents text as it appears onscreen or in Object Pascal code. It also represents anything you must type.
[ ]	Square brackets in text or syntax listings enclose optional items. Text of this sort should not be typed verbatim.
Boldface	Boldfaced words in text or code listings represent Object Pascal reserved words or compiler options.
Italics	Italicized words in text represent Object Pascal identifiers, such as variable or type names. Italics are also used to emphasize certain words, such as new terms.
Keycaps	This typeface indicates a key on your keyboard. For example, "Press *Esc* to exit a menu."
■	This symbol indicates the beginning of a procedure. The text that follows describes a set of general steps for performing a specified kind of task.
➤	This symbol indicates a specific action you should take, such as a step in an example.

Contacting Borland

The Borland Assist program offers a range of technical support plans to fit the different needs of individuals, consultants, large corporations, and developers. To receive help with this product send in the registration card and select the Borland Assist plan that best suits your needs. North American customers can register by phone 24 hours a day by calling 1-800-845-0147. For additional details on these and other Borland services, see the Borland Assist Support and Services Guide included with this product.

Part

I

Getting started with Delphi

The single chapter making up this part, **"Introducing Delphi,"** introduces the Delphi integrated development environment (IDE), and discusses basic concepts and techniques for creating Delphi applications.

Chapter

1

Introducing Delphi

Delphi is a component-based application development environment supporting rapid development of highly efficient Microsoft Windows-based applications with a minimum of coding. Many of the traditional requirements of programming for Windows are handled for you within the Delphi class library, shielding you from complicated, or merely repetitive programming tasks.

Delphi provides design tools such as application and form templates, so you can quickly create and test your application prototype. Then, by using Delphi's rich component set and intuitive code generation, you can turn your prototypes into robust applications that fit your business needs.

Delphi's database tools enable you to develop powerful desktop database and client/ server applications and reports. You can view "live" data at design time, so you know immediately whether your query results are what you want.

This chapter introduces the following topics:

- The Delphi programming environment
- Elements of the Delphi interface
- The Delphi development model
- Overview of Delphi projects
- Setting environment preferences

The Delphi programming environment

This section briefly describes the elements of the Delphi programming environment. You can also learn about Delphi by

- Running the "A Quick Look at Delphi" Computer-based Training (choose Help | Interactive Tutors from the Delphi menu bar)
- Viewing Help topics (choose Contents, or Topic Search from the Help menu)

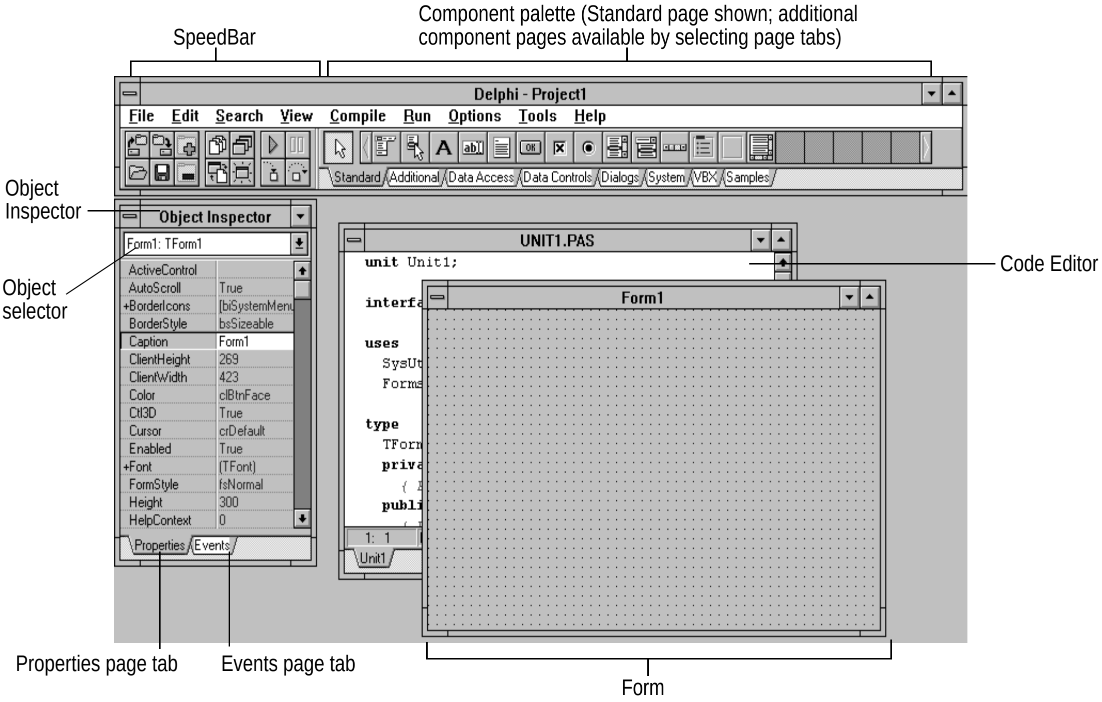
- Choosing context-sensitive help (*F1*) for a particular part of the interface.

Starting Delphi

You can start Delphi the same way you start any Windows-based application:

- Double-click the Program Item for DELPHI.EXE that was created by the Install program.
- Use File Manager to locate and double-click the DELPHI.EXE file (if you performed a default installation, this file is located in your DELPHI\BIN directory).
- Choose Run from the Program Manager File menu, and specify the path to DELPHI.EXE.
- Start Delphi from the command line: WIN DELPHI (assuming Windows is in your path statement).

Figure 1.1 The Delphi programming environment


SpeedBar
Component palette (Standard page shown; additional component pages available by selecting page tabs)
Object Inspector
Object selector
Code Editor
Properties page tab
Events page tab
Form
Delphi - Project1
File Edit Search View Compile Run Options Tools Help
Standard Additional Data Access Data Controls Dialogs System VBX Samples
Object Inspector
Form1: TForm1
Properties Events
UNIT1.PAS
1: 1
Unit1
Form1

ActiveControl	
AutoScroll	True
+BorderIcons	[biSystemMenu
BorderStyle	bsSizeable
Caption	Form1
ClientHeight	269
ClientWidth	423
Color	clBtnFace
Ctl3D	True
Cursor	crDefault
Enabled	True
+Font	(TFont)
FormStyle	fsNormal
Height	300
HelpContext	0

```
unit Unit1;

interfa

uses
  SysUt
  Forms

type
  TForm
  priva
    { P
  publi
```

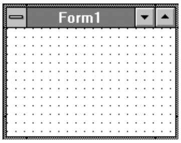
Elements of the Delphi interface

The elements of the Delphi programming environment were designed to provide you with the tools you need to quickly and intuitively develop high-performance applications. This section briefly describes each element. For more information, choose Programming Environment from the contents screen of online Help.

Elements visible upon starting Delphi

While many elements are visible as soon as you start Delphi, some others are not visible until needed, or until you activate them through menu commands or other actions. This section describes those interface elements that you can see right away when you start Delphi.

Form



Forms are the focal point of nearly every application you develop in Delphi. You use the form like a canvas, placing and arranging *components* on it to design the parts of your user interface. Components are the building blocks of Delphi applications. They appear on the Component palette, displayed in the top right-hand part of the screen (see Figure 1.1).

You can think of a form as a component that can contain other components. Your application's main form and its components interact with other forms and their components to create your application interface. The main form is your application's main interface; other forms can include dialog boxes, data entry screens, and so on.

You can resize the form and move it anywhere on your screen. A form includes standard features such as

- Control menu
- Minimize and maximize buttons
- Title bar
- Resizeable borders

You can change these features, as well as other *properties* of the form by using the Object Inspector to edit the form during *design time*—the time during which you are designing, rather than running, your form. Properties define a component's appearance and behavior.

Form tools

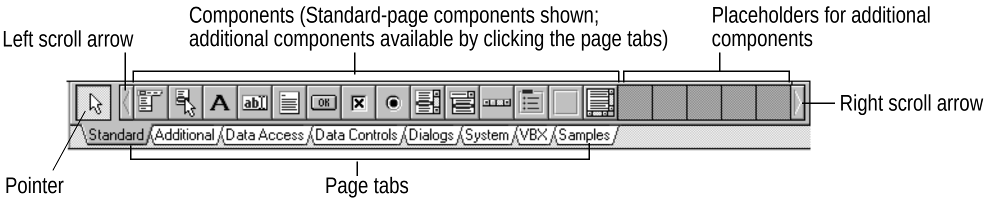
Forms created in Delphi can be reused among Delphi projects, and can also be saved as dynamic-link libraries (DLLs) so you can load them into projects built with other applications such as C++, Paradox, dBASE, Visual Basic, and PowerBuilder.

Delphi provides several development tools that make generating productive forms and reports easier than ever:

- *Project Templates* provide a selection of several application designs that you can use as a starting point when building your own applications. You can save your own projects as Project Templates.
- *Form Templates* enable you to choose from an array of predesigned forms when developing your user interface. You can save your own forms as Form Templates.
- *Project Experts* develop projects for you based on your specified preferences, according to general project categories.
- *Form Experts* develop custom forms for you based on your specified preferences. For example, the *Database Form Expert* generates a form that displays data from an external database (for more information, see the book *Building Database Applications with Delphi*).

For more information about creating forms, see Chapter 3; for more information about working with projects, see Chapter 4.

Component palette


Left scroll arrow
Components (Standard-page components shown; additional components available by clicking the page tabs)
Placeholders for additional components
Right scroll arrow
Standard
Additional
Data Access
Data Controls
Dialogs
System
VBX
Samples
Pointer
Page tabs

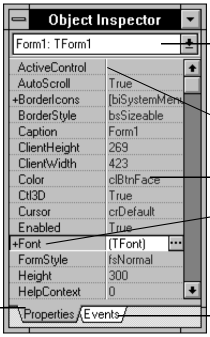
Components are the elements you use to build your Delphi applications. They include all the visible parts of an application, such as dialog boxes and buttons, as well as those that aren't visible while the application is running, such as system timers or Dynamic Data Exchange (DDE) servers.

Delphi components are grouped functionally on the different pages of the Component palette. For example, components that represent the Windows common dialog boxes are grouped on the Dialogs page of the palette.

You can create your own custom components and install them onto the Component palette, making the Delphi environment fully extensible. There is no difference in usability between the components you create yourself and those that ship with Delphi. You can also install Visual Basic (VBX) controls and third-party components. And the Component palette itself is configurable and scrollable, so you can select how you want components to be displayed in the palette.

The specific components provided with Delphi are discussed in Chapter 2 and in online Help under the search word "Component Palette." For information about how to configure the palette, see Chapter 2.

Object Inspector



ActiveControl	
AutoScroll	True
+BorderIcons	[biSystemMenu
BorderStyle	bsSizeable
Caption	Form1
ClientHeight	269
ClientWidth	423
Color	clBtnFace
Ctl3D	True
Cursor	crDefault
Enabled	True
+Font	(TFont)
FormStyle	fsNormal
Height	300
HelpContext	0

Object selector (shows name and type of selected object)

Movable column separator (drag horizontally to resize columns)

Value column

Nested property (double-click to view subproperties)

Properties page

Events page

The Delphi Object Inspector enables you to easily customize the way a component appears and behaves in your application. The properties and events of the component that is selected in the form are displayed in the Object Inspector.

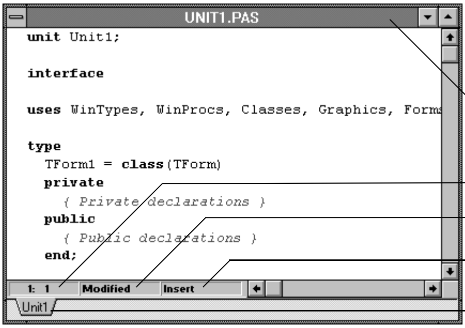
You use the Properties page of the Object Inspector to customize components you've placed on a form (or the form itself), and the Events page to generate and navigate among certain parts of program code, called *event handlers*. Event handlers are specialized procedures.

- To keep the Object Inspector visible at all times, right-click it and choose Stay On Top from the SpeedMenu.

Object selector

The Object selector (the drop-down list at the top of the Object Inspector) displays the name and type of every component in the current form, including the form itself. You can use the Object selector to easily switch among components in the form, or to switch back to the form.

Code Editor



```
unit Unit1;

interface

uses WinTypes, WinProcs, Classes, Graphics, Forms

type
  TForm1 = class(TForm)
  private
    { Private declarations }
  public
    { Public declarations }
  end;
```

Title bar (displays name of file being viewed)

Line/column indicator

Modified indicator

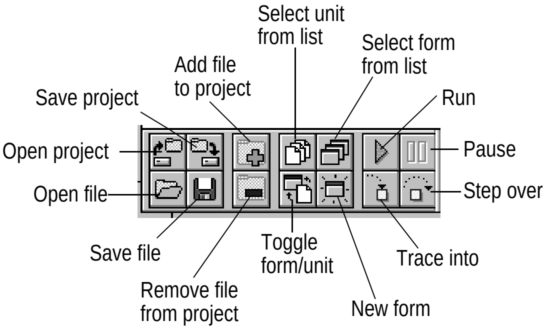
Mode indicator

Page tab

The Delphi Code Editor is a full-featured editor that provides access to all the code in a given application project. The Code Editor includes many powerful features such as Brief-style editing, color syntax highlighting, and virtually unlimited Undo. For information about using the editor, refer to the online Help topic Code Editor.

When you open a new project, Delphi generates a page in the Code Editor for the unit source code (.PAS) file. To view the source code for a particular unit, simply click that file's page tab. The Code Editor title bar displays the name of the file in the active page of the Code Editor.

SpeedBar

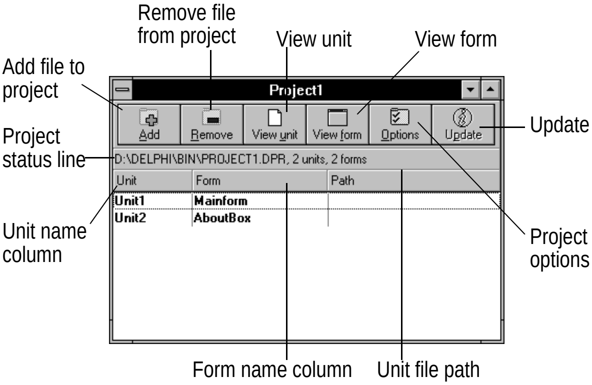


The Delphi SpeedBar, in its default state, provides you with shortcuts to some of the more common commands from the File, Edit, View, and Debug menus. You can configure the SpeedBar to include icons for most Delphi menu commands. For information about customizing the SpeedBar, right-click it and choose the Help command, then refer to the online Help topic SpeedBar. You can resize the SpeedBar by dragging the separator on the right-hand side.

Elements not visible upon starting Delphi

The following elements of the Delphi interface are not visible when you first start Delphi, but you can access them quickly from the menu bar.

Project Manager



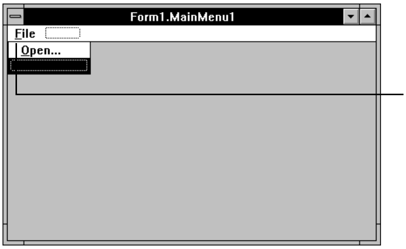
D:\DELPHI\BIN\PROJECT1.DPR, 2 units, 2 forms

Unit	Form	Path
Unit1	Mainform	
Unit2	AboutBox	

The Delphi Project Manager lists the files that make up your application, and enables you to easily navigate among them. You can use buttons on the Project Manager SpeedBar to generate new forms and units, to view files in the current project, and to save modifications to all opened project files. Units are discussed in more detail on page 24; for more detailed information about the Project Manager, see Chapter 4.

- To display the Project Manager, choose View | Project Manager.

Menu Designer



Menu item
(Menu commands appear
below menu items)

The Delphi Menu Designer enables you to easily add menus to your forms. You open the Menu Designer by double-clicking on a MainMenu or PopupMenu component (found on the Standard page of the Component palette) after placing the component on a form. Once the Menu Designer is opened, you can create your own custom menus, or use the predefined menu templates provided with Delphi to insert ready-made menus into your application.

The Menu Designer is discussed in more detail in Chapter 3.

Integrated debugger

Delphi provides a fully integrated debugger so you can debug your source code without exiting the development environment. Your debugging sessions take place in the same visual environment that Delphi provides. The debugger includes many advanced features, including syntactic awareness, expression evaluators, watches, conditional breakpoints, and the ability to view the call stack.

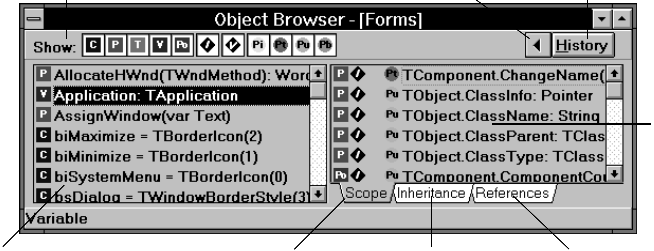
The integrated debugger is discussed in detail in Chapter 8.

ObjectBrowser

Browsing status line

Back

Show browsing history


Object Browser - [Forms]
Show:
C
P
T
V
Pb
Pi
Pt
Pu
Pb
History
AllocateHWnd(TWndMethod): Word
Application: TApplication
AssignWindow(var Text)
biMaximize = TBorderIcon(2)
biMinimize = TBorderIcon(1)
biSystemMenu = TBorderIcon(0)
bsDialog = TWindowBorderStyle(3)
TComponent.ChangeName(
TObject.ClassInfo: Pointer
TObject.ClassName: String
TObject.ClassParent: TClas
TObject.ClassType: TClass
TComponent.ComponentCo
Scope
Inheritance
References
Variable

Details
pane

Inspector pane

Scope page

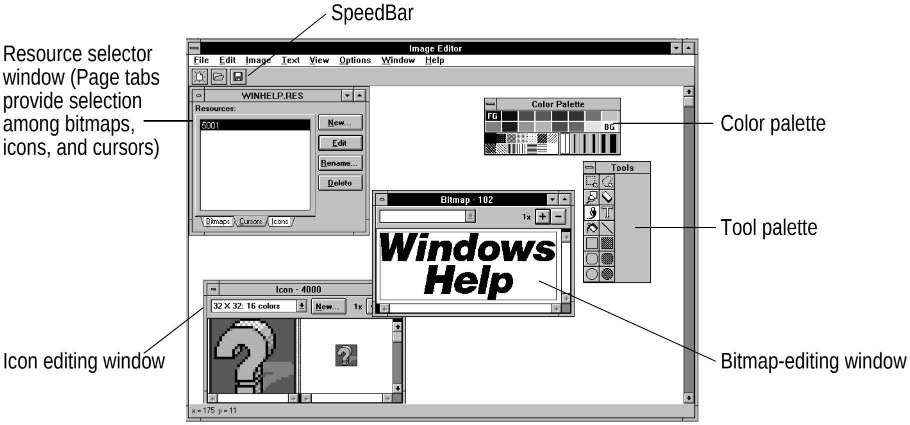
Inheritance page

Reference page

The Delphi ObjectBrowser enables you to visually examine object hierarchies, units, and global symbols your program uses. You need to compile your application with Symbol

Information (enabled by default) in order to enable the Browser item on the View menu. For more information, search online Help for the topic "ObjectBrowser."

Image editor



The Delphi Image editor is a design tool that you can use to create and edit bitmaps, icons, and cursors for display in your application. You can use any Windows-compatible bitmap, icon, or cursor—those in the Image Library shipped with Delphi, those you create in the Image editor, or third-party images you import for use in Delphi.

Note For more information about the Delphi Image Library, search online Help under Image Library.

■ To view the Image editor, choose Tools | Image Editor.

The Delphi development model

This section describes the fundamental steps involved in developing your own custom projects with Delphi. It's also easy to quickly build prototypes by using Delphi templates and database design tools. For more information on using Delphi templates and other rapid form design tools, see Chapter 3 of this book. For more information on developing forms to access your local or remote SQL databases, see *Database Application Developer's Guide*.

This section demonstrates the process of building two simple applications in Delphi. The first application changes the color of your form when you click a button; the second adds and clears text from a list box.

Each example illustrates the following steps, which are common to every application you build with Delphi:

- Designing a form
- Handling events
- Starting a new project

For the full-fledged applications you'll write once you're more familiar with Delphi, you'll perform the additional step of debugging your code. Debugging code is discussed in Chapter 8.

Designing a form

Designing forms is as simple as arranging objects in a window. If you're familiar with a graphical user interface (GUI) environment such as Windows, then you already know how to use the mouse to manipulate objects by selecting, moving, sizing, and so forth. (If you are not familiar with these techniques, consult your Microsoft Windows documentation.) In Delphi, the objects you manipulate are components, and the window is the Delphi form.

This section demonstrates the following concepts:

- Creating a new form
- Adding components to the form
- Setting component properties
- Running the program

Creating a new form

There are several ways to create a new form. When you first start Delphi, if you're running under a default configuration, a new, blank form opens. Other ways of generating new forms are discussed in Chapter 3. In the interest of simplicity, this section assumes a default Delphi configuration.

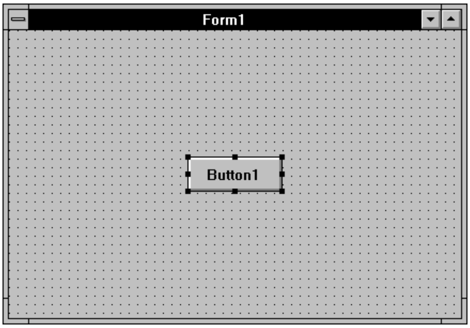
➤ Start Delphi.

Adding components to the form

The first application uses only one component—a button component.

➤ Click the Button component on the Standard page of the Component palette, then click the center of the form to place the button. (Alternatively, double-click the Button component on the Component palette to simultaneously select it and place it in the center of the form.)

The component appears in the center of the form.

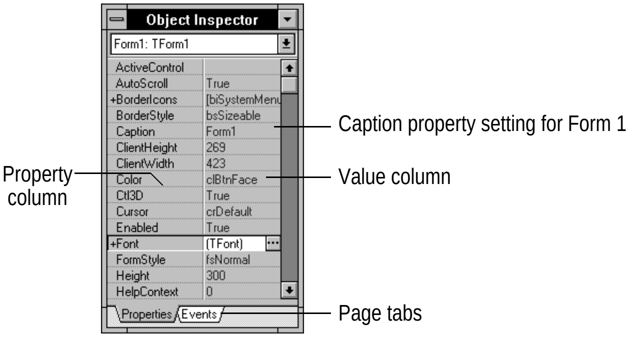


Setting component properties

Delphi makes it easy for you to set *properties*, the attributes that define how components are displayed and how they function in the running application. You use the Object Inspector to set a component's default (initial) properties when you design your application (during *design time*), and the code you enter in the Code Editor can change properties as the application runs (during *run time*).

For example, you probably want the caption—that is, the descriptive label—for both the form and the button to display something more meaningful than Form1, and Button1. You specify the caption you'd like by using the Object Inspector to change the value of the *Caption property*.

Figure 1.2 Object Inspector with Caption property selected



ActiveControl	
AutoScroll	True
+BorderIcons	[biSystemMenu
BorderStyle	bsSizeable
Caption	Form1
ClientHeight	269
ClientWidth	423
Color	clBtnFace
Ctl3D	True
Cursor	crDefault
Enabled	True
+Font	(TFont)
FormStyle	fsNormal
Height	300
HelpContext	0

Caption property setting for Form 1

Property column

Value column

Page tabs

If you wanted the *Caption* property to change as the application runs, you would type the appropriate code in the Code Editor. This is explained more fully under "Handling events" on page 18, and in Chapter 2.

■ To modify a property at design time,

1 In the form, select the component whose property you want to change.

  The Component List displays the name of the selected component.

2 From the Properties page of the Object Inspector, select the property that you want to change.

3 Modify the property by entering a new value.

Most property changes you make at design time are reflected immediately in the form. For more information about setting properties, refer to the online Help topic Setting Properties.

➤ Change the *Caption* property for *Form1* to `'My Demo'`. Then change the *Caption* property for *Button1* to `'Color'`. Notice that as you type, the Caption property for *Form1* and *Button1* display their changing value in the title bar of the form and on the button.

The Name property

The *Name property* identifies the component to the underlying program, and is the name shown in your code. It's good practice to change the *Name* property so that it is descriptive of the component's function, rather than relying on default names like*Form1* or *Button1*.

You can change the *Caption* property by changing the default value of the *Name* property before specifying a caption. The value of the*Name* property is then reflected in the caption. By contrast, changes to the *Caption* property are never reflected back into the *Name* property.

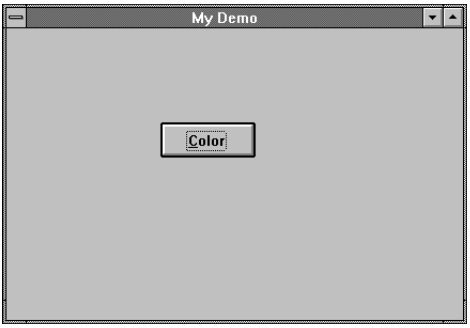
So long as the form *Caption* and *Name* begin with the same value, a subsequent change to the *Name* property is reflected in the *Caption*. If the *Caption* differs from the *Name*, changes to the *Name* do not affect the *Caption*.

Note While the *Caption* property can contain any alphanumeric character of your keyboard, including spaces, this is not the case for the*Name* property. The *Name* property must conform to standard Object Pascal naming conventions. For more information on naming conventions, see Chapter 5.

Running the program

Whenever you add components to a form, Delphi generates supporting code in the background. Likewise, whenever you choose the Run command, Delphi creates a complete standalone .EXE file that runs without any run-time interpreted DLLs. As a result, you can actually compile and run the form just as it is.

➤ Try it now: from the Run menu, choose Run.



Notice that the components in the compiled program behave as you would expect them to. The button appears to "push in" when you click it, and you can resize and move the form. Such behaviors are native to each component; you don't have to program them.

Of course, nothing useful happens when you click the button in this form. That's where your code comes in.

In Delphi, you write code that specifies what your program should do when it detects user interactions such as a button click, or a drag and drop. In programming terms, such user interactions are called *events*.

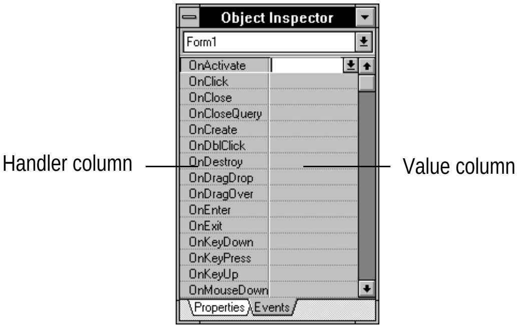
➤ Close the running application by double-clicking the Control-menu box.

Handling events

Events represent user actions (or internal system occurrences) that your application can recognize, such as a mouse click. The code that specifies how a component should respond to an event is called an *event handler*. Every component has certain events to which it can respond.

The Events page of the Object Inspector displays all events associated with the selected component, as shown in the following figure:

Figure 1.3 Events page



You can use the Object Inspector to generate an event handler for the form, or any component you have on the form. When you do so, Delphi generates and maintains parts of the code for you. For example, the following code is the initial “framework” event handler that Delphi generates for the *OnClick* event of *Button1* (the event that occurs when the button is clicked) on *Form1*:

```
procedure TForm1.Button1Click(Sender: TObject);
begin

end;
```

The first line of the event handler names the procedure (*TForm1.Button1Click*) and specifies the parameters it uses (this procedure uses only one: *Sender* of type *TObject*). The code you insert between the **begin..end** block is executed whenever the *OnClick* event occurs.

For this sample application, you’ll handle a button click.

■ To generate an event handler,

1 Select a component, then click the Events tab at the bottom of the Object Inspector.

2 Select an event, and double-click in the right (Value) column.

When you double-click the Value column for an event, Delphi generates an event handler in the Code Editor, and places your cursor inside the **begin..end** block.

3 Inside the **begin..end** block, type the code that you want Delphi to execute when the component receives the event.

- ➤ Generate an event handler for the button’s *OnClick* event, and write the following code inside the **begin..end** block:

```
Form1.Color := clAqua;
```

This specifies that when a user clicks the button, the form’s *Color* property changes to the new value, Aqua.

This is how your completed event handler should look:

```
procedure TForm1.Button1Click(Sender: TObject);
begin
Form1.Color := clAqua;
end;
```

Any time you use the Object Inspector to change the name of this event handler, Delphi maintains that name everywhere it appears in your source code.

- ➤ Try out the event handler you just wrote. Run the program again, and then click the Color button. The form changes color.
- ➤ Close the application.

Starting a new project

You can use the New Project command from the File menu to start a new application project, or to open any of the template applications provided with Delphi.

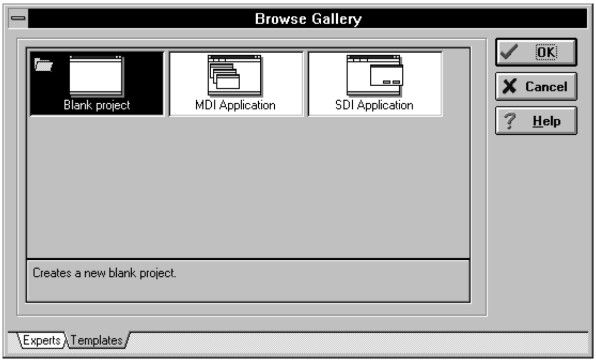
For the next sample application, you’ll start a blank project.

- ➤ To start this project, choose File | New Project.

Depending upon the configuration of the environment, one of two things can happen:

- A new instance of the project designated in the environment as the Default New Project is generated. This is a blank project unless you or another user have configured the Gallery differently using Options | Gallery.
- If the Projects Gallery is enabled in the environment, the Browse Gallery dialog box appears, with the Blank Project option selected, as illustrated in the following figure.

Figure 1.4 Browse Gallery dialog box displaying application templates



Creates a new blank project.

➤ Choose one of the following options:

- If you have an existing project open but you are not using the Gallery, you'll be prompted to save changes. Choose No. A blank form is displayed, just as when you first opened Delphi.
- If you are using the Gallery, double-click the Blank Project selection, and choose not to save changes to any open project. A blank form is displayed, just as when you first opened Delphi.

For this application you'll use two Button components, an Edit component, and a ListBox component.

➤ Add the components to the form, and set any properties as noted in the following table:

Icon	Component	Property	Setting
N/A	Form1	Caption	List Box Demo
OK	Button1	Caption Name Default	&Add AddBtn True
OK	Button2	Caption Name	&Clear ClearBtn
ab	Edit1	Text	(Blank)
☰	ListBox1		

Note The ampersand (&) character is used in button captions and menu items to provide quick keyboard access to the button or menu item (by means of accelerator keys). This technique is explained in more detail in Chapter 3.

Calling procedures and functions from event handlers

So far, this chapter has discussed how to set properties at design time and run time. However, setting properties is only a minor aspect of code development in Delphi. *Procedures* and *functions*, also known as routines, usually constitute the bulk of your program code.

Just as every component can respond to specific events, components in Delphi also have routines that pertain specifically to them. Procedures and functions associated with a component are called *methods*.

You call methods at run time the same way you set properties at run time by writing an event handler. Unlike properties, however, methods are never activated at design time.

To read more about methods, refer to Chapter 5 or see the online Help topic Methods.

This sample application uses the list box's *Add* and *Clear* methods to display and remove text in the list box.

■ To call methods from an event handler, 1 Generate a handler for the component event by double-clicking in the Value column next to the selected event. Delphi generates the initial code in the Code Editor, placing your cursor inside the **begin..end** block.

2 Inside the **begin..end** block, type the method call.

➤ For the sample application, write the following two event handlers:

1 Select *AddBtn*, generate an *OnClick* event handler and type the statement shown inside the **begin..end** block:

```
procedure TForm1.AddBtnClick(Sender: TObject);
begin
Listbox1.Items.Add(Edit1.Text);                             {add this line of code}
end;
```

The code you typed calls the *Add* method of the list box in response to a click on the *AddBtn*. The parameter being passed is the *Text* property of *Edit1*. This specifies that when the user clicks *AddBtn*, any text in *Edit1* is added to the items in the list box.

2 Now generate the *OnClick* event handler for *ClearBtn*, and type the statement shown inside the following **begin..end** block:

```
procedure TForm1.ClearBtnClick(Sender: TObject);
begin
ListBox1.Items.Clear;                                       {add this line of code}
end;
```

This code calls the *Clear* method of the list box in response to the *ClearBtn* click. As you might guess, the *Clear* method clears the text from the list box.

All that's left is to run your program.

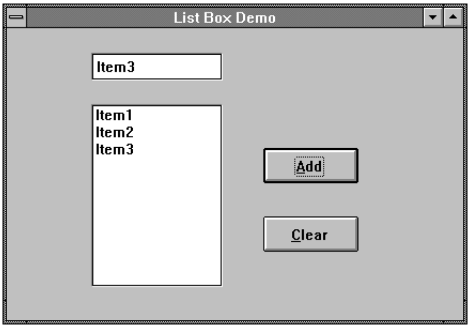
➤ Try this program out:

1 From the Run menu, choose Run.

Delphi compiles your code and runs your program.

2 Add text to the edit box, and then choose the Add button (or press *Alt+A*).

The text you typed in the edit box appears in the list box.



3 Choose the Clear button (or press *Alt+C*).

Any text in the list box is cleared.

Distributing your application

This chapter has shown how easy it is to build and run a simple Delphi application, and the same fundamental techniques apply when you create larger and more sophisticated applications as well. When you run your program, Delphi generates a fully distributable executable (.EXE) file. Unless your application uses dynamic-link libraries (DLLs) you have written, or database files you have created for the application, all you need to distribute the application is just that—the .EXE file. There is no run-time .DLL file required.

Overview of Delphi projects

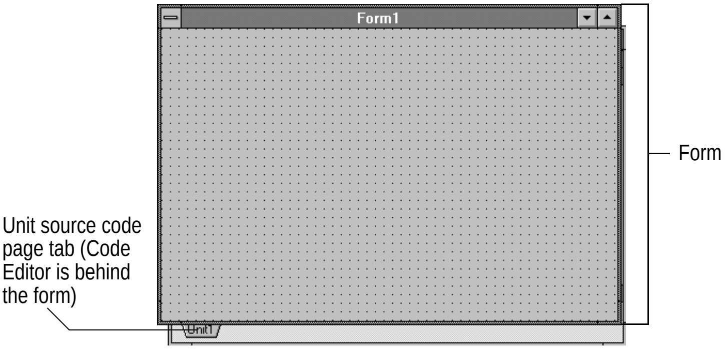
When you create a Delphi application, you can start with a blank project, an existing project, or one of Delphi's application or form templates. A project consists of all the files needed to create your target application.

This section introduces you to the "core" files in a Delphi project. It discusses the following topics:

- The project (.DPR) file
- The unit (.PAS) file
- The form (.DFM) file
- Source code for units without forms

When you first start Delphi, a blank project named *Project1* opens.

Figure 1.5 A default Delphi project



A blank Delphi project initially contains one unit (.PAS) file and one associated form (.DFM) file. The .PAS file contains the Object Pascal source code for the form, and the .DFM file contains binary code that stores the "image" of the form. Together these two files make up the form. For every additional form in a project, there will be a .PAS and .DFM file.

The project (.DPR) file

For each application you develop in Delphi, there is one project (.DPR) file that keeps track of all the unit and form files in the application project.

When you begin a new project, Delphi generates the project file, and maintains this file throughout the development of the project. Initially, the .DPR file consists of

- The default name of the project.

  Delphi provides all new projects with a default name, *Project1*. The project files for template applications have more descriptive names, for example *MDIApp*. You can change the name when you first save the project, or at any time by choosing File | Save As.

- A **uses** clause that lists the units in the project and their associated forms (if any).
- A program block containing the code that executes the application and activates the main application form (by default, *Form1*, the first form created in a project).

Normally, you view the project through the Project Manager, but you can also view the project file as source code, using the Code Editor. For a detailed discussion of project source code, see Chapter 4.

Viewing the .DPR file

You can view the .DPR file to see the units and forms in your current project. Because Delphi maintains the .DPR file, manually editing the .DPR file is not recommended.

■ To view the .DPR file,

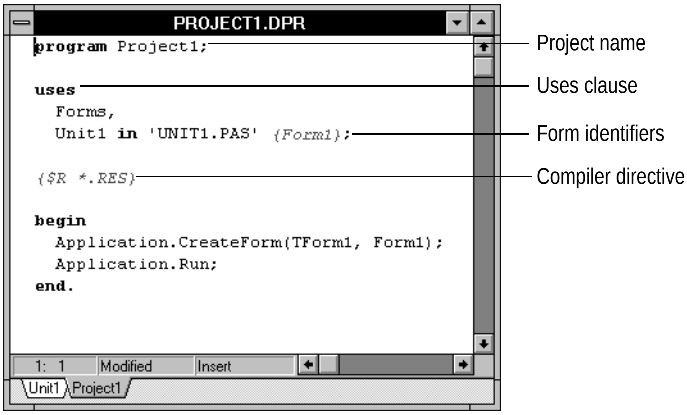
1 Choose View | Units.

The View Unit dialog box appears, displaying a list of the unit(s) in the project, and the (single) project file.

2 Select the name of the project file, and choose OK.

The .DPR file appears in a page in the Code Editor.

Figure 1.6 Default project source code



```
program Project1;

uses
  Forms,
  Unit1 in 'UNIT1.PAS' {Form1};

{$R *.RES}

begin
  Application.CreateForm(TForm1, Form1);
  Application.Run;
end.
```

Project name

Uses clause

Form identifiers

Compiler directive

As you add new forms or units to your project, Delphi automatically adds the appropriate code to the .DPR file.

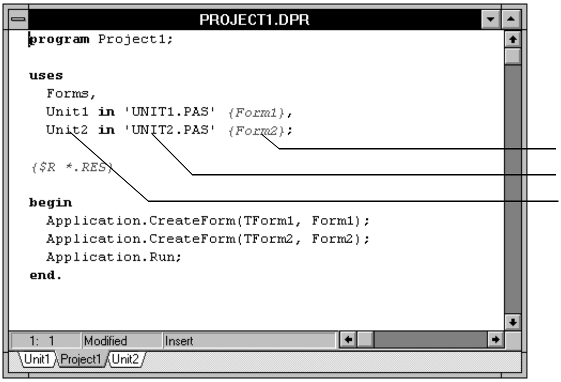
The uses clause in the .DPR file

To illustrate how Delphi maintains the project file, you can view the code Delphi generates when you add a new form to the project.

➤ Try the following:

1 View the project file for *Project1*.
2 Choose File | New Form, and accept the Blank Form option.
3 View the .DPR file again by clicking the *Project1* page tab in the Code Editor. Here's what you should see:

Figure 1.7 Modified project file source code



```
program Project1;

uses
  Forms,
  Unit1 in 'UNIT1.PAS' {Form1},
  Unit2 in 'UNIT2.PAS' {Form2};

{$R *.RES}

begin
  Application.CreateForm(TForm1, Form1);
  Application.CreateForm(TForm2, Form2);
  Application.Run;
end.
```

New form identifier
New unit file name
New unit identifier

Delphi added the identifier for the new unit, *Unit2*, its file name, UNIT2.PAS, and the identifier for its associated form, *Form2*.

The unit (.PAS) file

The unit file is the Object Pascal source code file, saved with a .PAS extension. Initially, the unit file consists of

- The default unit name.

  Delphi provides all new units with a default name (or unit identifier), for example *Unit1*, or *Unit2*. The units in a template application have more descriptive identifiers, for example, *MainForm*. You can change the name when you first save the project, or at any time by choosing File | Save As.

- An **interface** part that contains
  - The **uses** clause for the unit
  - The **type** declaration for the form
  - **public** and **private** sections
  - The declaration of an instance variable for the form

  Just as the **uses** clause in the .DPR file lists the units in the project, the **uses** clause in a .PAS file lists all other units that are accessed, in turn, by this unit. Whenever you generate a new default unit, Delphi automatically adds the library units needed to the unit's **uses** clause. For more information, see page 25.

- An **implementation** part, where the source code for the form appears.
- A program block containing initialization code.

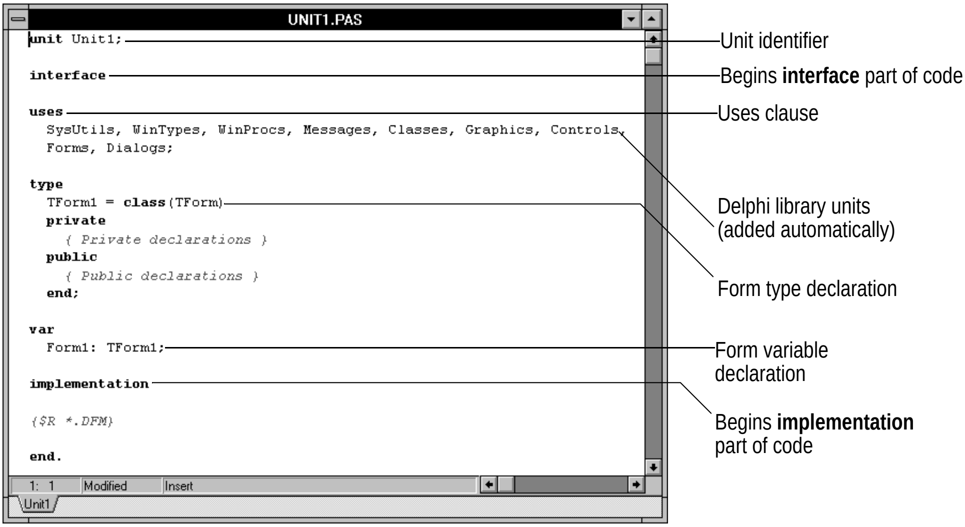
Viewing the .PAS file

You can view any of the unit source code files in your project by selecting the associated page in the Code Editor.

■ To view the unit file source code, click the Code Editor page tab with the name of the unit you want to view. (You can quickly zoom the Code Editor window to view as much code as possible by double-clicking the Code Editor title bar.)

➤ Click the *Unit1* page tab.

Figure 1.8 Default unit source code



```
unit Unit1;

interface

uses
  SysUtils, WinTypes, WinProcs, Messages, Classes, Graphics, Controls,
  Forms, Dialogs;

type
  TForm1 = class(TForm)
  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
  Form1: TForm1;

implementation

{$R *.DFM}

end.
```

UNIT1.PAS
Unit identifier
Begins **interface** part of code
Uses clause
Delphi library units (added automatically)
Form type declaration
Form variable declaration
Begins **implementation** part of code
1: 1
Modified
Insert
Unit1

For a detailed discussion of unit file source code, see Chapter 4.

The uses clause in the .PAS file

As mentioned, Delphi automatically adds the needed library units to the**uses** clauses of the default unit generated when you open a new project or unit. This is the default**uses** clause:

```
uses SysUtils, WinTypes, WinProcs, Messages, Classes, Graphics, Controls, Forms, Dialogs;
```

When you modify a form (discussed further, in following sections) by adding a component to it, Delphi modifies the form unit's **uses** clause by adding the name of the unit in which the component is declared if it does not already appear in the units listed.

➤ For an example of this, try the following.

1 Start a new, blank project.

2 From the Standard page of the Component palette, add a GroupBox component to *Form1*.

3 Run the program.

4 Select the *Unit1* page tab (it is not necessary to exit the running program) and examine the **uses** clause.

   It appears as

```
uses SysUtils, WinTypes, WinProcs, Messages, Classes, Graphics, Controls, Forms,
Dialogs, StdCtrls;
```

Delphi added the *StdCtrls* library unit because that is where the GroupBox component is declared. Similarly, whenever you add a new unit to a project, Delphi adds it to the project's **uses** clause.

When you add new forms to your project, other units in the project might need to reference them or their components or code. In this case, you need to add the new form's unit to the referencing unit's **uses** clause.

The form (.DFM) file

The form is the focal point for programming in Delphi. Whether you're adding components to the form, changing their properties using the Object Inspector, or typing code in the Code Editor for the unit associated with the form, you're really editing the form.

The .DFM file is a binary file, and therefore visible only by its onscreen graphical representation of the form, not normally by any code you directly modify. Any edits you make to the form's visual properties, such as changing the height, color, border, and so forth are stored in the .DFM file and reflected in the form.

Note You can, if you choose, view and edit the form file as text by directly opening it in the Code Editor.

The type declaration in the .DFM file

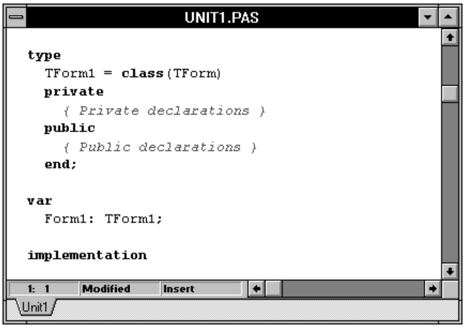
Just as Delphi generates an instance variable for the form, it also generates an instance variable, or field, for every component you add to the form. In this case, though, the form contains the component, so the component declaration appears *inside the form's type declaration*. The same is true for methods (event handlers) of the form. As you add components and event handlers to the form, the form's type declaration expands to include the declarations for each component and method.

For an illustration of this, try the following:

1 Arrange *Form1* and *Unit1* on your screen so that both are visible (resize the form if necessary).

2 Scroll in the Code Editor window until the type declaration for *Form1* is visible.

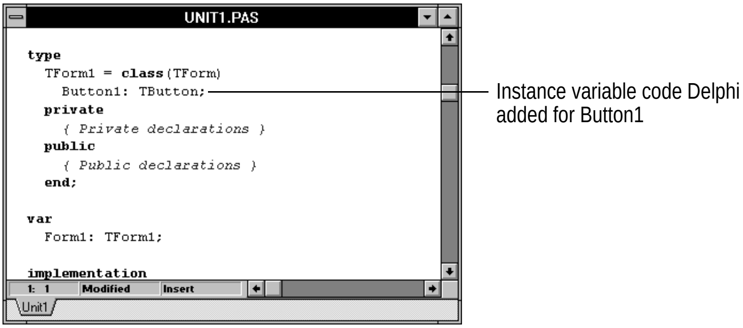
Figure 1.9 Form type declaration



```
type
  TForm1 = class(TForm)
  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
  Form1: TForm1;

implementation
```

3 Add a button component to the form, while watching what happens to the type declaration.

Figure 1.10 Modified type declaration



```
type
  TForm1 = class(TForm)
    Button1: TButton;
  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
  Form1: TForm1;

implementation
```

Instance variable code Delphi added for Button1

If you delete *Button1* from *Form1*, Delphi deletes the button's instance variable, but not any associated methods. For more information, see Chapter 2.

Note No code is generated when you change a component's design-time properties, because those values are stored in the .DFM file. The only exception to this is the *Name* property, as discussed previously. When you use the Object Inspector to change a component's *Name* property, Delphi changes its variable declaration for you to reflect the new name in the underlying code. This is discussed in more detail in Chapter 5.

Source code for units without forms

Although most Delphi units are associated with forms, you may want to create or use units that have no forms associated with them. For example, you might create a separately compilable unit of nonvisual objects, or import a library of certain mathematical functions.

This is the only code that Delphi generates when you add a new unit to a project without adding a form:

```
unit Unit2;
interface
implementation
end.
```

Because there is no need to synchronize the code in these files with an associated form, Delphi does not maintain the code for you. When you write your own units, or import existing units, you need to write the **uses** clause that specifies which other units and forms in your project they need to access. For example, if you want *UnitA* to be able to access methods or forms declared in *UnitB*, you need to add *UnitB* to the appropriate **uses** clause in *UnitA*.

Whenever you add a new unit to your application, however, whether or not it has an associated form, Delphi adds the unit name to the **uses** clause in the .DPR file.

Setting environment preferences

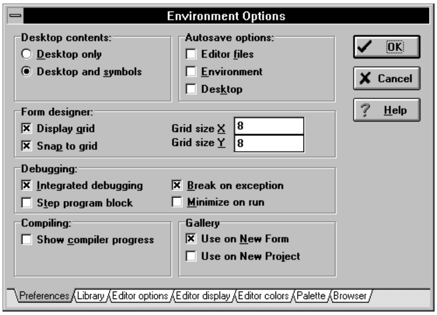
Delphi provides developers with a wide array of options for configuring the integrated development environment (IDE). References to the behavior and appearance of the IDE in this book are based upon the default configuration created by the Delphi installation program. If you are not working with a default installation of Delphi, bear in mind that another user might have modified parts of the IDE configuration.

The Environment Options dialog box provides several pages of configuration options that you can control. Some settings control behind-the-scenes elements such as the path to library files, while others directly affect the appearance and behavior of the Delphi interface—the Grid, Gallery, and Editor options, for example. This section discusses the Preferences page of the Environment Options dialog box, because the settings on this page directly affect the appearance and behavior of the IDE when you first start Delphi, and when you open new projects and forms. (Other pages from this dialog box are discussed elsewhere in this book, together with the topics that relate to their function. Complete information for each page and option is available in online Help for the Environment Options dialog box.)

Accessing environment options preferences

■ To display the Environment Options dialog box, choose Options | Environment from the Delphi menu bar, then choose the Preferences page tab.

Figure 1.11 Environment Options dialog box, Preferences page



Desktop contents:
○ Desktop only
● Desktop and symbols

Autosave options:
□ Editor files
□ Environment
□ Desktop

Form designer:
☒ Display grid
☒ Snap to grid
Grid size X 8
Grid size Y 8

Debugging:
☒ Integrated debugging
□ Step program block
☒ Break on exception
□ Minimize on run

Compiling:
□ Show compiler progress

Gallery
☒ Use on New Form
□ Use on New Project

Gallery options

The check boxes in the Gallery group that appear at the bottom of the Environment Options dialog box are some of the most important options because they control what you see when you open a new form or a new project.

Note The exercises in this and subsequent chapters assume that the Forms Gallery option is enabled, as it is by default when you install Delphi. However, if you share your installation of Delphi, this option might have been disabled by another user. See "Enabling the Gallery options" later in this section.

The Gallery is a collection of Form and Project Templates and Experts supplied with Delphi. (Some versions of Delphi contain more Form Templates and Project Templates than are illustrated in the following figures.) You can develop your own forms and projects to serve as templates for your applications and add them to the Gallery, making it easy to reuse forms, or even entire projects, in new applications. For information on creating form and project templates see Chapter 3 and Chapter 4.

The Use On New Form and Use On New Project check boxes in the Gallery group box control whether the Browse Gallery window is displayed when you create a new form or project in the current or future Delphi work sessions.

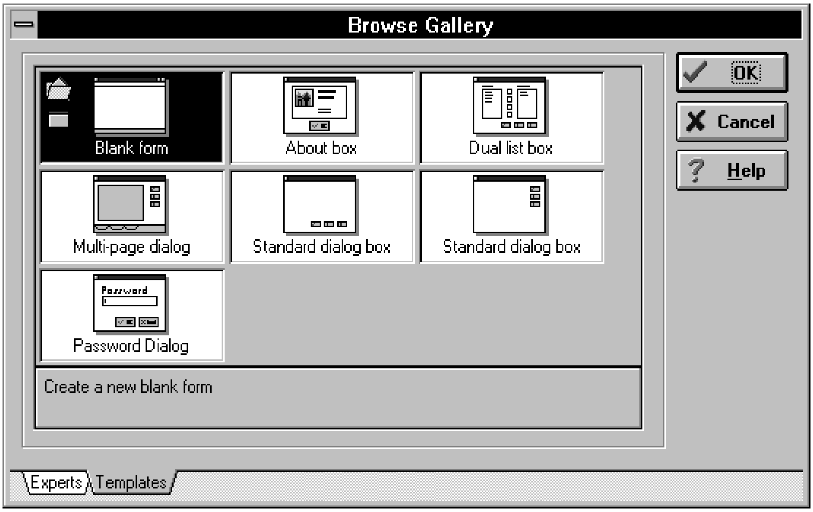
Use On New Form option

When this item is checked in the Environment options dialog box, the Browse Gallery dialog box for forms is displayed whenever you choose New Form from the File menu or Project Manager. You can then select from the Form Templates and Experts currently available. The new form is then built by the Expert or copied from the template and is ready for you to customize or use as is in your project.

If this item is not checked in the Environment Options dialog box, the Gallery is not displayed when you create a new form, and a new blank form is added to the project. The Gallery is still accessible through the Options menu, however. The Forms Gallery is discussed in detail in Chapter 3.

Note This option is *enabled* by default in a new Delphi installation.

Figure 1.12 The Forms Gallery



Create a new blank form

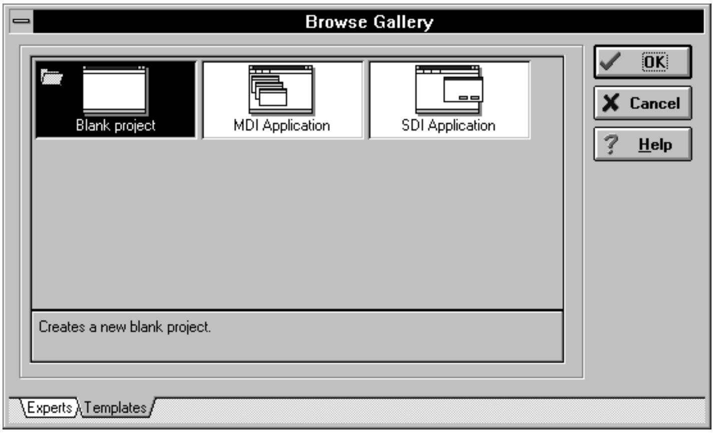
Use On New Project

When this item is checked in the Environment options dialog box, the Browse Gallery dialog box for projects appears whenever you choose New Project from the File menu. You can then select from the available Project Templates and Experts. The new project, including all forms and components, is then built by the selected project Expert or copied from the selected template and is ready for you to customize or use as is.

If this item is not checked in the Environment Options dialog box, the Gallery does not appear when you create a new project. A new blank project is created instead. The Gallery is still accessible through the Options menu as you work on the new project, however.

Note This option is *disabled* by default in a new Delphi installation.

Figure 1.13 The Projects Gallery



Creates a new blank project.

Enabling the Gallery options

Because the exercises in this part of the book assume that all Gallery options are enabled, check now to make sure that they are.

■ To enable the Gallery for new projects and forms,

1. Choose Options | Environment from the Delphi menu bar.
2. In the Gallery group, check the Use On New Form and Use On New Project check boxes if they are not already checked.
3. Choose OK to close the Environment Options dialog box.

Desktop Contents option

The setting of this option in the Environment Options dialog box controls what desktop information is saved when you choose File | Save Project or exit Delphi. It also affects your ability to use the ObjectBrowser, which enables you to step through the object hierarchies, units, and global symbols in your application. (For more information on using the ObjectBrowser, see online Help.)

Desktop Only

Choosing this option saves directory information, open files in the Code Editor, and open windows.

Desktop And Symbols

Choosing this option saves the same information as the Desktop Only option, plus symbol information from the last successful compilation. The ObjectBrowser uses this symbol information to construct the object hierarchy of your application. If you plan to use the ObjectBrowser to analyze your application, you should choose this Environment option.

Autosave Options

These options enable you to specify what files and options are automatically saved when you test run your program from within Delphi, and when you exit Delphi.

Editor Files

Choosing this option saves all *modified* files in the Code Editor. The advantage of this option is that changes to your code are saved whenever you test run your program.

Desktop

Choosing this option saves the arrangement of your desktop. Subsequent Delphi work sessions display the same desktop as the current session.

Form Designer options (grid)

These options control whether the form grid is displayed, whether components snap to the nearest *x,y* grid position, and the spacing of the grid positions. For information on using the grid feature, search online Help for the topic “aligning components.”

Debugging options

These options control debugging processes in the environment.

Integrated Debugging

Enables the Delphi integrated debugger in the environment. Check this option unless working exclusively with programs that have already been debugged.

Step Program Block

This option causes the integrated debugger to stop at the first unit initialization containing debug information.

Break On Exception

Choosing this option causes a running application to stop if an exception occurs and displays the exception class, message, and location. This provides a means for you to step through the exception handlers as if going through the code sequentially.

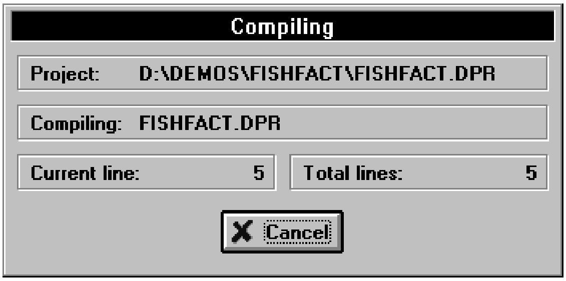
Minimize On Run

Choosing this option minimizes the Delphi IDE whenever you run an application from within Delphi. The IDE returns to a normal state when the running application terminates.

Compiling option

Delphi can display a dialog box showing the progress of the compiler as it compiles your program. To enable this display, check the Show Compiler Progress check box in the Environment Options dialog box. Enabling this option makes the Cancel button in the Compiling dialog box available so you can cancel a compilation in progress.

Figure 1.14 The Compiling dialog box



Compiling

Project: D:\DEMOS\FISHFACT\FISHFACT.DPR

Compiling: FISHFACT.DPR

Current line: 5

Total lines: 5

Summary

This overview introduced the following concepts:

- Elements of the Delphi programming environment interface
- Overview of the Delphi development model, including
  - Setting a component's design time properties by using the Object Inspector

  - Writing event handler code to set properties and call methods during run time
  - Running your application
- Structure of projects in Delphi
- The types of files in a project
- Setting environment preferences to control the behavior of Delphi when selecting New Project or New Form

Part

II

Fundamental skills

The chapters in this part present concepts and skills fundamental to creating Delphi applications. These concepts and techniques are illustrated by simple but functional examples that you can create.

The three chapters making up this part are

- **"Using components and code"**
  This chapter explains the nature of Delphi components, where to find them on the Component palette, how to place them on forms to create user interfaces, and how to attach code to events associated with those components. Additional topics include how to use the Component Expert to create custom components, how to add VBX components to the Delphi Component palette, and how to customize the Delphi Visual Class Library (VCL).
- **"Building form and menus"**
  This chapter explains how to design and create forms for maximum reusability, both within the same project and across multiple projects. Additional topics include how to use the Delphi Menu designer to create and modify Form menus for both Single-Document Interface (SDI) and Multiple-Document Interface (MDI) applications.
- **"Managing projects, files, and directories"**
  This chapter explains how to use the Delphi Project Manager to view and administer the files making up your Delphi project. Additional topics include how to set project and programming environment options, and how to streamline your programming tasks by using Delphi templates.

Chapter

2

Using components and code

This chapter introduces many of the fundamental tasks you'll perform as you build user interfaces with Delphi components. It expands on the concepts introduced in Chapter 1 by showing you how to create a dialog box that you can reuse in different applications. While building the dialog box, you'll find out more about manipulating components in the form (arranging, copying, and so on), and working with code in the Code Editor.

The About box you build in this chapter is available in its completed state as a template in the Delphi Forms Gallery. If you like, you can refer to the completed About box as you learn how to build your own. To open the template, choose File|Open File and select the ABOUT.PAS file in the \DELPHI\GALLERY directory.

This chapter discusses the following topics:

- Delphi components
- Manipulating components in your forms
- Setting component properties
- Working with code
- Customizing the Delphi Visual Component Library (VCL)

Delphi components

The pages of the Component palette display the components Delphi provides to enable you to quickly develop powerful and diverse applications. A large part of interface design consists of using these components to customize the forms that make up your application.

Delphi components include both *visual* and *nonvisual* types. Visual components appear essentially the same in your form at design time as they do at run time. Nonvisual components, on the other hand, are not visible on the form at run time. The MainMenu and Timer components are two examples of nonvisual components. The MainMenu component appears as an icon in your form at design time to give you access to the Menu Designer; but at run time, only the menu you've designed is visible, not the component. A Timer component, on the other hand, provides a visual representation at design time of the function that timers provide to your application—a means of triggering events at measured intervals—while at run time, the timer measures the intervals, but is not a visible part of your interface.

The form component

The form is a component that can contain other components. This makes it different from most other components, and is what makes it useful to you as an area for designing your application interface. (There are other Delphi components that can act as containers within a form. For more information, see "Grouping components" on page 47.)

By default, the form component doesn't appear on the Component palette. However, you can reuse a form by making it into a component that can be installed onto the Component palette. For more information, see the *"Delphi Component Writer's Guide."*

Default Component palette pages

The following tables illustrate the components as they initially appear on each page of the Component palette before any customizing you might choose to perform.

Note The pointer icon appears on each palette page. When the pointer icon is selected, the mouse cursor is shaped like an arrow, enabling you to select from the components in the palette.

Table 2.1 Components on the Standard page

Icon	Visual	Component name	Use to
	N	MainMenu	Design a menu bar and its accompanying drop-down menus for a form.
	N	PopupMenu	Design pop-up (local) menus, available to forms and controls when the user selects the component and clicks the right mouse button.
A	Y	Label	Create a non-windowed control that displays text such as titles, that the user cannot access. Usually this text labels some other control.
ab	Y	Edit	Display an area where the user can enter or modify a single line of text.
	Y	Memo	Display an area where the user can enter or modify multiple lines of text.
OK	Y	Button	Provide a button that users can choose to carry out an operation (for instance, stopping, starting, or cancelling a process).
☒	Y	CheckBox	Present Yes/No, True/False, or On/Off options. Check boxes operate independently of one another; the options presented are not mutually exclusive.
●	Y	RadioButton	Present mutually exclusive options. Radio buttons are usually used in conjunction with group boxes to form groups where only one of the listed options is available at any one time.
	Y	ListBox	Display a list of choices from which the user can select one or more items.

Table 2.1 Components on the Standard page (continued) (continued)

Icon	Visual	Component name	Use to
	Y	ComboBox	Combine the functionality of an edit box and a list box to display a list of choices. Users can either type text into the edit box part or select an item from the list.
	Y	ScrollBar	Provide a way to change which portion of a list or form is visible, or to move through a range by increments.
	Y	GroupBox	Group other related components on a form.
	Y	RadioGroup	Group radio buttons on a form.
	Y	Panel	Group other components, such as speed buttons on a tool bar; also often used to create a status bar.

Table 2.2 Components on the Additional page

Icon	Visual	Component name	Use to
✓OK	Y	BitBtn	Provide a button that can receive and display a bitmap.
	Y	SpeedButton	Provide a button that can be added to a Panel component to create a tool bar. Speed buttons have some unique capabilities that allow them to work as a set.
	Y	TabSet	Create notebook tabs that give your form the appearance of having pages. (Often used with the Notebook component.)
	Y	Notebook	Provide a stack of multiple pages (often used with the TabSet component).
	Y	TabbedNotebook	Create a multi-page form with page tabs at the top.
##I	Y	MaskEdit	Format the display of data or limit user input to valid characters.
	Y	Outline	Display information in a variety of outline formats.
abc	Y	StringGrid	Provide a means for handling strings in columns and rows.
	Y	DrawGrid	Provide a means for displaying non-textual information in columns and rows.
	Y	Image	Display a bitmap, icon, or metafile.
	Y	Shape	Draw geometric shapes: an ellipse, rectangle, or rounded rectangle.
	Y	Bevel	Provide a rectangle, the single lines or entire border of which can appear raised or sunken.
	Y	Header	Provide a sectioned visual control that displays text and allows each section to be resized with the mouse.
	Y	ScrollBox	Provide a scrollable display area (smaller than the form itself). Scroll bars automatically appear at run time if the size of the display exceeds the size of the scroll box.

Table 2.3 Controls on the Data Access page

Icon	Visual	Component name	Use to
	N	Database	Establish and maintain a connection between a Delphi application and a remote database server.
	N	Table	Link a database table with a Delphi application.
	N	Query	Construct, then execute, an SQL query to a local database or remote SQL server.
	N	StoredProc	Provide a means to locally store SQL procedures applicable to a remote SQL database.
	N	DataSource	Provide a conduit for data between a Query or Table component, and data-aware components in your application.
	N	BatchMove	Locally store a queried answer set from a remote database server, locally modify, add, or delete records, and write the updated batch back to the server.
	N	Report	Provide a means for your application to generate and print reports using Borland ReportSmith.

Table 2.4 Components on the Data Controls page

Icon	Visual	Component name	Use to
	Y	DBGrid	Provide a grid in which your application can display data.
	Y	DBNavigator	Provide a means for users to navigate or edit data records displayed by your application.
	Y	DBText	Provide a data-aware version of the Label component.
	Y	DBEdit	Provide a data-aware version of the Edit component.
	Y	DBMemo	Provide a data-aware version of the Memo component.
	Y	DBImage	Provide a data-aware version of the Image component.
	Y	DBListBox	Provide a data-aware version of the ListBox component.
	Y	DBComboBox	Provide a data-aware version of the ComboBox component.
	Y	DBCheckBox	Provide a data-aware version of the CheckBox component.
	Y	DBRadioGroup	Provide a data-aware version of the RadioGroup component.
	Y	DBLookupList	Provide a list-box type lookup list with values from a secondary table.
	Y	DBLookupCombo	Provide a combo-box type lookup of values from a secondary table.

Table 2.5 Components on the Dialogs page

Icon	Visual	Component name	Use to
	N	OpenDialog	Make the Windows Open common dialog box available to the application.
	N	SaveDialog	Make the Windows Save File common dialog box available to the application.
	N	FontDialog	Make the Windows Font common dialog box available to the application.
	N	ColorDialog	Make the Windows Color common dialog box available to the application.
	N	PrintDialog	Make the Windows Print common dialog box available to the application.
	N	PrinterSetupDialog	Make the Windows Printer Setup common dialog box available to the application.
	N	FindDialog	Make the Windows Find common dialog box available to the application.
	N	ReplaceDialog	Make the Windows Replace common dialog box available to the application.

Table 2.6 Components on the System page

Icon	Visual	Component name	Use to
	N	Timer	Provide a measured time interval that can be tied to events.
	Y	PaintBox	Provide a rectangular area of the form to be painted.
	Y	FileListBox	Provide a list box that displays the files in the current directory, and enable users to scroll among them at run time.
	Y	DirectoryListBox	Provide a list box that displays the directories on the current drive, and enable the user to switch among them at run time.
	Y	DriveComboBox	Provide a combo box that displays the current drive, and enable the user to choose a different drive from the drop-down list at run time.
	Y	FilterComboBox	Provide a combo box that displays the current file filter (for example, *.*), and enable the user to select from a list of available filters at run time.
	Y	MediaPlayer	Display a VCR-style control panel for playing and recording multimedia video and sound files.
OLE	Y	OLEContainer	Create an Object Linking and Embedding (OLE) client area in the form.
	N	DDEClientConv	Establish a client connection to a Dynamic Data Exchange (DDE) server application.
	N	DDEClientItem	Specify the (client) data that will be transferred during a DDE conversation.
	N	DDEServerConv	Establish a server connection to the DDE client application.
	N	DDEServerItem	Specify the server data that will be transferred during a DDE conversation.

Table 2.7 Components on the VBX page

Icon	Visual	Component name	Use to
	Y	BiSwitch	Provide a visual toggle switch (similar to a check box).
	Y	BiGauge	Provide a progress indicator for your application.
	Y	BiPict	Display a bitmap, icon, or metafile.
	Y	Chart	Provide charting capability.

Table 2.8 Components on the Samples page

Icon	Visual	Component name	Use to
	Y	Gauge	Display a bar, text, or pie-shaped gauge that serves as a progress indicator.
	Y	ColorGrid	Enable the user to select colors for the elements in the application.
	Y	SpinButton	Provide a means for the user to quickly increment or decrement a value in an edit box.
7	Y	SpinEdit	Provide an integrated combination of a spin control and an edit box.
	Y	DirectoryOutline	Provide a hierarchical listing of the current drive's directory structure.
21	Y	Calendar	Provide a simple monthly calendar grid.

Note The components on the VBX and Samples page are not included in the Delphi Visual Component Library (VCL). They are provided as examples only, and are not formally documented as part of the core product. All components in the VCL are fully documented in online Help. For more information, press *F1* with a component selected in the form.

Installing additional components

The components displayed in the Component palette reflect the contents of a library file that Delphi maintains, initially called COMPLIB.DCL. You can customize this library—and therefore what is displayed on the palette—by adding or removing components from the file. Whenever you customize the library, Delphi rebuilds the library file.

You can also install components such as Microsoft Visual Basic (VBX) controls and other third-party components onto the palette.

Installing components is described in the section "Customizing the Delphi Visual Component Library (VCL)" on page 68.

Manipulating components in your forms

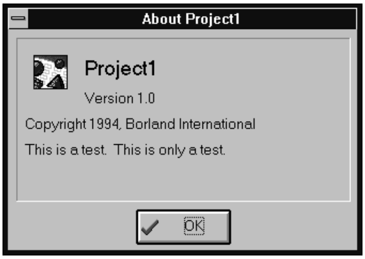
This section demonstrates fundamental skills you need as you work with the components in your forms. If you're comfortable using controls in a graphical user interface (GUI) environment, much of the material discussed here—such as selecting, sizing, and deleting components and so on—might be familiar to you. You might not be familiar, however, with how to perform some of these common operations within the Delphi environment. This section shows you how to do so.

In the context of designing a reusable About box, this section describes such skills as

- Setting form properties
- Adding components to the form
- Selecting components in the form
- Grouping components
- Cutting, copying, and pasting components
- Deleting and restoring components
- Aligning components
- Controlling the creation order of nonvisual components

Note Keyboard support is available for many of the tasks documented here. For more information about keyboard techniques, the online Help topic Form Keyboard Shortcuts.

Figure 2.1 About box



Project1

Version 1.0

Copyright 1994, Borland International

This is a test. This is only a test.

➤ To begin designing the About box, start a new project.

1 Choose File | New Project.

By default, Delphi creates a new, blank project. If you (or another user) have enabled the Project Gallery (see Chapter 3), the Browse Gallery dialog box appears, with the user-specified default project option selected.

2 Choose OK. (This step applies only if you are using the Project Gallery.)

Setting form properties

The first part of creating the dialog box involves setting properties for *Form1*. You were introduced to the notion of properties in Chapter 1. You'll change several form properties, including the form name.

➤ Set properties for *Form1* as described in the following table:

Property	Value
Name	AboutBox
Caption	About
BorderStyle	*bsDialog*
Position	*poScreenCenter*

Changing *BorderStyle* to *bsDialog* removes the form's Minimize and Maximize buttons and makes its borders non-resizable. Changing *Position* to *poScreenCenter* ensures that the dialog box appears in the center of the screen. Note that these changes become visible at run time, not design time.

The Name property

The most important of the properties you just changed is the *Name* property. In fact, the *Name* property is arguably the most important property for all components. Every component in an application must have a unique name, so assigning meaningful names at the outset not only makes your code more readable, but prevents possible name conflicts later.

Component names must follow the standard rules for naming Object Pascal identifiers. If you enter a value that is not consistent with Object Pascal naming requirements, the name reverts to its previous value, and Delphi displays the following error message:

> '<name> is not a valid component name.'

For more information about Object Pascal naming conventions, see Chapter 5.

Caution As mentioned in Chapter 1, so long as you use the Object Inspector to change a component's *Name* property, Delphi maintains your changes in the underlying code. This is not the case, however, if you edit the component name yourself by typing the change directly into the Code Editor. If you manually edit a component name, Delphi will be unable to load your form.

Adding components to the form

When you add components to the form, you can either accept the default component size, or resize the component as you add it. You can also easily add multiple copies of a component.

■ To add a component to the center of the form, simply double-click the component in the Component palette.

If there are already components in the form, additional components are offset (lower and to the right) as you add them, so all the components remain at least partially visible.

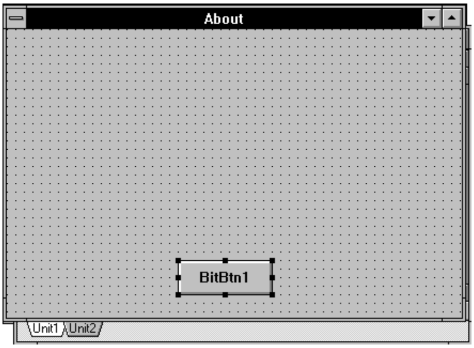
■ To add a component to a specific location in the form,

1. Click the component on the Component palette.
2. Move the cursor to where you want the upper left corner of the component to appear in the form, then click the form.

The component appears in its default size, in the position you clicked on the form.

➤ From the Additional page of the Component palette, add a BitBtn component to the lower center portion of *AboutBox*.

Figure 2.2 AboutBox with BitBtn component



As discussed in Chapter 1, when you add a component to a form, Delphi generates an instance variable, or field, for the component and adds it to the form's type declaration. You've seen how adding a component changes the form's type declaration:

```
type
  TAboutBox = class(TForm)
    BitBtn1: TBitBtn;                          { this is the code that Delphi added }
  end;                                      { some additional code omitted for brevity }
```

Similarly, when you delete a component, Delphi deletes the corresponding type declaration. For more information, see "Deleting event handlers" on page 67.

Sizing a component as you add it

The next component you'll add, an Image component, needs to be larger than its default size. You can resize and move components after they're on the form, or as you place them.

■ To resize a component as you add it,

1. Select the component on the Component palette.
2. Place the cursor where you want the component to appear in the form, then drag the mouse pointer before releasing the mouse button.

   As you drag, an outline appears to indicate the size and position of the control.
3. Release the mouse button when the outline appears as you want it.

➤ Add an Image component (on the Additional page of the palette) to the lower left corner of the form. Drag before you release the mouse button, until the outline is the size you want the image to be.

Later, you'll move the Image component to its final position.

Selecting components in the form

There are several ways to select components in the form; most, but not all, of these methods also apply to components contained by other components, such as the Panel or GroupBox component.

- To select a single component, do one of the following:
  - Click the component in the form.
  - Choose from the Object selector, located at the top of the Object Inspector.
  - With focus in the form, tab to the component.
- To select multiple components, do one of the following:
  - First hold down the *Shift* key, and then click the components, one at a time.
  - Click the form outside one of the components and drag over the other components you want to select. (If the components are inside a Panel or GroupBox component, press *Ctrl*, and then drag.)

    As you drag, you surround the components with a dotted rectangle, or "rubber band." When this rectangle encloses all the components you want to select, release the mouse button. In some cases, you might need to rearrange the components before they can be easily enclosed within a rectangle.

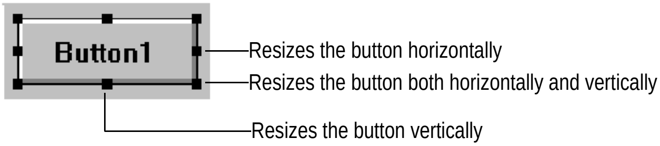
Note Multiple selection applies to all components in the form, including container components and any components they contain; but when the form itself is selected, no other components can be selected along with it.

- To select all components in a form, choose Edit | Select All.

Resizing components in the form

When a component is selected on a form, small squares called sizing handles appear on the perimeter of the component. You can use these handles to resize one or more components.

Figure 2.3 Sizing handles


Button1
Resizes the button horizontally
Resizes the button both horizontally and vertically
Resizes the button vertically

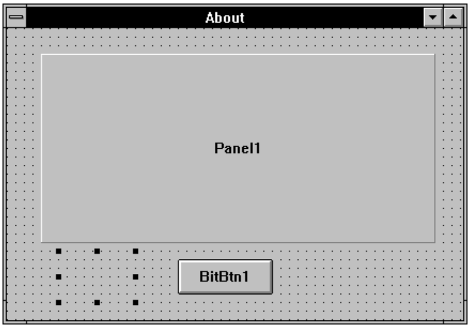
- To resize a single component, select the component on the form, and drag a sizing handle until you are satisfied with the component's size.

  When you release the mouse button, the component is redrawn in the new size.
- To resize multiple components,

1. Select the components you want to resize as a group.
2. Choose Edit | Size to display the Size dialog box.
3. Select appropriate sizing options, then choose OK.

➤ Add a Panel component (from the Standard page of the Component palette), then resize it so that it fills most of the form, without covering the other components, as shown in the following figure:

Figure 2.4 Form with Panel component



Adding multiple copies of a component

You can easily add more than one copy of the same type of component to a form by pressing the *Shift* key before selecting the component. The component remains selected until you select the pointer icon on the Component palette.

■ To add multiple copies of the same component,

1. Press and hold the *Shift* key.
2. Click the component in the palette, then click in the form once for each copy you want of the component. (You don't need to hold down the *Shift* key after the component is selected.)
3. Click the pointer icon to clear the selected component.

   Clicking in the form continues to add the component to the form, as long as the component remains selected in the palette.

➤ Add two Label components to the lower portion of *AboutBox*, to the right of the bitmap button.

Grouping components

Besides the form itself, Delphi provides several components—the GroupBox, Panel, Notebook, TabbedNotebook, and ScrollBox—that can contain other components. These are often referred to as *container components*. You can use these container components to group other components so that they behave as a unit at design time. For instance, you might group components, such as speed buttons and check boxes, that provide related options to the user. You often use container components such as the Panel component to create customized tool bars, backdrops, status lines, and so on.

For more information about creating tool bars and status lines, see Chapter 12, or search online Help under "tool bars" or "status lines."

When you place components within container components, you create a new *parent-child* relationship between the container and the components it contains. Design-time operations you perform on these "container" (or parent) components, such as moving, copying, or deleting, also affect any components grouped within them.

Note The form remains the *owner* for all components, regardless of whether they are *parented* within another component. For more information about the difference between a component's parent and owner, see online Help topics Owner Property and Parent Property.

You generally want to add container components to the form before you add the components you intend to group, as it's easiest to add components that you want grouped directly from the Component palette into the container component.

Once a component is in the form, you can add it to a container component by cutting and then pasting it.

■ To group components,

1 Add a GroupBox or Panel component to the form.
2 Making sure that the container component is selected, add components as you normally would.

   As you add components, they appear inside the container component.

When you double-click a component in the palette, it appears in the middle of whichever eligible receiving component has focus—either the form, or a container component in the form. If you select and then place components, the container component needn't be selected, so long as you click within it when you place the component.

■ To add multiple copies of a component to a container,

1 Press *Shift* and then select a component from the palette.

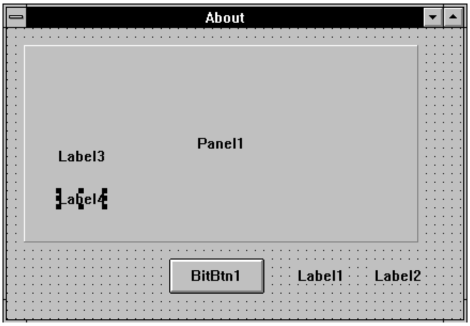
2 Click anywhere in the container component.

   Each subsequent click continues to place the component in whatever eligible receiving component (including the form) is clicked.

3 Select the pointer icon when you have finished adding components.

➤ Add two Label components to the Panel component, as shown in Figure 2.5.

Figure 2.5 AboutBox with Panel and Label components



Cutting, copying, and pasting components

You can cut, copy, and paste components between forms, or between a form and a container component such as a panel or group box. The container component can be on the original form or in another form.

Note When you copy components, you copy their property settings and event-handler associations as well. For example, copying a button with a *Caption* property of *Button1* and an event handler called *TForm1.Button1Click* creates another button with the same *Caption* property and an *OnClick* event handler that calls the code in *TForm1.Button1Click*. However, Delphi renames the copied button so that each button maintains a unique identifier. For an example of this, see "Scope of the Name property" on page 55.

Three general rules apply to all cut, copy, and paste operations:

- You can select multiple components to be cut or copied, but the selection can include only those components within a single parent. That parent can be either a form or a container component within the form, but not both.

  If you individually select components that have different parents and then attempt to cut or copy them, only the components in the parent of the component you first selected are cut or copied. For example, if you first select a button in the form, then select a check box in a panel on the form, and then attempt to cut or copy the two selected components, only the button is cut or copied.

- When you paste one or more components, they appear in whichever eligible receiving component has focus.

- When you cut, copy, or paste a component, any associated event handler code is not duplicated, but the copied component retains associations to the original event handlers.

■ To cut a component or components, select the component(s), then choose Edit | Cut.

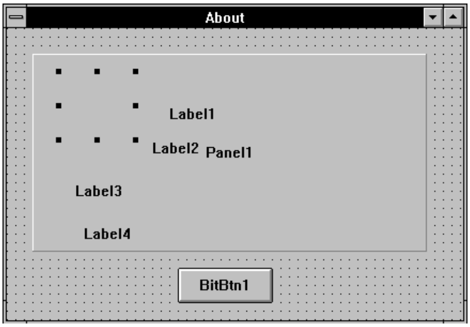
■ To copy a component or components, select the component(s), then choose Edit | Copy.

■ To paste a component or components (assuming you have first placed components on the Clipboard by cutting or copying),

1. Select the form, or other container component where you want the pasted components to appear.
2. Choose Edit | Paste.

➤ Cut the two Label components remaining in the form, and paste them into the panel. Then cut the Image component and paste it into the top left corner of the panel.

Figure 2.6 Panel with Labels and Image components



Deleting and restoring components

Deleting components that have been added to a form is simple, and if you change your mind after deleting a component, you can easily restore that component.

- To delete a component, select the component in the form and press *Del*, or choose Edit | Delete.
- To restore a component that's just been deleted, choose Edit | Undelete.

This restores the component just as it was, including any customizations you might have made to it such as setting properties or writing code.

Caution You must choose Undelete before performing any other operation, or the component are not restored.

Aligning components

You can align components relative to each other, or relative to the form. Once you select the component(s) you want to align, you can use the Alignment palette or the Alignment dialog box to set the alignment. When aligning a group of components, the first component you select is used as a guide to which the other components are aligned.

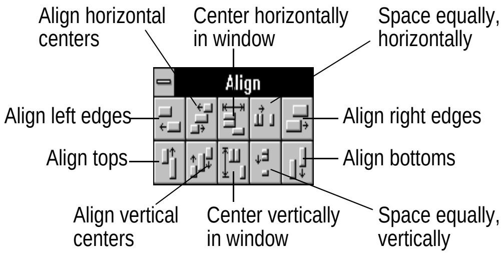
- To align components by using the Alignment palette,

1. Select the component(s).
2. Choose View | Alignment Palette.

   The Alignment palette appears.

3 Select an alignment icon from the palette.

Figure 2.7 Alignment palette


Align horizontal centers
Center horizontally in window
Space equally, horizontally
Align
Align left edges
Align right edges
Align tops
Align bottoms
Align vertical centers
Center vertically in window
Space equally, vertically

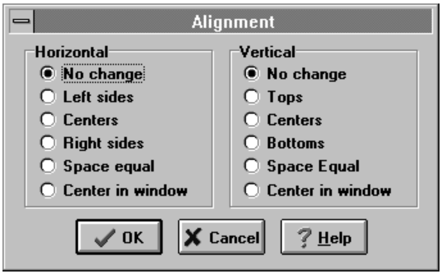
■ To align components by using the Alignment dialog box,

1 Select the component(s).

2 Choose Edit | Align.

The Alignment dialog box appears.

Figure 2.8 Alignment dialog box


Alignment

Horizontal
- ● No change
- ○ Left sides
- ○ Centers
- ○ Right sides
- ○ Space equal
- ○ Center in window

Vertical
- ● No change
- ○ Tops
- ○ Centers
- ○ Bottoms
- ○ Space Equal
- ○ Center in window

3 Select the alignment options you want in the dialog box.

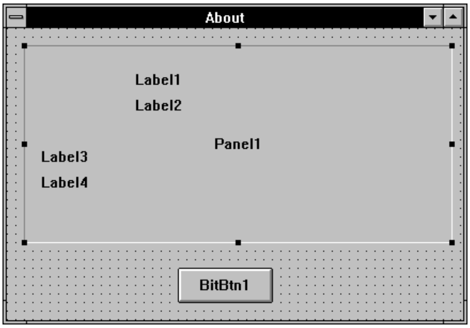
4 Choose OK to put your alignment options into effect.

You can continue to choose or modify alignment options as long as the components remain selected.

For more information about the Alignment palette and the Alignment dialog box, see online Help.

➤ Align the left edges of the top two Label components. Do the same for the bottom two Label components, so the components appear as shown in Figure 2.9.

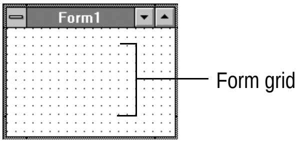
Figure 2.9 Aligned Label components



Using the form grid as an alignment guide

The evenly spaced dots that appear in the form at design time are the form*grid*. The grid makes it easier to align components visually.

Figure 2.10 Form grid



By default, both the grid and its Snap To Grid option, which causes the left and top sides of each component to always align with the nearest grid markings, are enabled at design time. You can, however, choose to disable the Snap To Grid option, or disable the grid altogether.

You can also modify the granularity of the grid—that is, how far apart the grid dots appear.

- To set form grid options, choose Options | Environment to display the Preferences page of the Environment Options dialog box.

The next step in creating the About box involves setting properties for the components you've just arranged.

Locking the position of components

Once you have aligned the components on a form, you can prevent components from being moved accidentally.

- To lock the position of the components on a form, choose Edit | Lock Controls from the Delphi menu bar.

Controlling the creation order of nonvisual components

When you run your Delphi application, Delphi automatically "creates," or loads into memory, all the application forms. When a form is created in memory, all the components encapsulated in the form are created as well. As you will see in Chapter 3, you can control the order in which forms are created at run time, and whether they are created automatically. Similarly, you can control the creation order for nonvisual components. (The MainMenu, PopupMenu, Database, Table, and Query are a few examples of nonvisual components.)

For more information about controlling component creation order, search online Help for Creation order.

Setting component properties

This section discusses different ways you can set component properties at design time, in the context of creating the About box. Table 2.9 lists the properties you will set for the About box.

You can also change property values while an application is running. This is discussed in the section, "Setting properties at run time" on page 59.

For more information about the properties for each component, search online Help for the keyword *components*, or see the topic Visual Component Library Components, and select the component whose properties you want to view. You can also press *F1* with the component selected in the form.

Note The components on the VBX and Samples page of the palette are provided as examples only, not formally part of the Delphi VCL, and therefore are not documented as part of Delphi.

Table 2.9 AboutBox component properties

Component	Property	Value
Panel	*Name*	*BackgroundPanel*
	BevelOuter	*bvLowered*
	Caption	*<Blank>*
Image	*Name*	*ProgramIcon*
Label1	*Name*	*ProductName*
Label2	*Name*	*Version*
Label3	*Name*	*Copyright*
Label4	*Name*	*Comments*
	AutoSize	*False*
	WordWrap	*True*
bitbtn	*Name*	*OKButton*
	Kind	*bkOK*

➤ Change the *Name* property for all the components in the form, as specified in Table 2.9. Notice that as you move from component to component, the *Name* property remains selected in the Object Inspector.

➤ Set the remaining properties, as noted, for *BackgroundPanel*, *Comments,* and *OKButton.*

How the Object Inspector displays properties

As discussed earlier, the Object Inspector dynamically changes the set of properties it displays, based on the component selected. The Object Inspector has several other behaviors that make it easier to set component properties at design time.

- When you use the Object Inspector to select a property, the property remains selected in the Object Inspector while you add or switch focus to other components in the form, provided that those components also share the same property. This enables you to type a new value for the property without always having to reselect the property.

  If a component does not share the selected property, Delphi selects its *Caption* property. If the component does not have a *Caption* property, Delphi selects its *Name* property.

- When more than one component is selected in the form, the Object Inspector displays all properties that are shared among the selected components. This is true even when the value for the shared property differs among the selected components. In this case, the property value displayed are either the default, or the value of the first component selected. When you change any of the shared properties in the Object Inspector, the property value changes to the new value in all the selected components.

  There is one notable exception to this: when you select multiple components in a form, their *Name* property no longer appears in the Object Inspector, even though they all have a *Name* property. This is because you cannot assign the same value for the *Name* property to more than one component in a form.

Tab-jumping to property names in the Object Inspector

Forms and components often have lengthy lists of properties, which can make scrolling through the list in the Object Inspector a bit unwieldy. You can jump directly to a property by pressing the *Tab* key followed by any alphabetic character. This causes the cursor to jump to the Property column of the first property beginning with the typed letter. (The Object Inspector lists property names alphabetically.)

➤ Try using the tab jump feature now.

1. Select the form.
2. In the Object Inspector, select the form's *AutoScroll* property.
3. Press *Tab*, *W* to jump directly to the *Width* property.
4. Press *Tab* again to place the cursor in the Value column, where you can begin entering your edits.

Pressing *Tab* acts as a toggle between the Value column and the Property column. Whenever you are in the Value column (as you are by default when you select a property with the mouse), pressing *Tab* moves you to the Property column. Whenever you are in the Property column, pressing an alphabetic character jumps you to the first property starting with that character.

Displaying and setting shared properties

You can set shared properties to the same value without having to individually set them for each component.

■ To display and edit shared properties,

1 In the form, select the components whose shared property you want to set.

The Properties page of the Object Inspector displays only those properties that the selected components have in common. (Notice, however, that the *Name* property is no longer visible.)

2 With the components still selected, use the Object Inspector to set the property.

➤ To view this in the About box, try the following:

1 Select the bitmap button component.

Notice the properties displayed in the Object Inspector, including the *Name* property.

2 Press *Shift*, then select the Panel component. The bitmap button component remains selected.

Notice how the properties displayed in the Object Inspector change to reflect only properties present in all the selected components. Notice also that the *Name* property is no longer visible.

For information about more ways to set properties at design time, see Setting Properties in online Help.

Scope of the Name property

Because every component in a given form and every form in a project must have a unique name, Delphi assigns default names to the forms and components in your project, and numbers them sequentially as you add them. For example, if you add three buttons to the form, Delphi names them *Button1*, *Button2*, and *Button3*, respectively.

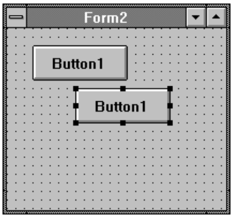
The default names that Delphi generates are defined within the *scope* of each form. In other words, if you have two forms in your application, each form could have a *Button1*. If, however, you add a button named *Button1* to a form that already contains a *Button1*, Delphi renames it to the next available sequential number.

➤ For an illustration of this idea, try the following steps:

1 Choose File | New Form, and add a blank form.
2 Add a button component to *Form2*.
3 Select the button component, and choose Edit | Copy.
4 Choose Edit | Paste.

You'll notice that both buttons maintain their default caption, that is, *Button1*. However, when you inspect the *Name* property, you'll see that Delphi recognized there was already a *Button1* in *Form2*, and consequently changed the *Name* property for the second *Button1* to *Button2*.

Figure 2.11 Form2 with two Button1 component captions



You'll be using *Form2* later in this example to open the dialog box at run time.

➤ Change the name for *Form2* to *MainForm*.

Using property editors

The Object Inspector provides several ways to edit properties at design time. So far, this chapter has described two such ways: directly typing in values, or choosing from a list of pre-existing values. For detailed information about other types of property editors, see the online Help topic Using Property Editors.

The following section illustrates one of the Delphi dialog box editors.

Dialog box editors

With certain properties, double-clicking in the Value column opens a dialog box that you use to set the property. Likewise, with some components, double-clicking the component in the form opens such a dialog box. Properties you edit through a dialog box are often indicated in the Object Inspector by an ellipsis (...) in the Value column beside that property.

The Image component provides an example of a dialog box property editor. When you double-click an Image component in a form, the Picture Editor dialog box appears. You use the dialog box to specify the image you want displayed in the component.

Loading an image

You can use the Image component to load a picture into your form at design time.

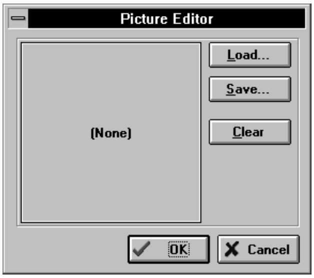
■ To load a picture into a form,

1 Add an Image component to your form.

2 In the form, double-click the Image component.

The Picture Editor dialog box appears.

Figure 2.12 Picture Editor dialog box

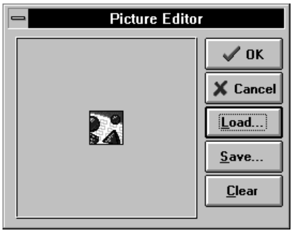


3 Choose the Load button.

4 In the Load Picture dialog box, select the bitmap (.BMP), icon (.ICO), or Windows Metafile (.WMF) you want to display, and then choose OK.

The Picture Editor dialog box reappears, with your image displayed.

Figure 2.13 Image displayed in Picture Editor dialog box

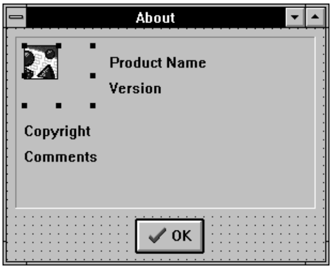


5 Choose OK to accept the image you've selected and exit the Picture Editor dialog box. Or, repeat steps 3 through 5 to choose another picture.

Your image appears in the form at design time.

➤ Load an image file from the Delphi Image Library into the Image component in the About box. (For more information about the Image Library, search online Help under Image Library.)

Figure 2.14 About box with image



Sizing an image

The picture you choose to display in an Image component won't often be the exact size and shape of the component. You can resize either the graphic or the component by choosing from the following methods:

- Use the Delphi Image editor (Tools | Image Editor) to resize the image before importing it into your form.
- Resize the graphic to conform to the size of the component, by setting the *Stretch* property of the Image component to *True*. (*Stretch* has no effect on the size of icon (.ICO) files.)
- Resize the component to conform to the size of the graphic by setting the component's *AutoSize* property to *True* before you load the graphic.

■ To resize a graphic in the form,

1 Resize the Image component according to how large or small you want the image to appear in the form.

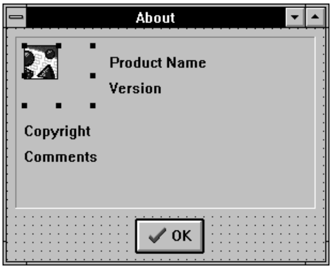
2 With a graphic loaded into the Image component, set the Image component's *Stretch* property to *True*.

Graphics that are larger will shrink to fit, and those that are smaller will expand to fit the Image component.

Note *.ICO file types will not stretch to fill the image area.

➤ Set the *Stretch* property to *True* for the Image component in the About box. The bitmap stretches to fit the component.

Figure 2.15 About box with sized image



Saving your project

Once you've completed your form layout and property settings, you'll probably want to save your work. Since you started with a new project, you could either save the entire project, or just the form.

■ To save just the form (and its associated unit file), choose File | Save File.

■ To save the entire project, choose File | Save Project.

➤ Choose File | Save Project.

You're prompted for a name for each unit (form) in the project, and for the project file itself. If you rely on the form and unit names that Delphi generates automatically, you are likely to experience name conflicts when you reuse those forms and units. On the other hand, if you assign descriptive names like *AboutBox*, you greatly reduce the likelihood of putting two like-named forms into the same project.

You can never be sure what names the forms and units in future projects will have, but if you consistently use descriptive names, it's much easier for you and other developers using your forms to find and use them without conflicts.

➤ Use the following names:

Default name	**Change to**
UNIT1.PAS	ABOUT.PAS
UNIT2.PAS	MAINFORM.PAS
PROJECT1.DPR	MYPROJ.DPR

Each file must have a unique prefix, even though their extensions can be different. For example, if you specify About as the file name for both the form and project file, Delphi displays the following error message:

> The project already contains a module named About.

If you see this error message, Delphi won't save the project file (or whichever file you named secondly). Simply rename the file by saving it again with a different name.

Setting properties at run time

Any property you can set at design time can also be set at run time by using code. There are also properties that can be accessed only at run time. These are known as *run-time-only* properties.

As you've seen, when you use the Object Inspector to set a component property at design time, you follow these steps:

1. Select the component.
2. Specify the property (by selecting it from the Properties page).
3. Enter a new value for that property.

Setting properties at run time involves the same steps: in your source code, you specify the component, the property, and the new value, in that order. However, run-time property settings override any settings made at design time.

Using properties to customize forms at run time

When you include a form, such as a dialog box, in several projects, you should avoid making design-time changes to the form that might conflict with the use of the form in another project. Instead, write code that changes the form's properties at run time.

For example, the caption of an About box generally includes the name of the program that uses it. If you use the same About box in several projects simultaneously, you don't want to accidentally use the name from another application.

The following section discusses how to customize the caption of the About box at run time. To do so, you'll use the Object Inspector and the Code Editor to generate, locate, and modify an event handler.

Working with code

In Delphi, almost all the code you write are executed, indirectly or directly, in response to an event. As noted, such code is called an event handler. Event handlers are actually specialized procedures.

In Delphi, you usually use the Object Inspector to generate event handlers. Of course, you can write source code in the Code Editor without using the Object Inspector. For example, you might write a general-purpose routine that's not associated directly with a component event, but that is called by an event handler. You can also write event handlers manually, but any time you can use the Object Inspector, you should. The Object Inspector not only generates the event handler name for you, but if you change that name later by using the Object Inspector, Delphi changes it everywhere that it occurs in your source code. This is not the case for event handlers you write without using the Object Inspector.

This section discusses ways to use the Object Inspector and the Code Editor to generate and navigate your source code. It describes this in the context of testing and using the About box at run time. The following topics are explained:

- Generating the default event handler
- Working with the Code Editor
- Locating an existing event handler
- Associating an event with an existing event handler

Generating the default event handler

In Chapter 1, you saw how to use the Object Inspector to generate an event handler. You can also generate an event handler for most components simply by double-clicking the component in the form. This generates a handler for the *default* event of that component, if one exists. The default event is the one the component most commonly needs to handle at run time. For example, a button's default event is the *OnClick* event.

■ To generate a default event handler, double-click the component in the form.

Note Certain components, such as the Timer or the Notebook, don't need to handle user events. For these components, double-clicking them in the form doesn't generate an event handler. Double-clicking certain other components, such as the Image component or either of the menu components, opens a dialog box where you perform design-time property edits.

Displaying the form as a dialog box

Unlike the main form of an application, dialog boxes are temporary windows that generally remain invisible until the user opens them. The main form of an application is generally the form that users first see when they run the application. (For more information about application forms, see Chapter 3.)

So far, you've been designing the About box as the application's main form, so you can run it without writing any code and have it appear immediately. To view it as a dialog box, as it would probably appear in a "real world" application, you first need to specify another form as the application's main form.

➤ Change the main form for *MyProj* to *MainForm*.

1 Choose Options | Project.
2 Select the Forms page tab.
3 Open the drop-down list next to Main form, and select *MainForm*.

For more information about changing the application's main form, see Chapter 3.

In this example, you'll write one line of code that enables you to "open" the About box at run time. A quick way to do this is to add a button to the main form and write code to open the dialog box when the user clicks the button. In a real application, you'd usually open an About box in response to a click on a menu item, but for a quick test, it's easier to add a command button.

Since you've already added buttons to *MainForm*, all you need to do is generate the event handler and write the code that displays the dialog box.

➤ To test the dialog box,

1 Double-click *Button1* (in *MainForm*) to generate the default event handler.

2 Inside the **begin..end** block, add the following line of code to execute the dialog box by calling its *ShowModal* method:

```
AboutBox.ShowModal;
```

The *ShowModal* method displays the About box modally, meaning the user must explicitly close this dialog box before performing any other action. For more information about modal versus modeless dialog boxes, see Chapter 3.

3 Add the *About* unit to *MainForm*'s **uses** clause. (For detailed information, see Chapter 1.)

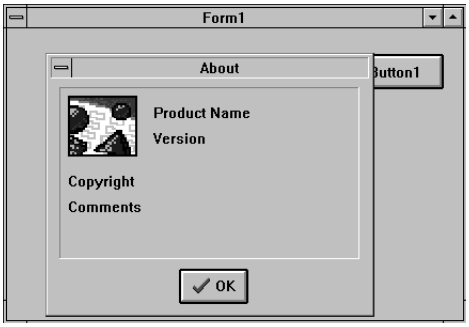
4 Compile and run the application.

The main form appears.

5 Click Button1.

The About box appears as designed, in the center of the screen.

Figure 2.16 Run-time About box



6 Click OK.

Clicking OK closes the dialog box automatically because, at design time, you set the button's *Kind* property to *bkOK* and the border style to *bsDialog*.

Working with the Code Editor

Using the Delphi Code Editor, you can easily view and modify your source code. You can also open related data files inside the Code Editor.

When you open a new project, Delphi automatically generates a page in the Code Editor for the initial form unit file. When you add a new form, unit, or other file to the project, Delphi adds a new Code Editor page to contain the associated source code or other data.

Viewing pages in the Code Editor

When a page of the Code Editor is displayed, you can scroll through all the data it contains, not just particular sections of your code. When entering and editing your source code, you can easily switch between viewing the form and viewing code to see how your design changes your code, and vice versa.

■ To view a page in the Code Editor, choose from the following methods:

- Click the tab for the page you want to view.
- Press *Ctrl+Tab* to move forward through the Editor pages, and *Shift+Ctrl+Tab* to move backward.
- Choose View | Units to open the View Unit dialog box, and choose the unit you want to view.
- Use SpeedBar buttons to display the current unit, or to open the View Unit dialog box.

When viewing a page in the Code Editor, you can return to the form associated with the current Code Editor page or to a different form at any time.

■ To return to the form, choose from the following methods:

- Click any part of the form that is visible under the Code Editor page.
- Choose View | Form to open the View Form dialog box, and choose the form you want to view.
- Use Speedbar buttons to display the current form, or to open the View Form dialog box.

Note Remember that simply toggling from viewing a unit to viewing a form returns you to the form associated with the selected page tab in the Code Editor. This might not necessarily be the form you were previously viewing.

Locating an existing event handler

Once you've generated an event handler, it's easy to locate it in the Code Editor.

■ To locate an existing event handler in the Code Editor,

1 In the form, select the component whose event handler(s) you want to locate.
2 In the Object Inspector, display the Events page.
3 In the Events column, double-click the event whose code you want to view.

Delphi displays the Code Editor, placing your cursor inside the **begin..end** block of the event handler. You can now modify this event handler.

Locating default event handlers

If you generated a default event handler for a component by double-clicking it in the form, you can locate that event handler in like fashion.

■ To locate an existing default event handler, double-click the component in the form.

➤ Double-click *Button1* in *MainForm*.

The Code Editor opens, with your cursor at the start of the first line of code for the *Button1 OnClick* event handler.

Modifying an existing event handler

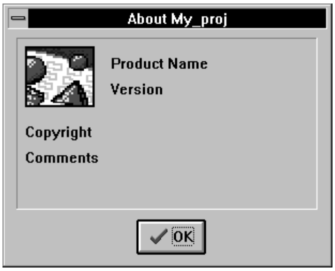
Once you know how to locate an event handler in the Code Editor, it's easy to modify it. For the purposes of the About box, for example, you might customize the About box caption before calling the *ShowModal* method to open the dialog box. To do so, you'd add a line of code to the event handler you wrote for the *Button1 OnClick* event.

➤ Modify the existing *Button1 OnClick* (default) event handler so that it looks like the following:

```
procedure TForm1.Button1Click(Sender: TObject);
begin
  AboutBox.Caption := 'About '+ Application.Title;          { use the application's name }
  AboutBox.ShowModal;                                          { then open the dialog box }
end
```

➤ Run the program again. The About box caption displays the name of the project file.

Figure 2.17 About box displaying program name in form title bar



Note The *Title* property for an application, which is displayed when the application is minimized as an icon, defaults to the name of the project (.DPJ) file. However, you can change this property by means of the Application page of the Project Options dialog box. For more information, see Chapter 4.

Associating an event with an existing event handler

Delphi emphasizes reuse at all levels of application development, from the project, to the form, to components and code. You can reuse code by writing event handlers that handle more than one component event.

You can do this in the case of generic event handlers that, for example, are called by both a menu command and an equivalent button on a SpeedBar.

Once you write one such event handler, you can easily associate other compatible events with the original handler.

To illustrate this concept, you'll add an **if..then..else** statement to the *OnClick* event handler for *MainForm.Button1*. Then you'll associate the event handler with *MainForm.Button2*.

Using the Sender parameter

The *Sender* parameter in an event handler informs Delphi which component received the event, and therefore called the handler. You can write a single event handler that responds to multiple component events by using the *Sender* parameter in an **if..then..else** statement.

For another example of code that uses the *Sender* parameter see Chapter 10. For more information about these and other Object Pascal language statements, see Chapter 5.

➤ Add an **if..then..else** statement to the existing *OnClick* handler for *MainForm.Button1* so that it looks like the following:

```
procedure TMain1.Button1Click(Sender: TObject);
begin
if Sender = Button1 then                                {this is the first line you add}
  AboutBox.Caption := 'About ' + Application.Title       {remove the existing semicolon}
else AboutBox.Caption := '';                           {this is the second line you add}
AboutBox.ShowModal;
end;
```

Now you'll associate *MainForm.Button2*'s *OnClick* event with this handler.

■ To associate a new component event with an existing event handler,

1 In the form, select the component whose event you want to code.

2 Display the Events page of the Object Inspector, and select the event to which you want to attach handler code.

3 Click the down arrow next to the event to open a list of existing event handlers.

The list shows only the event handlers in this form that can be assigned to the selected event.

4 Select from the list by clicking an event handler name.

The code written for this event handler is now associated with the selected component event.

➤ Select *Button2* and associate it with *Button1Click*.

Note Delphi doesn't duplicate the event handler code for every component event associated with a shared handler. You see the code for shared handlers in the Code Editor only once, even though the same code is called whenever any of the associated component events occurs.

➤ Run the program again and click *Button1*. The application title appears in the About box caption. Now, close the About box and click *Button2* in the main form. The About box opens but does not display the application title.

Displaying and coding shared events

There is another way to share event handlers. When components have events in common, you can select the components to display their shared events, select a shared event, and then create a new event handler for it, or select an existing one. All the selected components will now use this event handler.

To demonstrate this, you'll add a speed button to *MainForm* that calls the same *OnClick* event handler as *Button1* and *Button2*. Then you'll modify the shared event handler to display a different icon in the About box Image component.

■ To display shared events,

1 In the form, select all the components whose common events you want to view.
2 Display the Events page of the Object Inspector.

The Object Inspector displays only those events that pertain to all the selected components. (Note also that only events in the current form are displayed.)

■ To associate a shared component event with an existing event handler,

1 Select the components with which you want to associate a shared event handler.

2 Display the Events page of the Object Inspector, and select an event.

The Object Inspector displays only those events which the selected components have in common.

3. From the drop-down list next to the event, select an existing event handler, and press *Enter*.

   Whenever any of the components you selected receives the specified event, the event handler you selected is called.

■ To create an event handler for a shared event,

1. Select the components for which you want to create a shared event handler.
2. Display the Events page of the Object Inspector, and select an event.
3. Type a name for the new event handler and press *Enter*, or double-click the Handler column if you want Delphi to generate a name.

   Delphi creates an event handler in the Code Editor, positioning the cursor in the **begin..end** block.

   If you choose not to name the event handler, Delphi names it for you based on the order in which you selected the components. For example, if you create a shared event handler for several buttons, Delphi names the event handler *Button<n>Click*, where *Button<n>* is the first button you selected for sharing an event handler.
4. Type the code you want executed when the selected event occurs for any of the components.

➤ To see an example of these concepts, perform the following steps:

1. Add a SpeedButton component to *MainForm*.
2. In *MainForm*, select *Button1*.
3. Display the Events page of the Object Inspector.

   Note the events displayed.
4. Press and hold *Shift* while you select the speed button.

   Note how the events displayed dynamically change to show only events shared by the two components.
5. Select the *OnClick* event, and from the drop-down list, select *Button1Click*.

   The speed button *OnClick* event now calls *Button1Click*.

➤ Run the program and click the speed button. The About box appears.

Modifying a shared event handler

Modifying an event handler that is shared by more than one component is virtually the same as modifying any existing event handler. Just remember that whenever you modify a shared event handler, you are modifying it for *all* the component events that call it.

■ To modify the shared event handler,

1. Select any of the components whose event calls the handler you want to modify.
2. In the Events page of the Object Inspector, double-click the event handler name.

3 In the Code Editor, modify the handler.

Now when any of the components that share this handler receive the shared event, the modified code gets called.

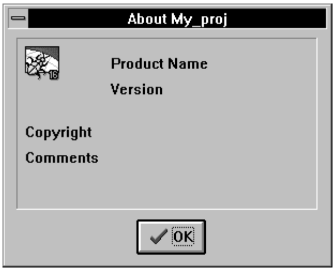
The following example demonstrates this notion. It also provides an illustration of how run-time property settings override those made at design time.

➤ Modify the *Button1 OnClick* event handler by adding the following line of code before the the following *ShowModal* method call, where <path> equals your Delphi \BIN directory:

```
AboutBox.ProgramIcon.Picture.LoadFromFile('<path>\TDW.ICO');
```

➤ Run the program and click any of the buttons in *MainForm*. The About box appears, with the newly specified icon showing in the Image component. Because all of the buttons in *MainForm* share the same event handler, and because the run-time property setting overrides deign-time values, clicking any button produces the same results.

Figure 2.18 About box with run-time icon



It's a matter of personal preference whether you load the picture, or other values, into the About box at run time or design time. If you want to share the About box as a standardized form, you'll probably want to complete it at design time as nearly as possible before making it available to other developers or users.

For more information about sharing forms and projects, see Chapter 3 and Chapter 4.

Deleting event handlers

When you delete a component, Delphi removes its reference in the form's type declaration. However, deleting a component does *not* delete any associated methods from the unit file, because as noted earlier, those methods might be called by other components in the form. You can still run your application so long as the method declaration and the method itself both remain in the unit file. If you delete the method without deleting its declaration, Delphi generates an "Undefined forward" error message, indicating that you need to either replace the method itself (if you intend to use it), or delete its declaration as well as the method code (if you do not intend to use it).

You can still explicitly delete an event handler, if you choose, or you can have Delphi do it for you.

- To manually delete an event handler, remove all event handler code*and* the handler's declaration.
- To have Delphi delete an event handler, remove all the code (including comments) inside the event handler. The handler is removed when you compile or save the project.

Customizing the Delphi Visual Component Library (VCL)

You can customize the Delphi component library, and therefore what's displayed on the Component palette, by adding or deleting components to parallel the functionality you need while developing a particular application. You use the Install Components dialog box to modify the contents of the Delphi library (.DCL) file.

You can develop as many such customized library files as you choose by saving each library configuration with a different file name. You can then choose to use a particular library file when building applications, so that the Component palette provides you with exactly the components you prefer.

Note Customizing the Component palette by using the Palette page of the Options | Environment dialog box does not affect the .DCL library file. When you use this dialog page to customize the palette, Delphi does not rebuild the library file, but merely changes the visual representation of the Component palette. This topic is discussed in online Help; see the Help topics Palette (Options | Environment) or Customizing the Component Palette.

When modifying libraries, keep the following points in mind:

- You can work on a project in Delphi only if the current component library contains all the components used in the project. If you try to load a project that uses components not currently installed, Delphi displays a message indicating which component type it tried to load but could not.
- Delphi always saves the last version of the component library, so if you remove components that you later want to use, you can easily revert to the previous version. The previous version of the library file is stored with the same name, and the extension .BAK. (If you are creating multiple versions of the library, you should give each version a distinct name.)
- Always follow the installation instructions that accompany any third-party components to ensure they are correctly installed in your system, before adding them to a library file.
- Avoid using the same file name for a library and a project.

This section discusses the following topics:

- Adding and removing components from the library
- Handling an unsuccessful compilation
- Using the Component Expert
- Using customized libraries

Adding and removing components from the library

You add and remove components from the library by adding or removing the unit file associated with the component(s). This adds the unit to the project, or removes it from the project.

- To add components to the component library,

1. Choose Options | Install Components.

   The Install Components dialog box appears.

   Note The directory in which the unit resides must be on the search path specified in this dialog box.

2. If necessary, specify a path to the component unit, or choose Add to open the Add Module dialog box.
3. In the Add Module dialog box, type the name of the unit you want to add, or choose Browse to specify a search path.

   Note that you can't specify a literal path in the Add Module dialog box. The path you choose in the Add Module Browse dialog box adds the directory path to the search path listed in the Install Components dialog box.

4. Choose OK to close the Add Module dialog box.

   The name(s) of the component unit(s) you have specified appear at the bottom of the Installed Units list. If you select the unit name, the class names for units already residing in the library are displayed in the Component classes list. Class names for newly added units are not shown.

5. Choose OK to close the Install Components dialog box and rebuild the library.

   Note that even if you've made no changes to the unit list, Delphi rebuilds the library. If you have unsaved forms open, you're prompted to save them. Once the library is rebuilt, the components you've installed are reflected in the Component palette.

Note Newly installed components initially appear on the page of the Component palette that was specified by the component writer in the component source code. You can move the components to a different page after they've been installed on the palette. For more information, see the online Help topics Palette (Options | Environment) or Customizing the Component Palette.

- To remove components from the component library,

1. Choose Options | Install Components to open the Install Components dialog box.
2. In the Installed Units list box, select the unit you want to remove.
3. Choose Remove to remove the unit from the list box.
4. Choose OK to close the Install Components dialog box.

   Delphi rebuilds the library, and the deleted components no longer appear in the palette.

Adding VBX controls

You can add VBX controls to the Delphi component library, so long as they conform to Microsoft Visual Basic 1.0 specifications. To do so, you specify the .VBX file that contains the control you want to add. Delphi then automatically creates a “wrapper” unit (a .PAS file) for the control to make it into a recognizable object type, and adds it to the list of installed units. You can specify a name for the control and which palette page you’d like it to appear on.

■ To add a VBX control to the component library,

1. Open the Install Components dialog box.
2. Choose VBX to open the Install VBX File dialog box.
3. Navigate until you locate the VBX file you want to add, then choose OK.

   The Install VBX dialog box appears, with the name of the specified .VBX file displayed in a read-only edit box.
4. Use the options in this dialog box to specify
   - The directory path where the .VBX file is located (use the Browse button if you’re not sure of the full directory path for the file)
   - The page on the palette where you want the VBX control to be installed
   - A new name for the component class, if necessary

     Change the name, for example, if you’re installing a VBX control that has the same class name as an existing component in your project.
5. Once you have specified the options you want, choose OK to return to the Install VBX File dialog box.
6. Repeat steps 3 through 5 until you have specified all the VBX controls you want to add.

   They should appear in the Installed Units list.
7. Choose OK to close the Install VBX File dialog box and rebuild the component library.

Note In many cases, VBX controls are written so as to require placement in the system path, or in the \WINDOWS\SYSTEM directory. If you see a message stating, “Can’t load VBX” when you compile or run your application, verify that any VBX controls are in the proper location.

Handling an unsuccessful compilation

Before rebuilding the component library, Delphi checks to make sure all the specified units are available and compilable. If the compilation succeeds, Delphi loads the newly built library into the Component palette.

If Delphi encounters a problem, it displays an error message, stops building the library, and displays the Code Editor so that you can correct the error. You may be able to correct the problem simply by adding missing directories to the search path.

In the event of an unsuccessful compile, Delphi maintains the Unit list with your most recent modifications so that you can try rebuilding again later in the same session, without having to exit Delphi. Once you correct the error, you must reopen the Install Components dialog box to rebuild the library. If you don't want to recompile, you can choose Revert to restore the unit list to match the state of the currently installed library.

Note Choosing Revert works only *before* you successfully rebuild the library. You cannot use Revert to specify a previous version of the library after it's been successfully rebuilt.

Saving library source code

After making changes to the library, you can save the code for the library project file using the .DPR extension.

■ To save library source code,

1. Choose Options | Environment, then click the Library page tab.
2. Check the Save Library Source Code check box.

The **uses** clause of this library source file lists all the units (.DCU) that are used to build the Component palette.

Using the Component Expert

Sometimes you might encounter a programming situation for which you want to create a new custom component, rather than simply using one of the components provided with Delphi or available from third-party vendors. Writing your own components generally requires a more in-depth knowledge of Object Pascal and object-oriented programming than using pre-built components.

Creating a new component requires you to

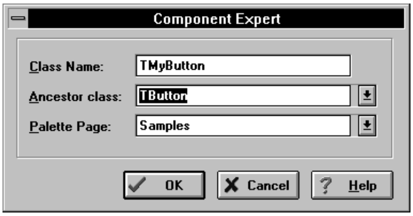
- Create a new unit file
- Derive the new component object from an existing class
- Register the new component

Once you are familiar with component writing, you can use the Component Expert to help you get started. You supply information about the component you want to create, and the Component Expert creates the new unit file with the appropriate declarations to derive and register the new class.

➤ To open the Component Expert and create a new component unit file,

1. Choose File | New Component to open the Component Expert dialog box.

Figure 2.19 The Component Expert dialog box



Class Name: TMyButton

Ancestor class: TButton

Palette Page: Samples

2 In the Class Name edit box, enter the name of the new class you are creating. Remember that all Object Pascal classes are generally prefaced with a letter *T* (for "type"). For example, the name of a new button component type could be *TMyButton*.

3 Use the drop-down list of the Ancestor Class combo box to select a base class, or enter the name of a base class for your new component. Unless you override them in the component declaration, your new component will inherit all the properties, methods, and events from its ancestor class.

4 Use the drop-down list of the Palette Page combo box to select a page, or enter the name of the palette page where you want your new component to appear when you add it to the library.

5 Choose OK to create the unit file for the new component you are creating.

The following code shows an example of component unit file code created by the Component Expert:

```
unit Unit1;
interface
uses
  SysUtils, WinTypes, WinProcs, Messages, Classes, Graphics, Controls,
  Forms, StdCtrls;
type
  TMyButton = class(TButton)
  private
    { Private declarations }
  protected
    { Protected declarations }
  public
    { Public declarations }
  published
    { Published declarations }
  end;

procedure Register;

implementation

procedure Register;
begin
  RegisterComponents('Samples', [TMyButton]);
end;

end.
```

You are now ready to write the rest of the Object Pascal code needed to program the new component.

Using customized libraries

During application development, you might want to work with your own custom component library file. You can create a distinct library file by saving your customizations to the Delphi library file under a new name.

- To create a new library file,

  1. Choose Options | Install Components. The Install Components dialog box appears.
  2. Specify the full path and new file name in the Library Filename box.
  3. Choose OK to create and compile the new library file.

  Now you can install this customized library whenever you want, or specify it as the default component library.

- To replace the current component library,

  1. Choose Options | Open Library.

     The Open Library dialog box appears.

  2. Select the library file you want to install and choose OK.

     Delphi replaces the current library with the library file you have chosen, and reflects the contents of your library file in the Component palette.

Summary

This chapter has presented the following topics, in the context of developing a reusable About box:

- The Delphi components and the pages of the Component palette on which they can be found
- Adding and manipulating components in your forms
- Setting component properties, both at design time and at run time
- Working with code to generate, locate, and modify event handlers
- Customizing the Delphi Visual Component Library by using the Component Expert, by writing your own customized components, or by adding Visual Basic (VBX) components

Chapter

3

Building forms and menus

Forms are the foundation for all your Delphi applications. The previous chapter, “Using components and code,” described how to build the simplest of forms, a reusable About box. This chapter discusses more about how forms work together to provide an integrated user interface.

An application usually contains multiple forms: a main form, which is the primary user interface, and other forms such as dialog boxes, secondary windows (for instance, those that display OLE 2.0 data,) and so on.

You develop your application by customizing the main form and adding and customizing forms for other parts of the interface. You customize forms by adding components, setting their properties, and creating menus to provide user control over the application at run time.

You can begin your form design from one of the Form Templates provided with Delphi, and you can save any form you design as a template that you can reuse in other projects. Likewise, you can use menu templates as starting points for menus you customize to suit your programming needs.

This chapter discusses the following topics:

- What is a form?
- Sharing forms
- Building forms
- Creating form menus
- Associating menu events with code
- Importing resource (.RC) files
- Managing run-time behaviors of forms

What is a form?

The term *form* means different things to different people depending upon what type of programming environment they have previously experienced. For the purposes of this book, a form is any component of the *TForm* class, and its visual representation onscreen. For more information about classes, see Chapter 6. For more information about the *TForm* class, press *F1* with the form selected.

Designing usable forms

When designing a graphical user interface, application developers must be part programmer and part visual designer. Good planning and design of forms and their interaction are important for a number of reasons. Well-designed, intuitively usable forms require less documentation, and well-designed forms and interfaces are easier to support and maintain.

Teaching you about basic visual and user interface design principles is beyond the scope of this book, but there are many good third-party books that can help you learn how to develop a consistent and efficient user interface design. This chapter presents techniques and tips for building usable forms—but it is up to you to incorporate the forms you design into an overall user interface that presents your application to its best advantage.

Sharing forms

Before you begin designing and building the forms for your applications, think about whether these forms will be available to other developers or users. Delphi is designed around the principle of reusable components, and this encompasses larger elements such as forms or even entire projects.

The easiest way to share a form is simply to add an existing form to a project. The About box you created in Chapter 2 is an example of a form that's broadly reusable. Delphi provides the About box as a Form Template for just that purpose. Form Templates are predesigned forms that you can easily reuse in your projects.

When you share forms among projects, there are several considerations to keep in mind:

- As discussed in Chapter 1, to make the forms you add visible to other forms in the project, you need to add their unit identifier to the **uses** clause of those other forms.
- When forms reference each other, you need to avoid creating a circular reference.
- When you modify a shared form, the modifications will show up in every project that uses the form, not just the project where the form was originally created.

These considerations are discussed in more detail in the sections that follow.

Making forms visible to other forms

As mentioned previously, adding a form, such as a Delphi Form Template (discussed later in this chapter), to your project adds it to the **uses** clause in the project (.DPR) file, but not to the **uses** clause of any other units in the project. Before you can use the new form interactively with other forms in the project, you need to add its unit identifier to the **uses** clause of those forms' unit files.

Enabling forms to reference each other

When two forms must reference each other, it's possible to cause a "Circular reference" error when you compile your program. To avoid such an error, do one of the following:

- Place both **uses** clauses, with the unit identifiers, in the **implementation** parts of the respective unit files. (This is the usual means of allowing two forms to reference each other.)
- Place one **uses** clause in an **interface** part and the other in an **implementation** part. (You rarely need to place another form's unit identifier in this unit's **interface** part.)

Do not place both **uses** clauses in the **interface** parts of their respective unit files. This will generate the "Circular reference" error at compile time.

Modifying a shared form

If you have several projects that all use the same form, changes to the shared form that you make in *any* of the projects show up in *all* of them. This might be your intention. If it's not, however, there are several ways to prevent this. You can

- Save the form under a different name and use the renamed form in your project instead of the original.

  This is similar to using a Form Template in your project.
- Make the changes to the form at run time instead of at design time, as discussed in Chapter 2.
- Make the shared form a component that can be installed onto the Component palette. This has the added advantage of enabling users to customize the form at design time. For more information, see the *Delphi Component Writer's Guide*.

If you expect to be the only user of the form, and you don't plan extensive or frequent changes, run-time customization is probably acceptable. If you plan on using the form in many different applications, run-time customization involves more coding for you and other developers. In this case it's usually more convenient, whenever possible, to make the form a component that other users or developers can install onto their Component palette.

Note You can also reuse a form by making it into a DLL. For more information, see the *Delphi Component Writer's Guide*.

Using the Form Templates of the Browse Gallery

As mentioned earlier, the easiest way to share and reuse forms within and among Delphi projects is to use the Form Templates of the Delphi Browse Gallery. The Browse Gallery for Form Tempaltes is enabled in a default Delphi installation, but you can choose to disable it.

- To enable or disable the Browse Gallery in the environment,

1 Choose Options | Environment.

  The Environment Options dialog box appears.

2 On the Preferences page, check or uncheck the Use On New Form check box, as appropriate, in the Gallery group box.

(For information on setting Environment Preferences, see Chapter 1.)

When the Browse Gallery for Form Templates is enabled, it appears whenever you choose File | New Form from the Delphi menu bar, or the New Form button on the SpeedBar.

Adding a template form to a project

You can easily add any Form Template from the Delphi Browse Gallery to your application. You can also save any form you've designed as a template that gets installed into the Gallery. For more information about saving forms as templates, see "Saving a form as a template" on page 93.

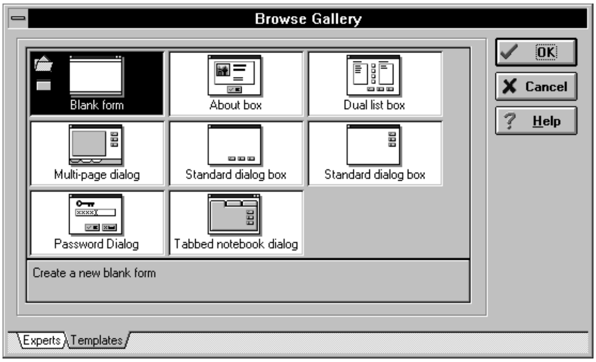
- To add a template form to your project,

1 With a project open, choose File | New Form.

  The Browse Gallery dialog box appears, with the Blank Form option highlighted by default. (If another form has been specified as the Default New Form, that option is highlighted instead.)

Note Depending on which templates have been installed, modified, or deleted in your Delphi installation, your Browse Gallery window for Form Templates might differ from that shown here.

Figure 3.1 Standard Delphi Form Templates in the Browse Gallery



Create a new blank form

2 On the Templates page, use the arrow keys or the mouse to select the template you want to add, and choose OK.

  Delphi adds a copy of the template form and its associated unit file to the project you have open. You can now use this form the way you would any form in a project. You can customize it, add components and code to it, and so on. Any modifications you make do not affect the original template.

Note With no project open, it is still possible to choose File | New Form and select a Form Template from the Gallery. The form's unit file then opens as a reference file (see the following section). If you subsequently open a project or create a new project, the open template form *is not part of that project*. To save it as part of the project, save the open unit file under a different name (File | Save File As).

Opening a Form Template for reference only

You can open a Form Template, or any form in any project, as a standalone form for reference purposes only, without adding the form to your current project.

■ To open a Form Template as a separate form and unit file,

1 Choose File | Open File to display the Open File dialog box.
2 Switch to the \DELPHI\GALLERY directory, and select the .PAS file that corresponds to the template you want to open.

The Form Template opens, and you can view it or its associated unit source code, but it is not included in your project. When you run your project, the template is not compiled or linked into the project. It remains open, however, just like any open file, until you close it.

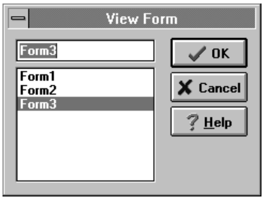
Viewing forms and units

When you're working with several forms at design time, it's easy to switch among them by bringing the form you want to work on to the front. Similarly, it's easy to view the unit source code for the form you're working in.

■ To switch among forms in a project,

1 Choose View | Forms.

The View Form dialog box appears.

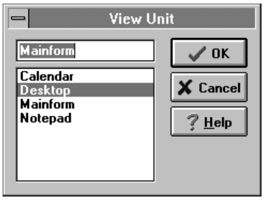


2 In the View Form dialog box, select the form to which you want to give focus, then choose OK.

■ To switch among units in a project,

1 Choose View | Units.

The View Unit dialog box appears.



2 In the View Unit dialog box, select the unit you want to view, then choose OK.

You can also use the Delphi Project Manager to navigate among the units and forms in your project. For more information, see Chapter 4.

Building forms

Delphi provides you with tools for building the forms that will make up your application's user interface. By using the Browse Gallery, simple function calls, and Delphi components, it's easy to create a wide variety of forms, from the simplest to the most complex.

One of the most common ways that Windows-based applications interact with users is through dialog boxes. Dialog boxes supply information about the application, and in most cases accept input from the user. The About box is an example of the most simple kind of dialog box. It doesn't accept any input from the user (other than a button click), but it does provide useful information. A message box that displays a warning or error message is also a kind of dialog box.

More intricate dialog boxes require input from the user before the application can continue. Delphi provides many such fully designed dialog boxes as components, and you can also develop your own custom dialog boxes by using Delphi components.

Using routines to display dialog boxes

The Delphi *Dialogs* unit provides several simple routines that display predesigned dialog boxes to the user, based on the parameters you specify.

This section discusses how to use those routines to perform the following tasks in Delphi:

- Displaying message boxes
- Creating simple input forms
- Masking input characters

Displaying message boxes

Message boxes display text to the user and must be manually cleared from the screen before the application can continue. Message boxes can be used for a variety of purposes, including

- Displaying warning information to the user

- Displaying error messages
- Requesting confirmation before closing a file or exiting the application

ShowMessage procedure

The *ShowMessage* procedure is the simplest way to display a brief message to the user. The syntax of the procedure is

```
ShowMessage(const Msg: string);
```

This procedure displays a modal dialog box containing the text you specify in the *Msg* parameter and an OK button that closes the dialog box.

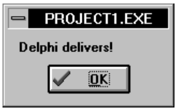
➤ To display a message box with the *ShowMessage* procedure, try this:

1 Create a new blank project and place a Button component on *Form1*.
2 In the button's *OnClick* event handler, write the following code:

```
ShowMessage('Delphi delivers!');
```

When you run the program and click the button, a modal dialog box appears with the name of the executable file in the title bar, the text from the *Msg* parameter, and an OK button, as shown in the following figure.

Figure 3.2 Example ShowMessage message box



Delphi delivers!

MessageDlg() function

The *MessageDlg* function displays a message box that contains text you specify, and optionally, various captions, symbols, and buttons.

Here is the syntax of the function:

```
function MessageDlg(const Msg: string; AType: TMsgDlgType; AButtons: TMsgDlgButtons;
HelpCtx: LongInt) : Word;
```

The following table summarizes what each parameter specifies. See online Help for detailed information regarding each parameter.

Table 3.1 MessageDlg parameters

Parameter name	Specifies	Comments
Msg	Text displayed in the dialog box	If you omit this parameter, no text appears in the dialog box.
AType	Caption on title bar, and accompanying symbol in dialog box	If you omit this parameter, no caption appears on the message box title bar.
AButtons	Type of button(s) in the dialog box	If you omit this parameter, no buttons appear in the box.
HelpCtx	Link to a Help topic	Not required.

You need to pass an integer into the *HelpCtx* parameter even if you don't have an application Help file. In this case, pass 0 (zero). If you do have an application Help file, you should include a Help button in the dialog box and pass the Help context that corresponds to the topic you want users to view for this dialog box. If the integer you pass is not a valid Help context, users will get an error message when they choose the Help button.

For more information on connecting your application to a Help system, see “Help file” on page 128 of Chapter 4.

➤ To create a sample message dialog box, try the following:

1 Start a new, blank project.

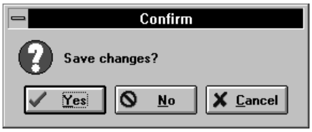
2 Add a button to *Form1*, and generate the following event handler:

```
procedure TForm1.Button1Click(Sender: TObject);
begin
  MessageDlg('Save changes?', mtConfirmation, mbYesNoCancel , 0);
end;
```

3 Run the program.

The message box illustrated here appears when you click *Button1*.

Figure 3.3 Confirmation message dialog box



Note *MessageDlg* displays the message box in the center of the screen by default. You can use the *MessageDlgPos* function to create a message box that appears at a screen location you specify.

For more information about *MessageDlg* and *MessageDlgPos*, look up the references in online Help and see the Help topic Displaying a Message Box.

Creating simple input forms

Where *MessageDlg* displays an informational form that requires only a button click from the user, the *Dialogs* unit also provides two functions, *InputBox* and *InputQuery*, that display forms requiring a single line of input from the user. For example, you might use such a form as a password entry screen.

Here is the syntax for each function:

```
function InputBox(const ACaption, APrompt, ADefault: string): string;

function InputQuery(const ACaption, APrompt: string; var Value: string): Boolean;
```

Both *InputBox* and *InputQuery* create a dialog box with an OK and Cancel button. Use *InputBox* if you simply want the string the user enters returned if the user chooses *OK*, and not returned if the user chooses Cancel or presses *Esc* to exit the dialog box. Use *InputQuery* if you want to be able to interpret the user’s action (OK, Cancel or *Esc*) as a Boolean variable that the program can recognize.

➤ For an illustration of how *InputBox* works, try the following:

1 Start a new, blank project.

2 Add a Button component and a Label component to *Form1*.

3 Generate the following *OnClick* event for *Button1*:

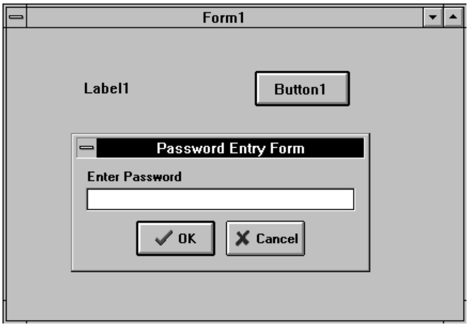
```
procedure TForm1.Button1Click(Sender: TObject);
begin
 Label1.Caption := InputBox('Password Entry Form', 'Enter Password', '')
end;
```

Leaving the *ADefault* parameter string empty means no text initially appears in the input box.

4 Run the program and choose *Button1*.

The input box appears.

Figure 3.4 Sample input box in running form



5 Type some text in the input box, and choose OK.

The text appears in *Label1*.

6 Choose *Button1* again to display the input box.

7 Type some text, and this time, choose Cancel or press Esc to exit the dialog box.

The text is not displayed in *Label1*: instead, the *ADefault* string is returned. In this case, the string is blank, so the text in *Label1*'s *Caption* property is cleared, but no other text replaces it.

For more information about *InputBox* and *InputQuery*, see the online Help topic for each function.

Masking input characters

In a dialog box that you create yourself, you can mask the characters that a user enters into an edit field. Use the *PasswordChar* property of the Edit component to display any characters the user enters as special characters, such as asterisks (*) or pound signs (#).

➤ To see an example of this, try the following:

1 Start a new, blank project.

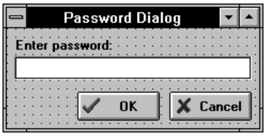
2 Choose File | Add File.

3 In the \DELPHI\GALLERY subdirectory, select the PASSWORD.PAS file and choose OK.

4 Choose View | Forms and choose *PasswordDlg*.

The Password Dialog Template opens in its design-time state.

Figure 3.5 Password Dialog Template at design time



➤ Select the Edit component in the Password Template.

Note that the *PasswordChar* property of the Edit component, *Password*, has already been set to *. When the user enters text in this dialog box at run time, only the asterisk character is displayed, so that the user's password is not visible onscreen. (You can enter any single character you choose as the *PasswordChar* property value.)

➤ To see the Password entry Form Template at run time, try the following:

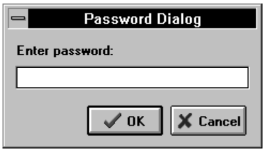
1 Add a button to *Form1*, and write the following *OnClick* event handler:

```
procedure TForm1.Button1Click(Sender: TObject);
begin
  PasswordDlg.ShowModal;
end;
```

2 Add *Password* to the **uses** clause in *Unit1*, and run the application.

3 Choose *Button1* to display the Password dialog box.

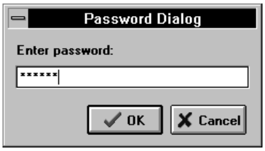
Figure 3.6 Password dialog box at run time



4 Type some text into the edit box.

Only asterisks appear.

Figure 3.7 Password dialog box displaying masked characters



Developing custom dialog boxes

In addition to routines that display simple, predesigned dialog boxes, and Form Template dialog boxes such as the Password Dialog Template, Delphi provides a number of fully designed dialog boxes as components. These appear on the Dialogs page of the Component palette, and include components that encapsulate the Windows common dialog boxes. You can specify different options for these dialog boxes, such as whether a Help button appears in the dialog box, but for the most part you cannot change their overall design.

It's useful, therefore, to know how to build a dialog box "from scratch," since you'll undoubtedly want to design your own. This section discusses the most common considerations when designing any dialog box, including

- Making a dialog box modal or modeless
- Setting form properties for a dialog box
- Providing command buttons
- Creating standard-command buttons
- Setting the tab order
- Testing the tab order
- Removing a component from the tab order
- Enabling and disabling components
- Setting the focus in a dialog box

Making a dialog box modal or modeless

At design time, dialog boxes are simply customized forms. At run time they can be either *modal* or *modeless*. When a form runs modally, the user must explicitly close it before working in another running form. Most dialog boxes are modal.

When a running form is modeless, it can remain onscreen while the user works in another form (for example, the application main form). You might create a modeless form to display status information, such as the number of records searched during a query, or information the user might want to refer to while working.

Note If you want a modeless dialog box to remain on top of other open windows at run time, set its *FormStyle* property to *fsStayOnTop.*

Forms have two methods that govern their run-time modality. To display a form in a modeless state, you call its *Show* method; to display a form modally, you call its *ShowModal* method.

The following two procedures use the Delphi About box Form Template to demonstrate the *Show* and *ShowModal* methods of the form.

Displaying a dialog box modelessly

➤ To run the About box in a modeless state,

1 Create a new blank project with a blank form.

2 Add a button to *Form1*.

3 Generate the following event handler for *Button1*:

```
procedure TMainForm.Button1Click(Sender: TObject);
begin
  AboutBox.Show; {This is the line you need to write}
end;
```

4 Add *Unit2* to the **uses** clause of the *Unit1* source code.

5 Add the About box to the project by choosing File | New Form and selecting the About Box template from the Browse Gallery.

6 Run the application, and choose *Button1*.

The About box appears.

7 Click on *Form1*.

Notice that focus shifts to *Form1*, and the About box shifts to the background. This is because the About box is acting as a modeless dialog box.

8 Use the Control menu to close the About box.

Displaying a dialog box modally

➤ To run the About box as a modal dialog box,

1 Change the code in the *OnClick* event handler for *Form1.Button1* to read as follows:

```
procedure TMainForm.Button1Click(Sender: TObject);
begin
  AboutBox.ShowModal;
end;
```

2 Now run the program, choosing *Button1* to display the About box.

3 Try to click *Form1*.

Notice that you cannot access it until you close the About box.

4 Choose the OK button in the About box; it now closes.

Note The choice of modality doesn't affect the appearance of a dialog box.

Setting form properties for a dialog box

By default, Delphi forms have Maximize and Minimize buttons, a resizable border, and a Control menu that provides additional commands to resize the form. While these features are useful at run time for modeless forms, modal dialog boxes seldom need them.

Delphi provides a *BorderStyle* property for the form that includes several useful values. Setting the form's *BorderStyle* to *bsDialog* implements the most common settings for a modal dialog box, such as

- Removing the Minimize and Maximize buttons
- Providing a Control menu with only the Move and Close options
- Making the form border non-resizable, and giving it a "beveled" appearance

The following table shows other form property settings that can be used, individually or in concert, to create different form styles.

Table 3.2 Alternate form settings

Property	Setting	Effect
BorderIcons		
biSystemMenu	False	Removes Control (System) menu
biMinimize	False	Removes Minimize button
biMazimize	False	Removes Maximize button
BorderStyle		
	bsSizeable	Enables the user to resize the form border
	bsSingle	Provides a single outline, non-resizable border
	bsNone	No distinguishable border; not resizable

Note Changing these settings doesn't change the design-time appearance of the form; these property settings become visible at run time.

Specifying a caption for the dialog box

In most Windows-based applications, each dialog box has a caption on its title bar that describes the primary function of the dialog box.

By default, Delphi displays the *Name* property value for each form in the form's title bar. If you change the *Name* property of the form prior to changing the *Caption* property, the title bar caption changes to the new name. Once you change the *Caption* property, the form's title bar always reflects the current value of *Caption*.

Providing command buttons

Depending on whether you intend to use your dialog box in a modal or modeless state, you'll want to provide certain command buttons in the dialog box. For modal dialog boxes, you need to provide the user with a way to exit the dialog box. It's fairly standard design to provide one or more command buttons for this purpose. For simple modal dialog boxes, such as a message box, one button is often sufficient. Such a button might be labeled, for instance, "OK" or "Close." (If you have another button in the dialog box labeled "No," as described in the next paragraph, this button might be labeled "Yes.")

In cases where the dialog box accepts input from the user, you want to provide users with a choice of whether or not to process their input on exiting the dialog box. You can do this by means of an additional button labeled, for example, "Cancel" or "No." (If your dialog box explicitly asks a question of the user, you might want to label this button "No"; otherwise, "Cancel" is usually more appropriate.)

Your code controls what happens when a user chooses a command button, for example, whether changes are processed or not.

By setting properties of the Button component, you can call a button's event handler code when the user presses *Enter* or *Esc*; and you can specify that the dialog box closes when the user chooses a command button, without writing any additional code.

Executing button code on Esc

Delphi provides a *Cancel* property for Button components. When your form contains a button whose *Cancel* property is set to *True*, pressing the Esc key at run time executes any code contained in the button's *OnClick* event handler.

- To designate a button as the Cancel button, set its *Cancel* property to *True*.

Executing button code on Enter

Buttons have a *Default* property that operates similarly to the *Cancel* property. When your form contains a button whose *Default* property is set to *True*, pressing Enter at run time executes any code contained in the button's *OnClick* event handler—unless another button has focus when the Enter key is pressed.

Even if your form contains a default button, another button can take focus away at run time. Pressing the Enter key calls the *OnClick* event handler code of the button with focus, overriding any other button's *Default* property setting. (The button with focus is indicated by a darker, thicker border than that of other buttons in the dialog box.)

Note Although other components in a form can have focus, only button components respond when the user presses Enter. The default button takes the *OnClick* event when another non-button component in the form has focus. For an example of this, see "Setting focus at run time" on page 92.

- To specify a button as the Default button, set its *Default* property to *True*.
- To change focus at run time, call the button's *SetFocus* method.

For more information, see "Setting the focus in a dialog box" on page 92.

Closing a dialog box when the user chooses a button

You can specify that a modal dialog box close automatically when the user chooses any button whose *ModalResult* property has a non-zero value. By setting *ModalResult* to match a button's caption, you can also determine which button the user chose. For example, if you have a Cancel button, set its *ModalResult* property to *mrCancel*; if your form contains an OK button, set its *ModalResult* to *mrOK*. Both buttons will close the form when chosen, because *ModalResult* returns a non-zero value to the *ShowModal* function. However, because *ModalResult* returns *mrCancel* in one case, and *mrOK* in the other, your code can determine which button was pressed and branch accordingly.

➤ To automatically close the dialog box when the user chooses a Cancel button or presses Esc, set the Cancel button's *ModalResult* property to *mrCancel*.

- To automatically close the dialog box when the user presses Enter when an OK button has focus, set the button's *ModalResult* property to *mrOK*.

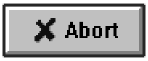
The following section describes how to create in one simple step such standard command buttons as the Cancel and OK buttons just described.

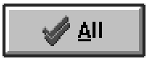
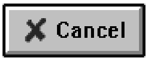
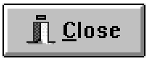
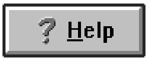
Creating standard-command buttons

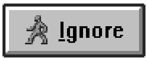
You can quickly create buttons for many standard commands by adding BitBtn components to the form and setting the *Kind* property for each button. The possible *Kind* property settings and their effect are shown in the following table. (In addition to the property settings shown, the bitmap button displays graphics, such as a green check mark for the OK button, or a red X for the Cancel button.)

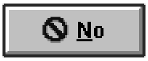
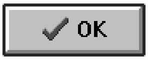
Table 3.3 Delphi's predefined bitmap button types

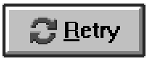
Kind value	Effect	Appearance	Equivalent property setting(s)	Comments

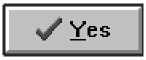
bkAbort	Makes a Cancel button with Abort as caption		Caption := 'Abort'
			ModalResult := mrAbort
				Red X appears next to caption.

bkAll	Creates an OK button (with All caption)		*Caption := '&All'* *ModalResult := 8*	Green double check mark appears next to caption.
bkCancel	Makes a Cancel button		*Caption := 'Cancel'* *Cancel := True* *ModalResult := mrCancel*	Red X appears next to caption.
bkClose	Creates a Close button; closes the window		*Caption := '&Close'*	A lavender "exit" door appears as the glyph for this button.
bkCustom	None	N/A	N/A	Use this setting to create a custom command button, including specifying a custom *Glyph* bitmap.
bkHelp	Creates a button with Help as the caption		*Caption := '&Help'*	A blue ? appears next to the caption. Use the event handler of this button to call your program Help file. (If the dialog box has a Help context, Delphi does this automatically.)

bkIgnore	Creates a button to ignore changes and proceed with specified action		Caption := '&Ignore'
			ModalResult := mrIgnore
				Use to continue an operation after an error condition has occurred.

bkNo	Makes a Cancel button (with No as the caption)		*Caption := '&No'* *Cancel := True* *ModalResult := mrNo*	Red circle with slash appears next to caption.
bkOK	Creates an OK button		*Caption := 'OK'* *Default := True* *ModalResult := mrOK*	Green check mark appears next to caption.

bkRetry	Creates a button to retry specified action		Caption := '&Retry'
			ModalResult := mrRetry
				Green circular arrow appears next to the caption.

bkYes	Creates an OK button (with Yes caption)		*Caption := '&Yes'* *Default := True* *ModalResult := mrYes*	Green check mark appears next to caption.

Note that setting the *Kind* property also sets the *ModalResult* property, discussed previously, in every case except *bkCustom*, *bkHelp* and *bkClose*. In these cases, *ModalResult* remains *mrNone* and choosing the button doesn't automatically close the dialog box.

Setting the tab order

Tab order is the order in which focus moves from component to component in a running application when the *Tab* key is pressed. To enable the *Tab* key to shift focus to a component on a form, the *TabStop* property of the component must be set to *True*.

The tab order is initially set by Delphi, corresponding to the order in which you add components to the form. You can change this by changing the *TabOrder* property of each component, or by using the Edit Tab Order dialog box.

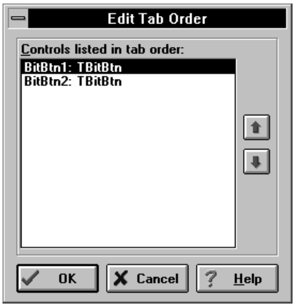
■ To use the Edit Tab Order dialog box,

1 Select the form, or a container component in the form, that contains the components whose tab order you want to set.

2 Choose Edit | Tab Order, or choose Tab Order from the form's SpeedMenu.

The Edit Tab Order dialog box appears, displaying a list of components ordered (first to last) in their current Tab order.

Figure 3.8 Edit Tab Order dialog box



BitBtn1: TBitBtn
BitBtn2: TBitBtn

3 In the Controls list, select a component, and press the appropriate arrow button (Up or Down), or drag the component to its new location in the tab order list.

4 When the components are ordered to your satisfaction, choose OK.

Using the Edit Tab Order dialog box changes the value of the components' *TabOrder* property. You can also do this manually, if you want.

■ To manually change a component's *TabOrder* property,

1 Select the component whose position in the tab order you want to change.
2 In the Object Inspector, select the *TabOrder* property.
3 Change the *TabOrder* property's value to reflect the position you want the component to have in the tab order.

Note The first component in the tab order should have the *TabOrder* value of 0.

Keep in mind the following points when manually setting your tab order (you needn't be concerned with these points if using the Edit Tab Order dialog box):

- Each *TabOrder* property value must be unique. If you give a component a *TabOrder* value that has already been assigned to another component on this form, Delphi renumbers the *TabOrder* value for all other components accordingly.

- If you attempt to give a component a *TabOrder* value equal to or greater than the number of components on the form (because numbering starts with 0), Delphi does not accept the new value, instead entering a value that ensures the component is last in the tab order.
- Components that are invisible or disabled are not recognized in the tab order, even if they have a valid *TabOrder* value. When the user presses *Tab*, the focus skips over such components and goes to the next one in the tab order. For more information, see “Enabling and disabling components” on page 91.

Testing the tab order

You can test the tab order you’ve set by running the application. At design time, focus always moves from component to component in the order that the components were placed on the form. Changes you make to the tab order at design time are reflected only at run time.

■ To test the tab order,

1. Run the application.
2. Use the *Tab* key to view the order in which focus moves from component to component.

Removing a component from the tab order

In some cases you might want to prevent users from being able to tab to a component on a form. For example, there’s usually no need for users to access a Panel component, because they can’t modify it. You might want, in such a case, to remove the component from the tab order altogether. When the user presses the *Tab* key in the running application, the focus will skip over this component and go to the next one in the tab order. This is true even if the component has a valid *TabOrder* value.

■ To remove a component from the tab order,

1. Select the component in the form.
2. Use the Object Inspector to set the value of the *TabStop* property to *False*.

Note Removing a component from the tab order doesn’t disable the component.

Enabling and disabling components

You often want to prevent a user from accessing certain components in a dialog box or form, either initially when the dialog box opens, or in response to changing conditions with the dialog box at run time. For instance, in file-handling dialog boxes you might want to disable the OK button unless a file name is first specified.

When a component is disabled, it appears dimmed in the running application, and the user cannot tab to it, even if its *TabStop* property is set to *True*.

By disabling a component at design time, you specify that the component is initially unavailable to the user when the dialog box first opens. You can also dynamically change whether a component is enabled at run time.

■ To disable a component at design time, use the Object Inspector to set the component’s *Enabled* property to *False*.

- To disable a component at run time, type the following code in an event handler for the component, where <component*n*> is the name of the component (for example, *Button1*):

```
<componentn>.Enabled := False;
```

For example, the following event handler specifies that when *Button1* receives an *OnClick* event, *Button2* is disabled.

```
procedure TForm1.Button1Click(Sender: TObject);
begin
  Button2.Enabled := False;
end;
```

Setting the focus in a dialog box

Only one component per form can be active, or have the focus, in a running application at any given time. The component having the focus by default corresponds to the *ActiveControl* property of the form, which can be set at design time, or used during run time to access the component that has focus. To change focus at run time, use the *SetFocus* method.

Setting focus at design time

When you design a dialog box, you usually want to specify which component should have focus when the dialog box first opens. For example, in a data entry form you might want to give focus to the edit or memo component where users will first be entering data. That way the user can begin typing immediately, without first having to tab to a certain component.

- To specify the active component at design time,

1. Select the form, then use the Object Inspector to select the form's *ActiveControl* property.
2. From the property's drop-down list, select the component you want to have focus when the form first opens.

If no component is specified as the form's active component, Delphi gives initial focus to the component that is first in the tab order, excluding

- Disabled components
- Components that are not visible at run time
- Components whose *TabStop* property is set to *False*

Setting focus at run time

Focus changes automatically at run time when the user tabs among components. You often want to actively specify a focus change. Taking the previous example, if you are designing a data entry form, you might want to specify that focus change from field to field each time the user presses an arrow key. You specify that a component gets focus by using the *SetFocus* method.

- To change the active component during run time, type the following code in the appropriate event handler, where <component*n*> is the name of the component, for example, *Button1*:

```
<componentn>.SetFocus;
```

For more information, see the online Help topic *SetFocus* method.

Note If you set a button as the active control for the form at design time, that setting overrides at run time any default button you might have specified. However, you'll often find ways to use an active control together with a default button to process user input.

➤ For an example of this, try the following.

1 On a blank form, add an Edit component, a Button component, and a Memo component.

2 Set the component properties as follows:

Table 3.4 Property settings for demonstrating ActiveControl

Component	Property	Setting
Form1	ActiveControl	Edit1
Edit1	Text	<blank>
Button1	Default	True
Button1	Caption	OK

3 Write the following *OnClick* event handler for *Button1*:

```
procedure TForm1.Button1Click(Sender: TObject);
begin
  Memo1.Lines.Add(Edit1.Text);
  Edit1.Clear;
end;
```

4 Run the program.

When the program starts, the cursor is in *Edit1*, the active control for the form.

5 Type some text in *Edit1*, and press *Enter*.

Because *Button1* is the default button, pressing *Enter* activates its *OnClick* event.

Saving a form as a template

Once you've designed a custom dialog box, you might want to reuse it in other projects. One convenient way to do this is to save it as a Form Template.

Saving a form as a template is similar to saving a copy of the form under a different name. When you save a form as a template, however, it then appears on the list of templates displayed in the Browse Gallery. You specify the bitmap and description of the template that appears in this template list.

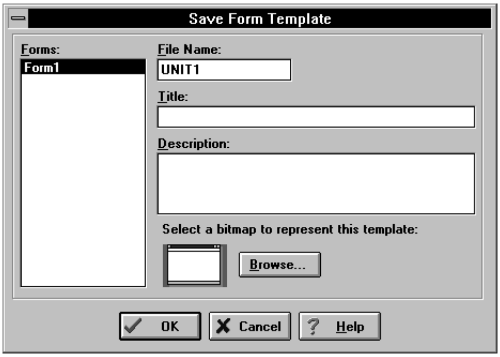
■ To save your current form as a template,

1 Right-click the form to open the Form SpeedMenu.

2 From the Form SpeedMenu, choose the Save As Template command.

The Save Form Template dialog box appears.

Figure 3.9 Save Form Template dialog box



Forms: Form1

File Name: UNIT1

3 In the Title edit box, specify a name for the template.

4 In the Description edit box, type a brief description of this template.

5 To specify an icon for the template, choose the Browse button.

The Select Bitmap dialog box appears.

6 Locate and select the bitmap (if any) you want to use, and choose OK to exit the Select Bitmap dialog box.

7 Choose OK to accept your specifications, and exit the Save Form Template dialog box.

The next time you choose File | New Form, your template appears in the templates list, with the bitmap you chose to represent it, and the description you entered.

Saving form files as ASCII text

Delphi enables you to save .DFM form files as ASCII text. You can then modify a form by using any standard text editor to edit the text file. Later, you can load the ASCII file in the Code Editor and convert it back into the binary .DFM format. This can be useful when using Delphi projects in a team development environment, or whenever version control is an issue, since most version control mechanisms depend on a text-based comparison.

■ To convert a form file to ASCII format,

1 Choose File | Open File. (You need not have a project open.)

2 Select the .DFM file you want to convert to ASCII.

If the form's unit file (.PAS) is open, you are prompted to save changes and close it before the .DFM file opens in the Code Editor.

3 Choose File | Save File As.

4 In the Save As dialog box, rename the file using a .TXT file extension.

Using the .TXT file extension automatically causes the .DFM file to convert to ASCII text.

5 Repeat these steps for any other .DFM files you want to convert to ASCII.

Note You cannot have the same form open simultaneously in both visual and text formats.

Converting text files back to .DFM format

After editing an ASCII form file, you can convert the text-based form back into its regular binary .DFM format. Once you understand the structure and content of a form file, it's even possible for you to create a form by writing its structure as a text file and converting that to binary format. However, it's normally far more efficient to create forms with the visual tools that Delphi provides.

■ To convert an ASCII-based form file back into binary (.DFM) format,

1 Choose File|Open File. (You need not have a project open.)

2 Select the text file you want to convert to binary .DFM format.

The file opens in the Code Editor.

3 Choose File|Save File As.

4 In the Save File As Type combo box, choose Form File (*.DFM).

5 Name the file with a .DFM extension in the File Name edit box.

6 Repeat this process for any other files you want to convert to binary .DFM format.

Sample ASCII Form file

Here is the text output of the Password Dialog Form Template. As you can see, it is basically a summary listing of the objects that make up the form, and the main visual properties of those objects.

```
object PasswordDlg: TPasswordDlg
  Left = 200
  Top = 99
  ActiveControl = Password
  AutoScroll = False
  BorderStyle = bsDialog
  Caption = 'Password Dialog'
  Font.Color = clBlack
  Font.Height = -11
  Font.Name = 'MS Sans Serif'
  Font.Style = [fsBold]
  PixelsPerInch = 96
  Position = poScreenCenter
  ClientHeight = 93
  ClientWidth = 236
  object Label1: TLabel
    Left = 8
    Top = 9
    Width = 92
    Height = 13
    Caption = 'Enter password:'
  end
  object Password: TEdit
    Left = 8
    Top = 27
    Width = 220
    Height = 20
    TabOrder = 0
    PasswordChar = '*'
  end
  object OKBtn: TBitBtn
    Left = 66
    Top = 59
    Width = 77
    Height = 27
    TabOrder = 1
    Kind = bkOK
    Margin = 2
    NumGlyphs = 2
    Spacing = -1
  end
  object CancelBtn: TBitBtn
    Left = 152
    Top = 59
    Width = 77
    Height = 27
    TabOrder = 2
    Kind = bkCancel
    Margin = 2
    NumGlyphs = 2
    Spacing = -1
  end
end
```

MDI and SDI forms

Any form you design can be implemented in your application as a Multiple Document Interface (MDI) or Single Document Interface (SDI) form. In an MDI application, more than one document or child window can be opened within a single parent window. This is common in applications such as spreadsheets or word processors. An SDI application, by contrast, normally contains a single document view.

It’s probably more common to design an MDI form as such from the beginning, but you can change forms you create into MDI or SDI forms simply by changing their *FormStyle* property.

The following table displays the possible *FormStyle* property settings and their purpose.

Table 3.5 FormStyle property settings

FormStyle value	Creates	Comments
fsNormal	A standalone (SDI) form	
fsMDIForm	An MDI parent or frame form	This form can contain other forms at run time.
fsMDIChild	An MDI child form	This form is contained by the MDI parent at run time.
fsStayOnTop	A standalone form that stays on top of other open forms at run time	

➤ To demonstrate how MDI parent forms contain child forms, try the following.

1 Start a new, blank project and add a new, blank form.

2 Set the *FormStyle* property for *Form1* to *fsMDIForm*, and for *Form2* to *fsMDIChild*.

3 Add a Panel component to *Form1*, and change its *Alignment* property to *AlTop*.

4 Add a SpeedButton component to the panel, and generate the following *OnClick* event handler for it:

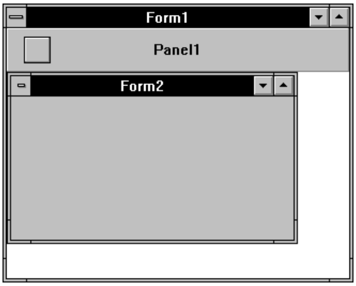
```
procedure TForm1.SpeedButton1Click(Sender: TObject);
begin
  Form2.Show;
end;
```

5 Add *Unit2* to *Unit1*'s **uses** clause.

6 Run the program, and click *SpeedButton1*.

Form2 opens inside *Form1*.

Figure 3.10 Sample MDI child and parent forms



You can resize and move either form, but the child form always stays within the borders of the parent.

Here are some rules about MDI parent and child forms:

- The MDI parent form must always be the application's main form.

  If the MDI parent form isn't specified as the application's main form, the application won't be correctly compiled.

- There can be only one form of style *fsMDIForm* per application.
- The application's main form can never be of type *MDIChild*. This would also prevent the application from being properly compiled.
- In general, you should remove the MDI child form from the Auto-create forms list on the Forms page of the Project Options dialog box.

  This is because for true MDI applications, you create multiple instances of a single child form at run time. If, on the other hand, your application uses only one instance of each of several different types of child forms, as might be the case in a database application, you probably don't need to create each child form at run time. In this case, you needn't remove the forms from the Auto-create list.

For more information about the Auto-create forms list, see "Specifying forms to auto-create" on page 113, or search online Help for "instantiating forms." For more information about MDI applications, see Chapter 10, which documents how to write the demo application, TEXTEDIT.DPR.

The next section describes the Delphi Menu Designer, which you use to add menus to your forms. For information about adding tool bars and status lines to your forms, see Chapter 12.

Creating form menus

Menus provide an easy way for your users to execute logically grouped commands. The Delphi Menu Designer enables you to easily add a menu—either predesigned or custom tailored—to your form. You simply add a menu component to the form, open the Menu Designer, and type menu items directly into the Menu Designer window. You can add or delete menu items, or drag and drop them to rearrange them during design time.

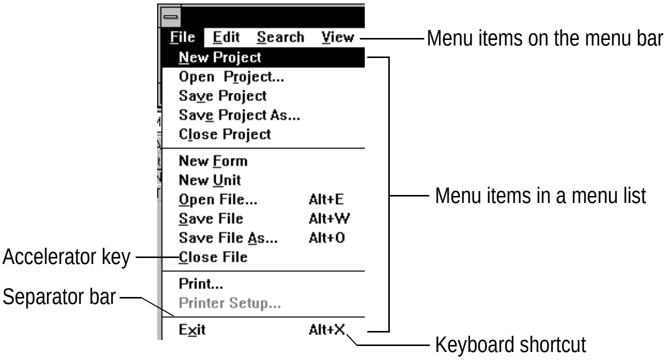
You don't even need to run your program to see the results—your design is immediately visible in the form, appearing just as it will during run time. Your code can also change menus at run time, to provide more information or options to the user.

This section explains how to use the Delphi Menu Designer to design menu bars and pop-up (local) menus. It discusses the following ways to work with menus at design time and run time:

- Opening the Menu Designer
- Building menus
- Editing menu items without opening the Menu Designer
- Using the Menu Designer SpeedMenu
- Using menu templates
- Saving a menu as a template

Note For specific code samples that demonstrate ways to manipulate menus at run time, refer to the example application chapter, Chapter 10.

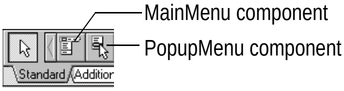
Figure 3.11 Delphi menu terminology



Opening the Menu Designer

To start using the Delphi Menu Designer, first add either a MainMenu or PopupMenu component to your form. Both menu components are located on the Standard page of the Component palette.

Figure 3.12 MainMenu and PopupMenu components



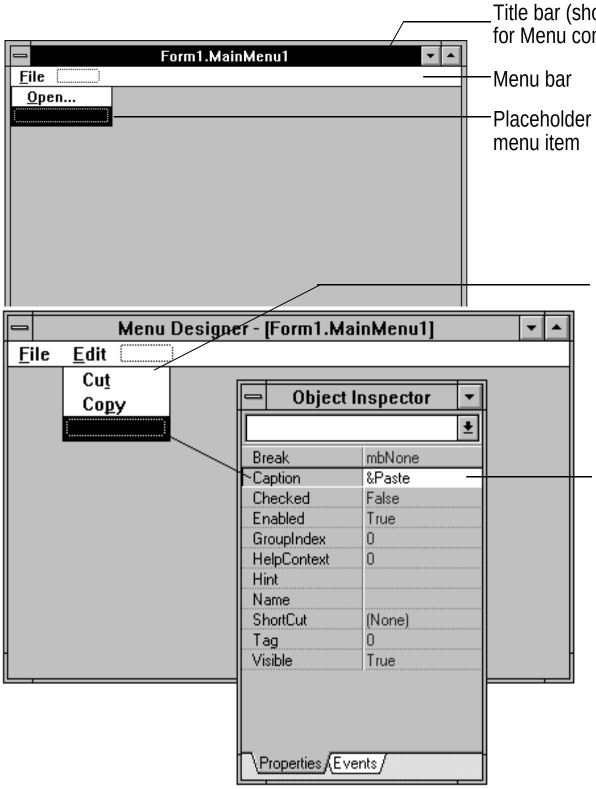
A MainMenu component creates a menu that's attached to the form's title bar. A PopupMenu component creates a menu that appears when the user right-clicks in the form. Pop-up menus do not have a menu bar.

■ To open the Menu Designer, select a menu component on the form, and then choose from one of the following methods:

- Double-click the menu component.
- From the Properties page of the Object Inspector, select the *Items* property, and then either double-click [Menu] in the Value column, or click the ellipsis (...) button.

  The Menu Designer appears, with the first (blank) menu item highlighted in the Designer, and the *Caption* property highlighted in the Object Inspector.

Figure 3.13 Menu Designer for a main menu



Break	mbNone
Caption	&Paste
Checked	False
Enabled	True
GroupIndex	0
HelpContext	0
Hint	
Name	
ShortCut	(None)
Tag	0
Visible	True

Title bar (shows *Name* property for Menu component)

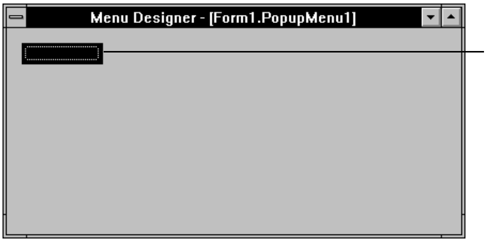
Menu bar

Placeholder for menu item

Menu Designer displays WYSIWYG menu items as you build the menu.

A TMenuItem object is created and the *Name* property set to the menu item *Caption* you specify (minus any illegal characters and plus a numeric suffix).

Figure 3.14 Menu Designer for a pop-up menu



Placeholder for first menu item

Building menus

You add a menu component to your form, or forms, for every menu you want to include in your application. You can build each menu structure entirely from scratch, or you can start from one of the Delphi predesigned menu templates.

This section discusses the basics of creating a menu at design time. For more information about Delphi menu templates, see "Using menu templates" on page 106.

Naming menus

As with all components, when you add a menu component to the form, Delphi gives it a default name; for example, *MainMenu1*. You can give the menu a more meaningful name that follows Object Pascal naming conventions. (For more detail on the Object Pascal language, see Chapter 5.)

Delphi adds the menu name to the form's type declaration, and the menu name then appears in the Component list.

Naming the menu items

In contrast to the menu component itself, you need to explicitly name menu items as you add them to the form. You can do this in one of two ways:

- Directly type in the value for the *Name* property.
- Type in the value for the *Caption* property first, and let Delphi derive the *Name* property from the caption.

  For example, if you give a menu item a *Caption* property value of *File*, Delphi assigns the menu item a *Name* property of *File1*. If you fill in the *Name* property before filling in the *Caption* property, Delphi leaves the *Caption* property blank until you type in a value.

Note If you enter characters in the *Caption* property that are not valid for Object Pascal identifiers, Delphi modifies the *Name* property accordingly. For example, if you want the caption to start with a number, Delphi precedes the number with a character to derive the *Name* property.

The following table demonstrates some examples of this, assuming all menu items shown appear in the same menu bar.

Table 3.6 Sample captions and their derived names

Component caption	Derived name	Explanation
&File	File1	Removes ampersand
&File (2nd occurrence)	File2	Numerically orders duplicate items
1234	N12341	Adds a preceding letter and numerical order
1234 (2nd occurrence)	N12342	
$@@@#	N1	Removes all non-standard characters, adding preceding letter and numerical order
- (hyphen)	N2	Numerical ordering of second occurrence of caption with no standard characters

As with the menu component, Delphi adds any menu item names to the form's type declaration, and those names then appear in the Component list.

Adding, inserting, and deleting menu items

The following procedures describe how to perform the basic tasks involved in building your menu structure. Each procedure assumes you have the Menu Designer window open.

■ To add menu items at design time,

1. Select the position where you want to create the menu item.

   If you've just opened the Menu Designer, the first position on the menu bar is already selected.

2. Begin typing to enter the caption. Or enter the *Name* property first by specifically placing your cursor in the Object Inspector and entering a value. In this case, you then need to reselect the *Caption* property and enter a value.

3. Press *Enter*.

   The next placeholder for a menu item is selected.

   If you entered the *Caption* property first, use the arrow keys to return to the menu item you just entered. You'll see that Delphi has filled in the *Name* property based on the value you entered for the caption. (See "Naming the menu items" on page 101.)

4. Continue entering values for the *Name* and *Caption* properties for each new item you want to create, or press *Esc* to return to the menu bar.

   Use the arrow keys to move from the menu bar into the menu, and to then move between items in the list; press *Enter* to complete an action. To return to the menu bar, press *Esc*.

- To insert a new, blank menu item, place the cursor on a menu item, then press *Ins*.

Menu items are inserted to the left of the selected item on the menu bar, and above the selected item in the menu list.

- To delete a menu item or command, place the cursor on the menu item you want to delete, then press *Del*.

Note You cannot delete the default placeholder that appears below the item last entered in a menu list, or next to the last item on the menu bar. This placeholder does not appear in your menu at run time.

Adding separator bars

Separator bars insert a line between menu items. You can use separator bars to indicate groupings within the menu list, or simply to provide a visual break in a list.

- To make the menu item a separator bar, type a hyphen (-) for the caption.

Specifying accelerator keys and keyboard shortcuts

Accelerator keys enable the user to access a menu command from the keyboard by pressing *Alt*+ the appropriate letter, indicated in your code by the preceding ampersand. The letter after the ampersand appears underlined in the menu.

Keyboard shortcuts enable the user to perform the action without accessing the menu directly, by typing in the shortcut key combination.

- To specify an accelerator, add an ampersand in front of the appropriate letter.

For example, to add a Save menu command with the *S* as an accelerator key, type `&Save`.

- To specify a keyboard shortcut, use the Object Inspector to enter a value for the *ShortCut* property, or select a key combination from the drop-down list.

This list is only a subset of the valid combinations you can type in.

When you add a shortcut, it appears next to the menu item caption.

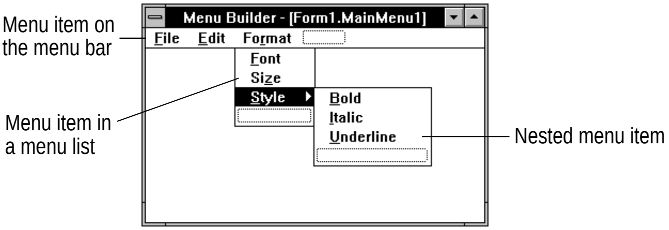
Caution Delphi does not check for duplicate shortcut keys or accelerators, so you need to track values you have entered in your application menus.

Creating nested (sub)menus

Many application menus contain drop-down lists that appear next to a menu item to provide additional, related commands. Such lists are indicated by an arrow to the right of the menu item. Delphi supports as many levels of such nested, or submenus as you want to build into your menu.

Organizing your menu structure this way can save vertical screen space. However, for optimal design purposes you probably want to use no more than two or three menu levels in your interface design. (For pop-up menus, you might want to use only one such nested level, if any.)

Figure 3.15 Nested menu structures



- To create a nested menu,

1 Select the menu item under which you want to create a nested menu.

2 Press *Ctrl*→ to create the first placeholder, or choose Create Submenu from the SpeedMenu.

3 Type a name for the nested menu item, or drag an existing menu item into this placeholder.

4 Press *Enter*, or ↓, to create the next placeholder.

5 Repeat steps 3 and 4 for each item you want to create in the nested menu.

6 Press *Esc* to return to the previous menu level.

Creating nested menus by demoting existing menus

You can create a nested menu by inserting a menu item from the menu bar (or a menu template) between menu items in a list. When you move a menu into an existing menu structure, all its associated items move with it, creating a fully intact nested menu. This pertains to nested menus as well—moving a menu item into an existing nested menu just creates one more level of nesting.

Moving menu items

During design time, you can move menu items simply by dragging and dropping. You can move menu items along the menu bar, or to a different place in the menu list, or into a different menu entirely.

The only exception to this is hierarchical: you cannot demote a menu item from the menu bar into its own menu; nor can you move a menu item into its own nested menu. However, you can move any item into a *different* menu, no matter what its original position is.

While you are dragging, the cursor changes shape to indicate whether you can release the menu item at the new location. When you move a menu item, any items beneath it move as well.

■ To move a menu item along the menu bar,

1. Drag the menu item along the menu bar until the arrow tip of the drag cursor points to the new location.
2. Release the mouse button to drop the menu item at the new location.

■ To move a menu item into a menu list,

1. Drag the menu item along the menu bar until the arrow tip of the drag cursor points to the new menu.

   This causes the menu to open, enabling you to drag the item to its new location.
2. Drag the menu item into the list, releasing the mouse button to drop the menu item at the new location.

Viewing the menu

You can view your menu in the form at design time without first running your program code. (Pop-up menu components are visible in the form at design time, but the pop-up menus themselves are not. Use the Menu Designer to view a pop-up menu at design time.)

■ To view the menu,

1. If the form is visible, click the form, or from the View menu, choose the form whose menu you want to view.
2. If the form has more than one menu, select the menu you want to view from the form's *Menu* property drop-down list.

   The menu appears in the form exactly as it will when you run the program.

Editing menu items without opening the Menu Designer

This section has discussed how to set several properties for menu items—for example, the *Name* and *Caption* properties—by using the Menu Designer.

The section has also described how to set menu item properties, such as the*ShortCut* property, directly in the Object Inspector, just as you would for any component selected in the form.

When you edit a menu item by using the Menu Designer, its properties are still displayed in the Object Inspector. You can switch focus to the Object Inspector and continue editing the menu item properties there. Or you can select the menu item from the Component list and edit its properties without ever opening the Menu Designer.

- To edit a menu item without opening the Menu Designer, select the item from the Component list.
- To close the Menu Designer window and continue editing menu items,

1. Switch focus from the Menu Designer window to the Object Inspector by clicking the properties page of the Object Inspector.
2. Close the Menu Designer as you normally would.

   The focus remains in the Object Inspector, where you can continue editing properties for the selected menu item. To edit another menu item, select it from the Component list.

Using the Menu Designer SpeedMenu

The Menu Designer SpeedMenu provides quick access to the most common Menu Designer commands, and to the menu template options. (For more information about menu templates, refer to "Using menu templates" on page 106.)

- To display the SpeedMenu, right-click the Menu Designer window, or press*Alt+F10* when the cursor is in the Menu Designer window.

Commands on the SpeedMenu

The following table summarizes the commands on the Menu Designer SpeedMenu.

Table 3.7 Menu Designer SpeedMenu commands

Menu command	Action
Insert	Inserts a placeholder above or to the left of the cursor.
Delete	Deletes the selected menu item (and all its sub-items, if any).
Create Submenu	Creates a placeholder at a nested level and adds an arrow to the right of the selected menu item.
Select Menu	Opens a list of menus in the current form. Double-clicking a menu name opens the designer window for the menu.
Save As Template	Opens the Save Template dialog box, where you can save a menu for future reuse.
Insert From Template	Opens the Insert Template dialog box, where you can select a template to reuse.
Delete Templates	Opens the Delete Templates dialog box, where you can choose to delete any existing templates.
Insert From Resource	Opens the Insert Menu from Resource file dialog box, where you can choose an .MNU file to open in the current form.

For more information about the Menu Designer SpeedMenu, see the online Help topic Menu Designer SpeedMenu.

Switching among menus at design time

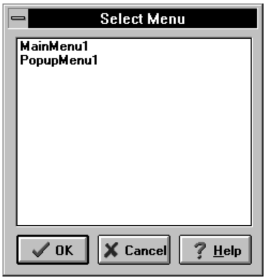
If you're designing several menus for your form, you can use the Menu Designer SpeedMenu or the Object Inspector to easily select and move among them.

- To use the SpeedMenu to switch among menus in a form,

1. Right click in the Menu Designer to display the SpeedMenu.
2. From the SpeedMenu, choose Select Menu.

   The Select Menu dialog box appears.

   Figure 3.16 Select Menu dialog box

   This dialog box lists all the menus associated with the form whose menu is currently open in the Menu Designer.
3. From the list in the Select Menu dialog box, choose the menu you want to view or edit.

- To use the Object Inspector to switch among menus in a form,

1. Give focus to the form whose menus you want to choose from.
2. From the Component list, select the menu you want to edit.
3. On the Properties page of the Object Inspector, select the *Items* property for this menu, and then either click the ellipsis button, or double-click [Menu].

Using menu templates

Delphi provides several predesigned menus, or menu templates, that contain frequently used commands. You can use these menus in your applications without modifying them (except to write code), or you can use them as a starting point, customizing them as you would a menu you originally designed yourself. Menu templates do not contain any event handler code.

The menu templates shipped with Delphi are stored in the \DELPHI\BIN directory in a default installation. These files have a .DMT (Delphi menu template) extension.

You can also save as a template any menu that you design using the Menu Designer. After saving a menu as a template, you can use it as you would any predesigned menu. If you decide you no longer want a particular menu template, you can delete it from the list.

- To add a menu template to your application,

1. Right-click the Menu Designer window.

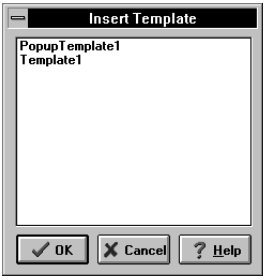
   The Menu Designer SpeedMenu appears.

2. From the SpeedMenu, choose Insert From Template.

   (If there are no templates, the Insert From Template option appears dimmed in the SpeedMenu.)

   The Insert Template dialog box opens, displaying a list of available menu templates.

   Figure 3.17 Sample Insert Template dialog box for menus

   Insert Template

   PopupTemplate1
   Template1

3. Select the menu template you want to insert, then press *Enter* or choose OK.

   This inserts the menu into your form at the cursor's location. For example, if your cursor is on a menu item in a list, the menu template is inserted above the selected item. If your cursor is on the menu bar, the menu template is inserted to the left of the cursor.

- To delete a menu template,

1. Right-click the Menu Designer window.

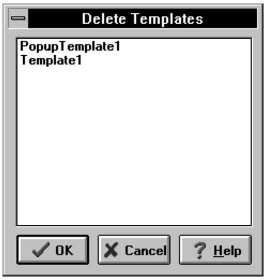
   The Menu Designer SpeedMenu appears.

2. From the SpeedMenu, choose Delete Templates.

   (If there are no templates, the Delete Templates option appears dimmed in the SpeedMenu.)

   The Delete Templates dialog box opens, displaying a list of available templates.

   Figure 3.18 Delete Templates dialog box for menus

   Delete Templates

   PopupTemplate1
   Template1

3 Select the menu template you want to delete, and press *Del*.

Delphi deletes the template from the templates list and from your hard disk.

Saving a menu as a template

Any menu you design can be saved as a template so you can use it again. You can use menu templates to provide a consistent look to your applications, or use them as a starting point which you then further customize.

The menu templates you save are stored in your \DELPHI\BIN directory as .DMT files.

■ To save a menu as a template,

1 Design the menu you want to be able to reuse.

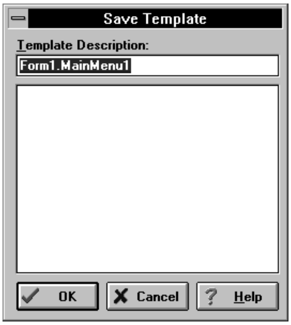
This menu can contain as many items, commands, and submenus as you like; everything in the active Menu Designer window will be saved as one reusable menu.

2 Right-click in the Menu Designer window to open the SpeedMenu.

3 From the Menu Designer SpeedMenu, choose Save As Template.

The Save Template dialog box appears.

Figure 3.19 Save Template dialog box for menus



Form1.MainMenu1

4 In the Template Description edit box, type a brief description for this menu, and then choose OK.

The Save Template dialog box closes, saving your menu design and returning you to the Menu Designer window.

Note The description you enter is displayed only in the Save Template, Insert Template, and Delete Templates dialog boxes. It is not related to the *Name* or *Caption* property for the menu.

Naming conventions for template menu items and event handlers

When you save a menu as a template, Delphi does not save its *Name* property, since every menu must have a unique name within the scope of its owner (the form). However, when you insert the menu as a template into a new form by using the Menu Designer, Delphi then generates new names for it and all its items.

For example, suppose you save a File menu as a template. In the original menu, you name it *MyFile*. If you insert it as a template into a new menu, Delphi names it *File1*. If you insert it into a menu with an existing menu item named *File1*, Delphi names it *File2*.

Delphi also does not save any *OnClick* event handlers associated with a menu saved as a template, since there is no way to test whether the code would be applicable in the new form. When you generate a new event handler for the menu template item, Delphi still generates the event handler name.

You can easily associate items in the menu template with existing *OnClick* event handlers in the form. For more information, see "Associating a menu item with an existing event handler" in the next section.

Associating menu events with code

While you use the Delphi Menu Designer to visually design your application menus, the underlying code is what makes the menus ultimately useful. Each menu command needs to be able to respond to an *OnClick* event, and there are many times when you want to change menus dynamically in response to program conditions.

The following topics describe how to associate code with menu events. For specific code examples that demonstrate ways to dynamically modify menus in a running application, refer to Chapter 10.

Menu component events

The MainMenu component is different from most other components in that it doesn't have any associated events. You can verify this for yourself by adding a menu component to the form and then selecting the Events page of the Object Inspector. You access the events for items in a main menu by means of the Menu Designer.

By contrast, the PopupMenu component has one event: the *OnPopup* event. This is necessary because pop-up menus have no menu bar, therefore no *OnClick* event is available prior to users opening the menu. (The *OnClick* event handler for menu items on a menu bar is often used to change the state of underlying menu items, dependent on program conditions, before the menu is opened.)

Handling menu item events

There is only one event for menu items (as opposed to menu components): The *OnClick* event. Code that you associate with a menu item's *OnClick* event is executed whenever the user chooses the menu item in the running application, either by clicking the menu command or by using its accelerator or shortcut keys.

■ To generate an event handler for any menu item,

1. From the Menu Designer window, double-click the menu item.
2. Inside the **begin..end** block, type the code you want to execute when the user clicks this menu command.

You can also easily generate event handlers for menu items displayed in a form. This procedure does not apply to pop-up menu items, as they are not displayed in the form at design time.

- To generate an event handler for a menu item displayed in the form, simply click the menu item (not the menu component). For example, if your form contains a File menu with an Open menu item below it, you can click the Open menu item to generate or open the associated event handler.

This procedure applies only to menu items in a list, not those on a menu bar. Clicking a menu item on a menu bar opens that menu, displaying the subordinate menu items.

Associating a menu item with an existing event handler

You can associate a menu item with an existing event handler, so that you don't have to rewrite the same code in order to reuse it.

- To associate a menu item with an existing *OnClick* event handler,

1. In the Menu Designer window, select the menu item.
2. Display the Properties page of the Object Inspector, and ensure that a value is assigned to the menu item's *Name* property.
3. Display the Events page of the Object Inspector.
4. Click the down arrow next to *OnClick* to open a list of previously written event handlers.

   Only those event handlers written for *OnClick* events in this form appear in the list.
5. Select from the list by clicking an event handler name.

   The code written for this event handler is now associated with the selected menu item.

Adding menu items dynamically

Sometimes you want to add menu items to an existing menu structure while the application is running, to provide more information or options to the user. You can insert a menu item by using the menu item's *Add* or *Insert* method, or you can alternately hide and show the items in a menu by changing their *Visible* property. The *Visible* property determines whether the menu item is displayed in the menu. To dim a menu item without hiding it, use the *Enabled* property.

For specific code examples that use the menu item's *Visible* and *Enabled* properties, see Chapter 10 and online Help.

In Multiple Document Interface (MDI) and Object Linking and Embedding (OLE) applications, you can also merge menu items into an existing menu bar. The following section discusses this in more detail.

Merging menus

For MDI applications, such as the text editor sample application, and for OLE client applications, your application's main menu needs to be able to receive menu items either from another form or from the OLE server object. This is often called *merging menus*.

You prepare menus for merging by specifying values for two properties:

- *Menu*, a property of the form
- *GroupIndex*, a property of menu items in the menu

Specifying the active menu: Menu property

The *Menu* property specifies the active menu for the form. Menu-merging operations apply only to the active menu. If the form contains more than one menu component, you can change the active menu at run time by setting the *Menu* property in code. For example,

```
Form1.Menu := SecondMenu;
```

Determining the order of merged menu items: GroupIndex property

The *GroupIndex* property determines the order in which the merging menu items appear in the shared menu bar. Merging menu items can replace those on the main menu bar, or can be inserted.

The default value for *GroupIndex* is 0. Several rules apply when specifying a value for *GroupIndex*:

- Lower numbers appear first (farther left) in the menu.

  For instance, set the *GroupIndex* property to 0 (zero) for a menu that you always want to appear leftmost, such as a File menu. Similarly, specify a high number (it needn't be in sequence) for a menu that you always want to appear rightmost, such as a Help menu.

- To replace items in the main menu, give items on the child menu the same *GroupIndex* value.

  This can apply to groupings or to single items. For example, if your main form has an Edit menu item with a *GroupIndex* value of 1, you can replace it with one or more items from the child form's menu by giving them a *GroupIndex* value of 1 as well.

  Giving multiple items in the child menu the same *GroupIndex* value keeps their order intact when they merge into the main menu.

- To insert items without replacing items in the main menu, leave room in the numeric range of the main menu's items and "plug in" numbers from the child form.

  For example, number the items in the main menu 0 and 5, and insert items from the child menu by numbering them 1, 2, 3 and 4.

Additional rules apply for OLE client applications. For more information, refer to Chapter 15.

Importing resource (.RC) files

Delphi supports menus built with other applications, so long as they are in the standard Windows resource (.RC) file format. You can import such menus directly into your Delphi project, saving you the time and effort of rebuilding menus that you created elsewhere.

■ To load existing .RC menu files,

1 In the Menu Designer, place your cursor where you want the menu to appear.

The imported menu can be part of a menu you are designing, or an entire menu in itself.

2 From the Menu Designer SpeedMenu, choose Insert From Resource.

The Insert Menu From Resource dialog box appears.

3 In the dialog box, select the resource file you want to load, and choose OK.

The menu appears in the Menu Designer window.

Note If your resource file contains more than one menu, you first need to save each menu as a separate resource file before importing it.

Managing run-time behaviors of forms

The main focus of this chapter up to this point has been on the design and construction aspects of forms. There are two run-time aspects of forms that you might find you want to specify at design time. These are designating a form as the project main form, and controlling the creation order of forms at run time.

Specifying a form as the project main form

The first form you create and save in a project becomes, by default, the project's main form, which is the first form created at run time. (For more information about form creation order, see "Controlling the form auto-create order" later in this chapter, or see online Help.) As you add forms to your projects, you might decide to designate a different form as your application's main form. Also, specifying a form as the main form is an easy way to test it at run time, because unless you change the form creation order, the main form is the first form displayed in the running application.

■ To change the project main form,

1 Choose Options | Project from the Delphi menu bar to display the Project Options dialog box.

2 Select the Forms page of the dialog box.

3 In the Main Form combo box, select the form you want as the project main form and choose the OK button.

Now if you run the application, your new main form choice is displayed.

Specifying forms to auto-create

The form you specify as the project main form is always "created" (loaded in memory) when the application runs. The main form is also the first form loaded unless you specify otherwise in code. As you create additional forms for the project, these are also auto-created at run time.

This has the advantage of having all forms in the application available to display without writing any code to specifically create the form (you still need to show or hide the form). However, there might be times when you decide you don't want all the forms in an application created in memory when the application first starts running; you might prefer to control programmatically when the forms are created. For example, if there are several different forms that automatically connect to databases, you might prefer to create those forms only as necessary.

You can use the Project Options dialog box to specify which of your application's forms will auto-create at run time.

■ To specify whether forms are auto-created at run time,

1 Choose Options | Project, and select the Forms page of the dialog box.

The names of all forms in the project are displayed in the Auto-Create Forms list.

2 In the Auto-Create Forms list, select any form(s) that you do *not* want created in memory at run time, and choose the **>** button. To move all form names from one list to the other, choose the **<<** or the **>>** button.

The selected files move to the Available Forms list. Forms displayed in this list do not auto-create at run time.

3 Choose the OK button to save the information and close the dialog box.

Note It's usually best to have Delphi create your application forms. If you decide not to auto-create a form, you must specifically create the forms at run time by writing code. If you try to reference a form that hasn't first been created, for example by calling its *Show* method, Delphi raises an exception.

For more information on creating forms at run time, search online Help for "Instantiating Forms."

Controlling the form auto-create order

After the main form, the forms you specify in the Auto-Create Forms list are created at run time in the order they are displayed in the list. You can change the order by changing a form name's position in the list. For instance, if you've designed one form that contains dependencies to another form, you can ensure the form is available by creating it first.

■ To change a form's creation order, in the Auto-Create list, select the form name and drag it to the position you want.

Note The main form and auto-create specifications on the Forms page of the Project Options dialog box are reflected in the *Application.CreateForm* statements in the project (.DPR) file.

Summary

This chapter has presented the following topics:

- Sharing forms with other units, both in the same project and in other projects
- Using the Browse Gallery to add Form Templates to your project
- Viewing forms and units
- Designing forms, including setting design-time and run-time properties, specifying the tab order, and setting focus
- Adding and saving forms as ASCII
- MDI and SDI forms
- Creating form menus, including how to use the Menu Designer to create and name menu items, specifying accelerator keys and keyboard shortcuts, creating nested menus, and moving menu items
- Setting menu properties through the Object Inspector
- Using the Menu Designer SpeedMenu
- Using and saving menu templates
- Dynamically adding menu items
- Merging menu items
- Importing resource (.RC) files
- Changing the project main form designation
- Controlling the auto-create order of forms

Chapter

4

Managing projects, files, and directories

The purpose of this chapter is to help you understand what a Delphi project comprises and how to manage the projects you create as you work with Delphi. The topics covered in this chapter include

- What is a project?
- Beginning new projects
- Customizing project options
- Managing project content
- Compiling, building, and running projects
- Managing multiple project versions and team development

What is a project?

The Delphi application development process centers around the concept of *projects*. A Delphi *project* is a collection of all the files that together make up a Delphi application (or distributable library). Some of these files are generated as you work on a project at design time. Others are created when you compile the project source code.

Project directories

Normally, you should store each Delphi project you create in its own directory. If you begin a project using any Project Template other than the Blank Project template, Delphi prompts you for a directory path and then (if necessary) creates the specified directory for the project. If you begin with the Blank Project template, Delphi saves it by default in the \BIN directory, unless you specify otherwise. To avoid cluttering this directory, and potentially overwriting files, create the project directory from the Windows operating environment before saving the new project for the first time. (See "Beginning a project with a Project Template" on page 122 for more information about Project Templates.)

Note Projects can reside in any network or local drive location that your computer can access. Delphi doesn't *require* you to store projects in separate directories, but you will find it much easier to manage them if you do.

Constituent files of a project

To manage projects effectively, you need to understand the various files and file types that constitute a Delphi project. Simply opening a new project within Delphi does not create project files on disk. Delphi generates the actual files at different times as you work on the project—some at design time, when you initially save the project or changes to it, and some when you compile the project's source code. Still other files used in a project might be created by other applications and integrated into your Delphi application at save or compile time.

Files generated at design time

Some project files are generated as you develop a project. These are mainly source code, configuration, and backup files. File- or project-saving operations within Delphi trigger their creation on disk. Table 4.1 summarizes these files and their DOS file extensions and explains when they are written to disk.

Table 4.1 Design-time project files

File extension	Definition	Purpose
.DPR	Project file	Pascal source code for the project's main program file. Lists all form and unit files in the project, and contains application initialization code. Created when project is first saved.
.PAS	Unit source (Object Pascal) code	One .PAS file is generated for each form the project contains when the project is first saved. (Your project might also contain one or more .PAS files not associated with any form.) Contains all declarations and procedures, including event handlers, for the form.
.DFM	Graphical form file	Binary file containing the design properties of a form contained in the project. One .DFM file is generated along with the corresponding .PAS file for each form the project contains when the project is first saved.
.OPT	Project options file	Text file containing the current settings for project options. Generated with first save and updated on subsequent saves if changes were made to project options.
.RES	Compiler resource file	Binary file containing the application icon and other outside resources used by the project.
.~DP	Project backup file	Generated on the second save of a project and updated on subsequent saves, this file stores a copy of the .DPR file as it existed before the most recent save.
.~PA	Unit backup file	This file stores a copy of a .PAS file as it existed before the most recent save. If a .PAS file changes, this parallel file is generated on the second project save, or any save of the .PAS unit file after a change has occurred. It is updated on subsequent saves if the .PAS file has changed.

Table 4.1 Design-time project files (continued)

File extension	Definition	Purpose
.~DF	Graphical form backup	If you open a .DFM file as text in the Code Editor and make changes, this file is generated when you save the .DFM file. It stores a binary-format copy of the .DFM file as it existed before the most recent save.
.DSK	Desktop settings	This file stores information about the desktop settings you have specified for the project in the Environment options dialog box.

Compiler-generated project files

Some project files are created on disk at compile time. These include the application executable file that you can deploy and distribute when the project is complete, and the object code for the project unit files (each separately compiled, to minimize time required for compilation).

Table 4.2 summarizes the project files created and/or written at compile time.

Table 4.2 Compiler-generated project files

File extension	Definition	Purpose
.EXE	Compiled executable file	This is the distributable executable file for your application. This file incorporates all necessary .DCU files when your application is compiled. There is no need to distribute .DCU files with your application.
.DCU	Unit object code	Compilation creates a .DCU file corresponding to each .PAS file in the project.
.DLL	Compiled Dynamic-link library	For information on creating DLLs, see the *Delphi Component Writer's Guide*.

Non-Delphi resource files

Some files that you use in a Delphi project might be files created with applications other than Delphi and need not reside in the project directory. When you correctly specify such files in a project, Delphi integrates them when you save or compile the project. Some of these files might be common to multiple projects. The most common examples of non-Delphi files used in Delphi projects are

- *Image files.* The bitmaps (.BMP, .WMF files) that you use in *TImage*-type components, or as glyphs on *TBitBtn* components, can reside anywhere on your system. When specified as properties of these graphical components, Delphi takes a “snapshot” of the disk file and stores this in the binary form (.DFM) file. They are eventually compiled into the project executable file. Once the image has been stored in the form file, the original image file is no longer required by Delphi.
- *Icon files.* The icons (.ICO files) that you specify in the *Icon* property of forms and in the Project Options dialog box can also reside anywhere. They are integrated into the project in the same way as bitmap image files. After being included in the project, the original icon file is no longer required by Delphi. .BMP and .ICO files can also be created with the Delphi Image Editor, or you can choose from the bitmaps and icons

available in the Delphi Image Library. For more information on the Image editor, and the Delphi Image Library, see online Help.

- *Help files.* The online Help (.HLP) file that you specify for the project in the Project Options dialog box can also reside anywhere. The .HLP file can be compiled using either the Microsoft Help Compiler shipped with Delphi, or another third-party Help compiling system. Only the file name and its path (if specified) are integrated into the project, not the Help file itself. This can affect the accessibility of Help when you deploy or distribute your application. For more information, see "Application page" under "Project options" on page 128.

Understanding the files in a project

As described in Tables 4.1 and 4.2, several different DOS file types work together to create a project, specifying project and environment options, containing compiled and uncompiled Object Pascal code, detailing the appearance and behavior of the project's forms, and so on.

This section discusses the file types within the project that affect the appearance and behavior of your completed application, including

- The project source code (.DPR) file
- Unit source code (.PAS) files
- Unit object code (.DCU) files
- Graphical form (.DFM) files

The project source code (.DPR) file

The .DPR file is the main program file Delphi uses to compile all other units. Delphi updates this file throughout the development of the project.

When you initially save the project, you are prompted to name the project source code file (after being prompted to name any unit source code files the project contains). Since the project file is stored by the operating system, the file name must conform to DOS file naming rules.

As introduced in Chapter 1, Delphi generates the following source code for a default project:

```
program Project1;
uses
  Forms,
  Unit1 in 'UNIT1.PAS' {Form1};

{$R *.RES}

begin
Application.CreateForm(TForm1, Form1);
Application.Run;
end.
```

- *Project1* represents the file name of the project source code file. For example, if you save the project source code file under the name MYNEWAPP.DPR, the first line of the source code would be

  ```
  program Mynewapp;
  ```

- *Unit1* represents the unit identifier, where 'UNIT1.PAS' represents the actual DOS file name for the unit. If the unit identifier is longer than the standard eight character DOS file-name convention, Delphi creates the file name as a truncated version of the identifier. Otherwise these names are identical and must remain so in order for your project to be correctly compiled.
- The **in** clause tells the compiler where to find the unit file. {*Form1*} represents the variable identifier for the form associated with this unit (this would not appear in the clause if this were not a form-associated unit.) This is the same as the*Name* property of the form. Because you use the Object Inspector to name the form, Delphi maintains the name in the .DPR file.
- The **$R** *compiler directive* specifies that the file with a .RES extension and the same base name as the project is to be included in the project. For more information, search online Help for the Resource File Directive topic.
- The *Application.CreateForm* statement loads the form specified in its argument. Delphi adds an *Application.CreateForm* statement to the project file for each form you add to the project. The statements are listed in the order the forms are added to the project. This is the order that the forms will be created in memory at run time. If you want to change this order, do not edit the project source code. Use Options | Project on the Delphi menu bar. (For more information see Chapter 3.)
- The *Application.Run* statement starts your application.

Each time you add a new form or unit to the project, Delphi adds it to the**uses** clause in the project source code file. For more information, see "Integrating forms and units into a project" on page 133.

Important Because Delphi maintains the .DPR file, you should not normally need to modify it manually, and in general it is not recommended that you do so.

Unit source code (.PAS) files

Units are the main building blocks of Delphi applications. Unit files are identified by a .PAS file extension. They contain the Object Pascal source code for the elements of the Delphi applications you build. For example, every form has its own unit source code file. Unit source code files may initially be created as part of a project, but this is not required. You can create and save a unit as a stand-alone file that any project can use. Once you add a unit to a project, Delphi registers the unit in the **uses** clause of the project .DPR file.

If you open and save a default new project, the project directory initially contains one unit source code (.PAS) file, and one associated graphical form (.DFM) file. The .PAS file contains the source code for the form and its event handlers; the .DFM file contains binary code that stores the visual image data for the form.

Not all unit files need be associated with forms. For example, if you write your own procedures, functions, DLLs, or components, their source code might reside in a separate .PAS file that has no associated form. The rest of this section explains how to generate a default unit (.PAS) file for each purpose.

Form-associated unit files

The type of unit source code file you will probably work with most is the form-associated unit. This is the type of unit created whenever you open a new form. As introduced in Chapter 1, Delphi generates the following code for *Unit1* of a default blank project, and for every unit with an associated blank form that you add to the project. Of course, the default unit identifier will be incrementally updated (*Unit2, Unit3*, and so on) as you add new forms.

```
unit Unit1;
interface
uses
  SysUtils, WinTypes, WinProcs, Messages, Classes, Graphics, Controls,
  Forms, Dialogs;
type
  TForm1 = class(TForm)
  private
    { Private declarations }
  public
    { Public declarations }
  end;
var
  Form1: TForm1;
implementation
{$R *.DFM}
end.
```

Form unit type declaration

The **type** declaration (or class declaration) part introduces the form as a *class*. A class is simply an object, which you will recognize if you are familiar with previous versions of Borland Pascal products, or another object-oriented programming language. Chapter 5 discusses classes and objects in more detail.

All the elements that make up a Delphi application, such as buttons, labels, fonts and so forth, are objects. Delphi objects encapsulate Windows behaviors, enabling you to interact with the object instead of directly with Windows.

Form unit var declaration

The form unit **var** declaration declares your form as an instance of *TForm1*. This means it contains all the behaviors and characteristics of a *TForm* object.

Form unit compiler directive

The **$R** *compiler directive* links the *TForm*'s binary file (.DFM). This adds the .DFM file(s) in your project to the compiled executable.

You can change which form is specified as your application's main form. For more information, see "Gallery options" on page 124.

Caution Do not remove the **$R** *.DFM directive from a form unit file. Doing so will result in code that will never work correctly.

Unit files for procedures and functions

You can write custom procedures or functions within any source code unit, including those associated with a form file. You might, however, want to reuse the routines that you write. In this case, it's usually better to create a unit specifically to contain those routines. By creating "stand-alone" units that have no associated form, you can make your specialized procedures and functions easily available to other projects.

■ To create a unit file not associated with a form, choose File | New Unit.

It is not necessary to have a project open unless you want the new unit to be part of a project.

Unit files for components

If you elect to write a new Delphi component, you need to create a unit file for the source code. The default structure of the unit source code for a new component differs somewhat from other unit files. (You begin creating a new component unit file when you choose New Component from the File menu.)

For information on creating a component unit file, see "Using the Component Expert" in Chapter 2. You can find an example of unit file source code for a new component on page 72. The *Delphi Component Writer's Guide* provides complete information on creating new Delphi components.

Unit object code (.DCU) files

When you compile a project, Delphi creates an object code file for each unit. The file name is the same as the corresponding unit source file (.PAS), and Delphi adds a .DCU extension. Thus, the object code file for UNIT1.PAS is UNIT1.DCU.

The .DCU file is a binary file maintained by the Object Pascal compiler, so you should never need to open or modify this file by any other means.

Note .DCU files are used to help achieve the high speed and efficiency of the Delphi compilation process. You do not need to distribute .DCU files with your completed application.

Graphical form (.DFM) files

As discussed in previous chapters, a file with a .DFM extension is a binary file that contains information about the graphical properties of a form. The visual display of a form at design time and at run time derives its information from this file. Delphi maintains a corresponding .DFM file for each form-associated unit source code file.

If you develop forms exclusively with the visual tools provided by Delphi, you seldom, if ever, need to deal directly with .DFM files. Delphi updates them as you save changes to the visual form image. You can, however, edit a .DFM file as text by opening it as a file in the Code Editor (using File | Open File). When you close a .DFM file, the Code Editor automatically converts it back to binary format.

For more information on .DFM files, see Chapter 3, "Saving form files as ASCII text" on page 94.

Beginning new projects

As discussed in Chapter 1, you can choose from a number of options that control what occurs when you begin a new project in Delphi. In a default installation of Delphi, opening a new project displays a blank form, based on the Blank Project template. You can change this default behavior in several ways. By changing Gallery options, (setting Gallery options is discussed on page 124) you can

- Specify the default new project to be one of the other Delphi Project Templates, including any project you have created and saved as a Project Template. (Saving a project as a Project Template is discussed on page 126.)
- Specify the default new project be started from one of the Delphi Project Experts. For more information about Project Experts, search the online Help system under Experts.
- Specify that the default new form be one of the Delphi Form Templates, including any form you have created and saved as a Form Template. (Saving a form as a Form Template is discussed on page 126.)
- Specify that the default new form be one of the Delphi Form Experts.

The following section discusses how to begin a new project from one of the non-default Delphi Project Templates. "Customizing project options" on page 123 describes how to set your preferred project options or modify project options set by another Delphi user.

Beginning a project with a Project Template

Delphi's Project Templates provide you with predesigned projects that you can use as a starting point for your applications. Project Templates are part of the Gallery (located in the \DELPHI\GALLERY directory), which also provides Form Templates and Experts.

When you begin a project from a Project Template (other than the Blank Project Template), you are prompted to specify a *project directory*, a unique subdirectory in which to store the new project files. If you specify a directory that doesn't currently exist, Delphi creates it for you. From that point on, Delphi treats the template as a separate open project. You can modify it, adding new forms and units, or use it unmodified, adding only your event handler code. In either case, your changes affect only the open project. The original Project Template is unaffected and can be used again.

■ To start a new project from a Project Template,

1. Choose File | New Project to display the Browse Gallery dialog box.
2. Select the Project Template you want and choose OK.

3 In the Select Directory dialog box, specify a directory for the new project's constituent files.

A copy of the Project Template opens in the specified directory.

Note If the Browse Gallery dialog does not appear in step 2, the Gallery is not enabled in the environment. The Project Template option in the Gallery is disabled by default in a new Delphi installation..

Customizing project options

While the preceding section discusses how to create new projects using the default values of a new Delphi installation, your ability to control project options doesn't end there. Delphi offers you the option of customizing the integrated development environment (IDE) itself. The appearance and behavior of the IDE when you start Delphi or begin a new project are governed by the settings of several types of options:

- Environment settings affect all Delphi projects.
- Gallery settings determine the default new form and new project.
- Project settings affect the current project only.

Note If you share your installation of Delphi with other users, it's possible that another user has modified the default option settings; in which case, displays or behaviors might differ from those described in the examples and illustrations in this chapter. In a shared-installation situation, it's a good idea to check and modify environment options (if necessary), as described in the following sections, before creating a new project.

Environment options

The settings in the Environment Options dialog box affect all Delphi projects. This dialog box contains several pages of options that you can change to customize your installation of Delphi. Some of the settings affect the behavior of Delphi when you open a new project, or add new forms and units to an open project. This section covers those particular settings.

■ To open the Environment Options dialog box, choose Options | Environment.

For more information on the Environment Options dialog box, see Chapter 1 or online Help.

Environment preferences

The options on the Preferences page have the most impact on what occurs when you open a new project, reopen an existing project, or add forms and units to an open project.

Autosave options

The Autosave options are Editor Files and Desktop. The settings of these options affect what you see when you start Delphi.

If the Desktop option is checked, Delphi loads the last project you worked on, and displays any forms that were open at that time.

If the Editor files option is checked, Delphi saves all modified files in the Code Editor when you choose from the Run menu (Run, Trace Into, StepOver, or Run To Cursor), or when you exit Delphi.

By default, these boxes are unchecked. Thus, when you start Delphi, the default new project opens.

Gallery

The Gallery check boxes specify whether Delphi displays the Browse Gallery dialog box when you choose File | New Project or File | New Form.

When checked,

- Use On New Form displays the Browse Gallery dialog box whenever you choose File | New Form.
- Use On New Project displays the Browse Gallery dialog box whenever you choose File | New Project.

If you check an option that causes the Browse Gallery dialog box to be used, its appearance and defaults are controlled by the settings specified in the Gallery Options dialog box.

Gallery options

The settings in the Gallery Options dialog box affect the behavior of Delphi when you begin a new project or create a new form in an open project. This is where you specify

- Default Project. The Project Template or Expert to be used whenever you open a new project.
- Default New Form. The Form Template Form Expert to be used when the Gallery is disabled in the environment and you open a new form.
- Default Main Form. The Form Template used as the main form for a blank project only.

■ To open the Gallery Options dialog box, choose Options | Gallery.

Specifying the default new project

The default new project opens whenever you choose New Project from the File menu on the Delphi menu bar. In a new Delphi installation the Blank Project template is the default. You can specify any other Project Template (including a project you have created and saved as a Project Template) as the default new project. Alternatively, you can designate a Project Expert to run by default when a new project is begun.

Specifying a Project Template

■ To specify a Project Template as the default new project, 1 Choose Options | Gallery to display the Gallery Options dialog box.

2 Choose the Project Templates page tab.

3 Select the project template you want as the default new project.

4 With the template you want selected, choose the Default Project button.
The folder icon appears in the box for the selected default project.

5 Choose OK to register the new default setting.

Specifying a Project Expert

A Project Expert is a program that enables you to build a project based on your responses to a series of dialog box options.

Instead of opening a Project Template by default when you begin a new project, you can run a Project Expert instead.

■ To specify a Project Expert as the default new project,

1 Choose Options | Gallery.

2 Choose the Project Experts page tab.

3 Select the box displaying the Project Expert you want to run when a new project is opened.

4 With the Expert you want selected, choose the Default Project button.
The folder icon displays in the box for the selected Expert.

5 Choose OK to register the new default setting.

Specifying the default new form

The default new form opens whenever you choose File | New Form or use the Project Manager to add a new form to an open project. In a new Delphi installation, the Blank Form template is the default. You can specify any other Form Template, including a form you have created and saved as a Form Template, as the default new form. Or you can designate a Form Expert to run by default when a new form is added to a project.

■ To specify the default new form for new projects,

1 Choose Options | Gallery to display the Gallery Options dialog box.

2 Choose the Form Templates page tab.

3 Select the Form Template you want as the default new form.

4 With the template you want selected, choose Default New Form.
The form icon appears in the box for the selected default form.

5 Choose OK to register the new default setting.

Specifying the default main form

Just as you can specify the Form Template to be used whenever a new form is added to a project, you can also specify which Form Template should be used as the default main form whenever you begin a new project.

- To specify the default main form for open projects,

1. Choose Options | Gallery to display the Gallery Options dialog box.
2. Choose the Form Templates page tab.
3. Select the Form Template you want as the default main form.
4. With the template you want selected, choose Default Main Form.
   The folder-with-form icon appears in the box for the selected default form.
5. Choose OK to register the new default setting.

Adding templates to the Gallery

You can save your own projects and forms as templates and add them to those already available in the Gallery. This is helpful in situations where you want to enforce a standard framework for programming projects throughout an organization.

For example, suppose you develop custom billing applications. You might have a generic billing application project that contains the forms and functionality common to all billing systems. Your business centers around adding and modifying features in this application to meet specific client requirements. In such a case, you might want to save the project containing your Generic Billing application as a Project Template and optionally specify it as the default new project on your Delphi development system. Likewise, you'll probably have a particular form within this project that you want to appear as the default main or new form.

Before adding a project or form to the Gallery, you should develop it as fully as possible and practical, to minimize the amount of additional work needed when you open the template.

- To add a project to the Gallery,

1. If necessary, open the project you want added to the Gallery.
2. Choose Options | Gallery.
3. On the Project Templates page, choose Add to display the Save Project Template dialog box.
4. Specify a DOS-compatible file name (without extension) for the template file.
   By default, Delphi suggests the name of the project (.DPR) file.
5. In the Title edit box, enter a project title.
   The title for the template will appear in the Browse Gallery window.
6. In the Description field, enter text that describes the template.
   This text will appear in the Gallery window's status panel.
7. Choose Browse and select bitmap file to represent this template in the Gallery.
   This can be any Windows-compatible bitmap (including those you create in Delphi's Image editor), but the Gallery displays only the upper left portion of any bitmap too large to fully fit the available space.
8. Choose OK to put your choices into effect, and save the current project as a Project Template.

Note If you later make changes to a Project Template, you will need to resave the project*as a template*, not merely as a project.

You can also save your own forms as Form Templates and add them to those already available in the Forms Gallery. This is helpful in situations where you want to develop standard forms for an organization's software, as in the earlier example.

■ To add a form to the Gallery as a Template, follow the preceding steps for adding projects as templates, using the Form Templates page of the Gallery Options dialog box instead of the Project Templates page.

Project options

The settings in the Project Options dialog box affect only the current open project. If you modify any of the defaults, a configuration file with a file extension .OPT is created in the project directory the next time you save the project. When you reopen the project in future work sessions, the project options, as saved in the .OPT file, are in effect.

■ To display the Project Options dialog box, choose any of these methods:

- In the Project Manager, choose the Options button on the SpeedBar.
- In the Project Manager, choose the Options SpeedMenu command.
- Choose Options | Project from the Delphi menu bar.

The next sections point out the options in the Project Options dialog box that pertain to project management. Detailed information for each option in the dialog box can be found in online Help.

Default check box

The Project Options dialog box displays a check box control labeled Default. This control enables you to modify some of Delphi's default project configuration properties. Checking this control writes the current settings from the Compiler, Linker, and Directories/Conditionals pages of the Project Options dialog to a file called DEFPROJ.OPT. Delphi creates this file when you check the Default box and choose OK in the Project Options dialog box. Delphi then uses the project options settings stored in this file as the default for any new projects you create.

Delphi maintains all its original project defaults, which the settings in DEFPROJ.OPT simply override.

■ To restore Delphi's original default settings, delete or rename the DEFPROJ.OPT file.

Note Project options you set for an open project override the current Delphi defaults, whether those defaults are as originally shipped or as modified by you or another user.

Form options

The options on the Forms page of the Project Options dialog box enable you to change the form designated as the project's main form, and to control the creation order of forms at run time. For more information see Chapter 3.

Application page

The Application page is where you specify a title, Help file, and icon for the project. You can also specify these options as default project settings.

Title

The text you enter here appears below the application icon when you minimize the running application. If no title is specified, the minimized application displays the file name of the .EXE file.

Help file

If you have created a Windows Help (.HLP) file for the project, you “connect” it to the application by specifying it in the Help File edit box. Either type a file name or use the Browse button to select an existing Help file.

At run time, the Help file name (and path if it exists) is passed to the Windows WINHELP.EXE, which attempts to load your help file and access the context topic if appropriate. For further information, consult your Windows Help documentation, or the online Help file, “Creating Windows Help.”

Caution Be aware that the Help file for your distributed application might not reside in the same location, relative to the executable file, as it does on your development system. Avoid specifying a drive name unless you know for certain that the finished application’s Help file will always reside on a drive with that name.

Consult your Windows Help documentation for further information on how WINHELP.EXE attempts to locate Help files.

Icon

Delphi supplies a default icon for all projects, which appears whenever the running application is minimized, or when the application’s .EXE is specified in creating a program item for the Windows Program Manager. You’ll probably want to use a different icon for your applications. The Delphi Image Library supplies some icon files that you can use directly or modify by using the Delphi Image editor. You can specify any standard Windows icon file (.ICO) residing in any location. The specified icon is compiled into the project’s executable file.

Compiler page

The options on this page enable you to specify compiler options. Modified settings affect only the current project unless the Default box is checked. Checking the Default box preserves the settings on this page as the default compiler settings for all new projects (see “Default check box” on page 127).

For information on the individual settings on this page, see online Help.

Linker page

This page enables you to specify how the link options are configured. The two options that relate to project management are Include TDW Debug Info and the Default check box.

Checking the Include TDW Debug Info check box causes debugging information to be compiled into the project executable file. This enlarges the size of that file. See online Help for information about using this or other options on the Linker page.

Checking the Default check box preserves the settings on this page as the default linker configuration for all new projects (see "Default check box" on page 127).

Directory and Conditional options

On the Directories/Conditionals page, you can control the location of the project's compiled output and specify the location of resources needed to compile, link, and distribute the application.

If you want the compiled project output to be stored in a directory other than the project directory, you can enter a path in the Output Directory edit box. The specified directory must exist or be accessible at compile time or Delphi generates an error message.

The Search Path edit box specifies the location(s) of any non-Delphi library file(s) needed to compile the program. The Delphi compiler always includes \DELPHI\BIN and \DELPHI\LIB directories in its search for resources. If your program needs to access libraries residing elsewhere, you need to specify the library path location in this area of the dialog box. See online Help for more information.

Enter any symbols referenced in conditional compiler directives in the Conditional Defines edit box. Again, see online Help for information.

Managing project content

Delphi's object-oriented architecture enables projects to use resources from a wide variety of physical locations. Some of the units in a project might reside in the project directory, while others might reside in the directory of the project that created them, or in some other directory.

If you never reuse in other projects anything you create in one project, you'll have little difficulty keeping track of what files are being used in a project and where they reside. (You'll also miss out on one of Delphi's biggest benefits, however!)

As you create new projects, create new forms and units in projects, and share files from other projects, keeping track of what files a project uses and where those files are stored becomes more and more necessary. The Delphi Project Manager makes this task and several others easier to do, and more centrally accessible.

Using the Project Manager

The Delphi Project Manager provides a high-level view of the form and unit files listed in the **uses** clause of your .DPR file. (It looks at the **in** directive to get the file names.) You can use the Project Manager to open, add, save, and remove project files, and to open the Project Options dialog box, where you can configure project default settings.

You access the Project Manager window by means of the View menu.

If you share files among different projects, using the Project Manager is recommended because you can quickly and easily tell the location of each file in the project. This is especially helpful to know when creating backups that include all files the project uses. (See page 139 for more information on making backups.)

Displaying the Project Manager

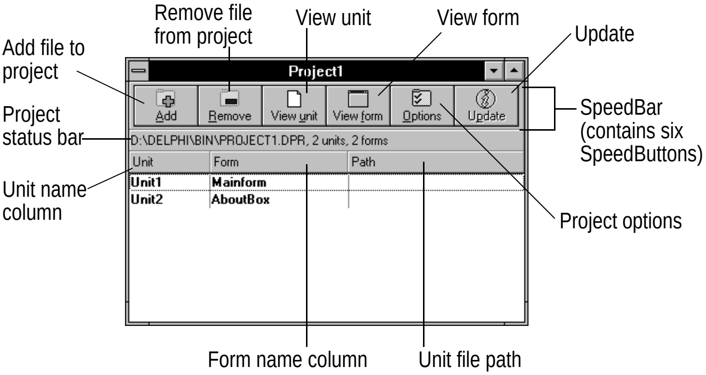
You need to have a project open in order to view the Project Manager.

■ To view the Project Manager window, with a project currently open, choose View | Project Manager.

The Project Manager window

The Project Manager window displays information about the status and file content of the currently open project. It also provides quick access to project management functions, easy navigation among the constituent files, and access to project options through the SpeedBar and SpeedMenu.

Figure 4.1 Project Manager window



D:\DELPHI\BIN\PROJECT1.DPR, 2 units, 2 forms

Unit	Form	Path
Unit1	Mainform	
Unit2	AboutBox	

As shown in the preceding figure, the main elements of the Project Manager window are

- The SpeedBar
- The project status bar
- The project file list

The Project Manager also has a SpeedMenu which you can display by right-clicking anywhere inside the window.

Project Manager SpeedBar

The SpeedBar has six buttons that provide commonly needed functionality:

Table 4.3 Project Manager SpeedBar buttons

Button	PM SpeedMenu command	Delphi menu command	Function	Comment
Add	Add File	File | Add File	Adds a shared or non-shared file to the project. The Path column of the Project Manager's constituent file list reflects the location of any shared file.	Non-shared files reside in the project directory. Shared files still reside outside the project directory; they are not copied to the current project directory. Any changes to the shared file, in any project, are reflected in *all* projects using the file.
Remove	Remove File	File | Remove File	Removes the selected file(s) from the current project.	Only the relationship of the selected file(s) with the current project is removed. The file still exists in its current location. The .DPR file is updated to reflect the change.
View Unit	View Unit	View | Units (*Ctrl + F12*)	Opens (if necessary) and displays the selected file in the Code Editor. If multiple files are selected in the Project Manager window, displays the most recently selected file.	Using the Delphi menu command opens the View Unit dialog box, where you can select which unit to view.
View Form	View Form	View | Forms (*Shift + F12*)	Displays the visual image of the currently selected form unit. If the currently selected file is not a form unit, this button is disabled and the SpeedMenu command is dimmed.	Using the Delphi menu command opens the View Form dialog box, where you can select which form to view.
Options	Options	Options | Project	Displays the Project Options dialog box.	
Update	Update		Synchronizes the Project Manager window display with listings in the project unit source code (.DPR) file.	This button normally remains disabled, and its parallel SpeedMenu command dimmed, unless you have manually modified the project (.DPR) file (which is not recommended).

Project Manager status bar

This area, immediately below the SpeedBar, displays information about the location of the main project source code (.DPR) file, and a summary of the number of forms and units registered in the .DPR file.

The .DPR file location can be a useful reference if you are bringing many forms and units that reside in locations other than the main project directory into the current project. It can help you track what you are doing as you either add shared files as part of the project, or save copies of shared files in the current project directory. The form and unit summary information can also be helpful in evaluating the scope of proposed project modifications.

Project Manager file list

This area of the Project Manager details the current composition of the project. It gets its information from the project source code (.DPR) file. If you have modified this file manually (that is, you edited the source code directly), the information in this list might be inaccurate. When you open the Project Manager, Delphi compares the information in the .DPR file to the last saved information for the Project Manager. If these are not synchronized, the contents of the Project Manager file list become dimmed, and the Update button on the SpeedBar becomes enabled so that you can synchronize the information.

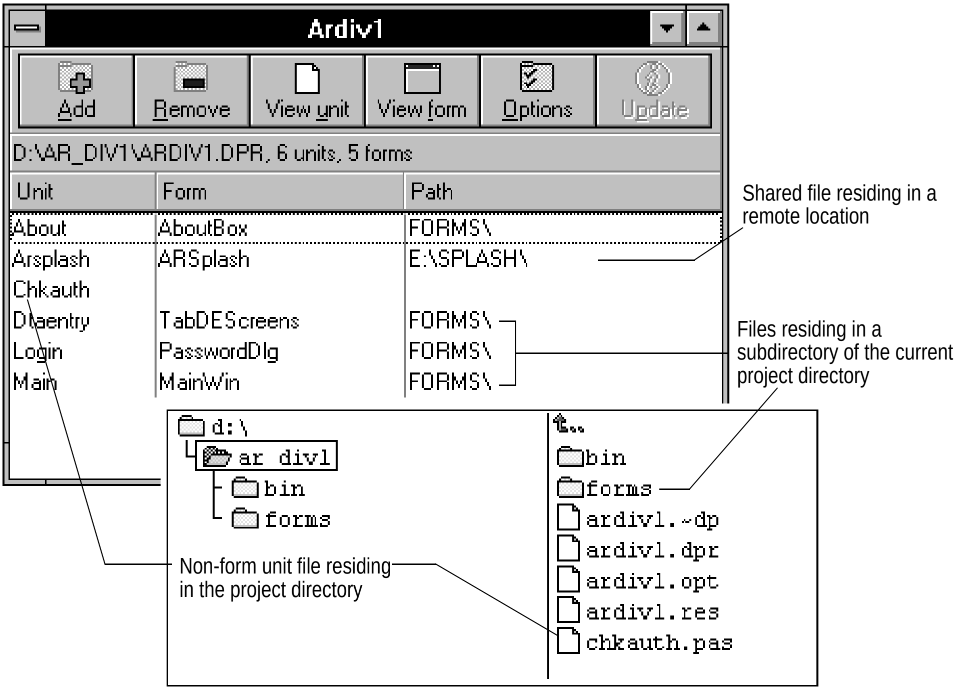
Caution Delphi has mechanisms for automatically tracking the files that make up a project and for keeping the project .DPR file updated. Avoid editing project files manually unless you have a thorough understanding of this process and its ramifications. By editing a .DPR file, you circumvent Delphi's automated project management mechanisms and risk maintaining inaccurate information about project composition. Compilation failures and other problems can result.

Project Manager Path column

If you have an open project that uses files that reside in a location other than the current project directory, or if you save a copy of a project to another location, the Path column of the constituent file list can be the most important bit of information the Project Manager provides. This column tells you exactly where each file resides on disk, regardless of its project affiliation.

If the Path column is empty for a listed file, this means the file resides in the current project directory. On the other hand, if there is an entry in the Path column, you know immediately that the file resides elsewhere. If you often share files among different projects, this can alert you that this file might be used by another project. This is illustrated in the following figure.

Figure 4.2 Example Project Manager project listing



D:\AR_DIV1\ARDIV1.DPR, 6 units, 5 forms

Unit	Form	Path
About	AboutBox	FORMS\
Arsplash	ARSplash	E:\SPLASH\
Chkauth		
Dtaentry	TabDEScreens	FORMS\
Login	PasswordDlg	FORMS\
Main	MainWin	FORMS\

```
d:\
  ar divl
    bin
    forms
```

```
..
bin
forms
ardivl.~dp
ardivl.dpr
ardivl.opt
ardivl.res
chkauth.pas
```

Shared file residing in a remote location

Files residing in a subdirectory of the current project directory

Non-form unit file residing in the project directory

Notice how this project's directories are structured. The project directory contains only project source and configuration files, and a \BIN directory for compiled output and a \FORMS directory for form unit and graphical form (.DFM) files were created. This structure is purely optional—storing all these files in the project directory (D:\AR_DIV1) would work equally well.

In the Path column, observe that

- Files residing in the project directory do not display any path information.
- Files in subdirectories beneath the project directory appear with no preceding backslash (\) character.
- Files in other locations display full path information. In this case, the*ARSplash* unit resides on a different drive. If it resided on the same drive as the project directory, the path column would display the information as \SPLASH\.

Using the Project Manager is highly recommended because it enables you to track the location of everything in your project.

Integrating forms and units into a project

You can use either the Project Manager or commands on the Delphi File menu to create new forms or new unit files in a project, or to add existing files from locations outside the project directory. In order for any form or unit to "belong" to a project, the project must be open so that Delphi can update the project source code (.DPR) file as new or shared unit files are added.

As you build a project, you can

- Create new form units
- Create new source code units
- Create new component units
- Use files from a different project or location (shared files)
- Use existing Borland Pascal source code units

This section discusses each of these topics.

Creating new form units

Opening a new form unit in a project is one of the tasks you probably do most frequently. For information on creating new forms in a project, see Chapter 3.

Creating new source code units

If you want to write a custom Object Pascal procedure, function, or DLL as a stand-alone program callable from any unit, you need to save it in a new source code unit. If you want to create this type of unit and not have it be part of a project, you can open the new unit without having a project open.

■ To open a new source code unit, choose File | New Unit from the Delphi menu bar.

If you have a project open, you can also choose New Unit from the Project Manager SpeedMenu. When you create a unit in an open project by means of the New Unit command, the new unit is registered in the project (.DPR) file when you save the project or new unit file.

Creating new component units

You need to create a new component unit only if the purpose of your project is to write a new Delphi component. For information on opening a new component unit, see “Using the Component Expert” on page 71. Complete information on writing Delphi components is contained in the online Help system.

Sharing files from other projects or directories

A project can use existing form and unit files that it did not create and which don’t reside in the current project directory, or any subdirectory of that directory. When you compile your project, it does not matter whether the files that make up the project reside in the project directory, a subdirectory of the project directory, or any other location.

If you add a shared file to a project, bear in mind that the file is not copied to the current project directory; it remains in its current location. Adding the shared file to the current project simply registers the file name and path in the **uses** clause of the project’s .DPR file. Delphi automatically does this as you add units to the project. The compiler treats shared files the same as those created by the project itself.

■ To add a shared file to the current project, do one of the following:

- Choose File | Add File from the Delphi menu bar.

- Choose the Add File button on the Delphi SpeedBar.
- Choose the Add button on the Project Manager SpeedBar.
- Choose Add File from the Project Manager SpeedMenu.

Any of these actions displays the Add To Project dialog box, in which you can select the file you want the current project to use. The Path column of the Project Manager's file list displays the path to the shared file.

Using Borland Pascal source code units

If you have existing source code units for custom procedures or functions written in Borland Pascal or Turbo Pascal, you can use these units in a Delphi project. You add these files in the same way as files created in Delphi.

Removing constituent files from a project

You can remove forms and units from a project at any point during project development. The removal process deletes the reference to the file in the **uses** clause of the .DPR file. Note that using the following procedure to remove a unit that has an associated form file removes the form file as well.

■ To remove a unit from a project, open the project and choose any of these methods:

- In the Project Manager window,
  - Select the unit or units you want to remove, then choose the Remove button on the SpeedBar.
  - Select the unit or units you want to remove, then choose Remove File from the SpeedMenu.
- Choose the Remove File button on the Delphi SpeedBar.
- Choose File | Remove File from the Delphi menu bar.

Removing a file from the project ends its relationship with the project; it does not delete the file from disk. Use the Windows File Manager or another utility to delete unwanted files from disk.

Caution Do not use Windows file management programs or DOS commands to delete Delphi project files from disk *until* you have performed the preceding removal process in *every* Delphi project that uses the files. Otherwise, the project (.DPR) file of each project using the deleted files retains references to them in the **uses** clause. When you open the project again, Delphi attempts to find the deleted files and displays error messages for each file it cannot find. When the project opens, the information about its constituent files in the Project Manager is inaccurate.

Saving projects and individual project files

At any time during project development, you can save an open project in its current state to the project directory. You can optionally save a copy of the project in a different directory under the same or a different name.

You can also save your project as a Project Template which adds it to the Gallery so that you or others can reuse it. For more information, see "Adding templates to the Gallery" on page 126.

You are not limited to saving a project as a whole. Delphi enables you to save individual constituent files of a project, including saving a copy of a file to a different directory or under a different file name.

Saving a project

This section explains how to save an open project to the directory created to store it (that is, the *project* directory).

Note If the project was begun from a Project Template, the Gallery selection process creates the project directory. Otherwise, Delphi saves projects by default to the \BIN directory, unless you specify otherwise.

■ To save all open project files to the project directory, use one of the following methods:

- Choose File|Save Project.
- Choose the Save Project button on the Delphi SpeedBar.
- Choose the Save Project command on the Project Manager SpeedMenu.

From here, the save process for projects varies somewhat depending upon whether or not the project has been saved.

First project save

If you have not previously saved the project, Delphi displays the Save As dialog box. This dialog box prompts you to supply a name for each open unit file that has been created in the current project. (You are not prompted for any shared files you might have added to the project. See "Sharing files from other projects or directories" earlier in this chapter.)

After you name the unit file(s), Delphi prompts you to name the project source code (.DPR) file before saving it to disk. This processing order ensures that the unit and form file names you just specified are correctly registered in the project file's source code.

Subsequent saves

If you have previously saved the project, all open files that reside in the project directory are saved to disk if they have been modified.

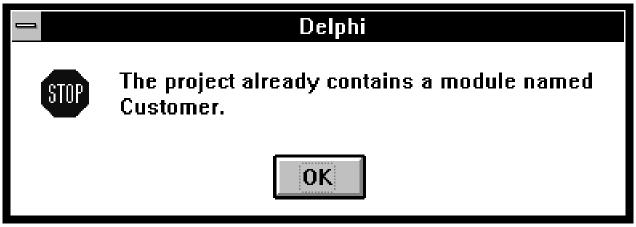
If you have opened any new forms or units in the project since the last save, the Save Unit As dialog box appears and prompts you to name those unit files before saving them.

The .DPR project file is then updated to reflect any new units and any newly shared files that you might have specified for the project to use.

Naming unit and project source code files

As you open new units in a project, Delphi supplies them with default names such as UNIT1.PAS, UNIT2.PAS, UNIT3.PAS, and so on. You will soon run into confusion if you use these default names when saving the project. It is highly advisable to supply a meaningful name for each unit in a project as you save it.

When naming the project source code file, you need to supply a name not previously used by any of the unit files listed in the **uses** clause of the .DPR file. If you attempt to give the project the same name as one of these units, Delphi displays an error message similar to the following:



The project already contains a module named Customer.

If this occurs, respond OK to the error message box and supply a different name for the .DPR file in the Save As dialog box.

As with unit files, Delphi supplies a default name, PROJECT1.DPR, for the unit source code (.DPR) file. Again, you should supply a more meaningful name when saving the file for the first time.

All unit and project file names must conform to DOS naming conventions.

Saving a separate version of the project file

Delphi enables you to save a separate version of an open project in a directory other than the project directory. The File | Save Project As command initiates the process. However, because the open project might use shared files in addition to files that were created as part of the current project, the Save Project As command saves only a copy of the project source code (.DPR) file, project options settings (.OPT file), and the project resource (.RES) file to the new location.

Important *No unit files are saved to the new location.* When you open the copied version, the Project Manager displays all units in the copied project as shared files; that is, none of them reside in the project directory of the currently open project.

■ To save a separate copy of the project (.DPR) file in another location,

1. Choose File | Save Project As from the Delphi menu bar to display the Save <projectname> As dialog box.
2. Select the directory where you want to copy the project file.
3. If you want to save the project file under a different name, enter the new name in the File Name edit box. If a .DPR file with the same name exists in the directory you specify, you're prompted as to whether you want to overwrite the existing file.
4. Choose OK to complete the task.

   The open project is now the project you just saved.

Delphi saves the .DPR file, the project options (.OPT) file, and the project resource (.RES) file under the name and/or new location you specify. Delphi also saves any modified unit files (in their current location), so you won't be prompted to save these changes again when you close the project. When you open either version of the project, all changes saved with the Save As operation are reflected in both places.

If you check the constituent file list in the Project Manager, you will see that all the files in the currently open version of the project reside in a directory other than the current project directory. If you want separate copies of any of those files in the new project directory, you need to save them individually to the new location using File | Save File As. (See "Creating a backup of an entire project" on page 139 for more information.)

If you leave the new project unchanged, it continues to use the files in their present (that is, old) location as shared files, which might or might not be what you want. If you don't understand how the new project is using its constituent files, you can run into problems later (see "Project Manager Path column" on page 132 for an example).

Caution Do not use file management tools other than those in Delphi to save a copy of a project to a new location.

Saving files

You can save individual files in a project, or non-project files (such as text files) that you may have open in the Code Editor. To save a file, it must be open.

■ To save an individual file,

1. Bring the file to the topmost level of the Code Editor by selecting its tab.
2. Choose File | Save File. If this is the first time you've saved the file, you're prompted to name it.
3. If necessary, name the file and choose OK.

   Delphi saves the file.

■ To save a file under a different name or location,

1. Bring the file to the topmost level of the Code Editor by selecting its tab.
2. Choose File | Save File As.

   The Save File As dialog box appears.
3. Specify the new file name, or location, or both, and choose OK.

   Delphi saves a copy of the file under the name and location you specify.

Note This changes the name of the file, and if it is already part of the project, includes the file with the new name in the project. The older unit name still exists as a file but isn't included in the project any longer.

File|Save versus File|Save As

Using the File | Save As command is, in many respects, the same as choosing File | Save—you're prompted to name any unsaved units and forms before saving the .DPR file. Once all project files have been named, File | Save and File | Save As both prompt you to name only new (not modified) units; and both then save any modifications to previously named project files. The distinction between the two commands is that the

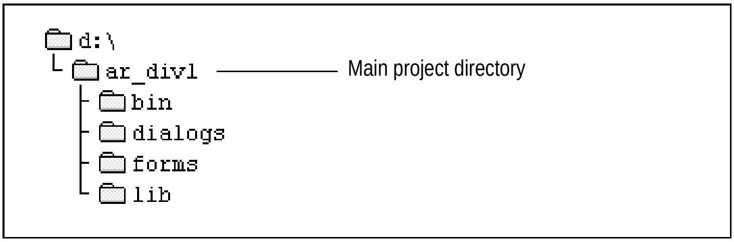
File | Save As command expects you to save the .PAS file to a new location. If you do not specify either a new name, or new location for the .PAS file, Delphi prompts you to specify whether you want to overwrite the existing .PAS file.

Creating a backup of an entire project

Backing up a project can be a simple matter of copying directories or can involve some additional steps. This depends upon how your project directories are structured and whether the project uses files from outside its own directory tree.

The project directory isn't encoded into the project (.DPR) file. The project file does, however, record the location of all constituent project files. If these files reside in subdirectories of the main project directory, than all path information is relative, which makes backup easy, as shown in figure Figure 4.3.

Figure 4.3 Example project directory tree



You could back up this entire project simply by copying the directory tree to another location. If you open the project at the backup location, all the project files that reside within that structure are present, and the project will compile.

If this project uses files that reside outside this tree, the project might or might not compile at the backup location. Check the Project Manager's file list to see if these outside files are accessible from the backup location. If they are, the project will compile. If other backup processes already preserve these outside files, then there is probably no need to make separate backup copies of them in the backup project directory.

Navigating among project components

As you work on a project, you will find that you frequently need to navigate back and forth among forms, units, and the various open windows such as the Project Manager, Alignment Palette, and so on. This section explains the basic techniques involved.

Viewing forms and units

You can easily toggle between viewing the currently displayed form and its unit source code by using commands from the View menu, a keyboard shortcut, or the Project Manager.

You can also view or edit any open unit or form by choosing commands from the View menu, buttons on the Project Manager SpeedBar, or commands from the Project Manager SpeedMenu.

Toggling between form image and unit source code

■ To switch between viewing the current form and its unit source code, use any of the following methods:

- Press *F12.*
- Choose View | Toggle Form/Unit.
- In the Project Manager, double-click in the Unit column of the unit you want to display its source code, or the Form column to display the form image.

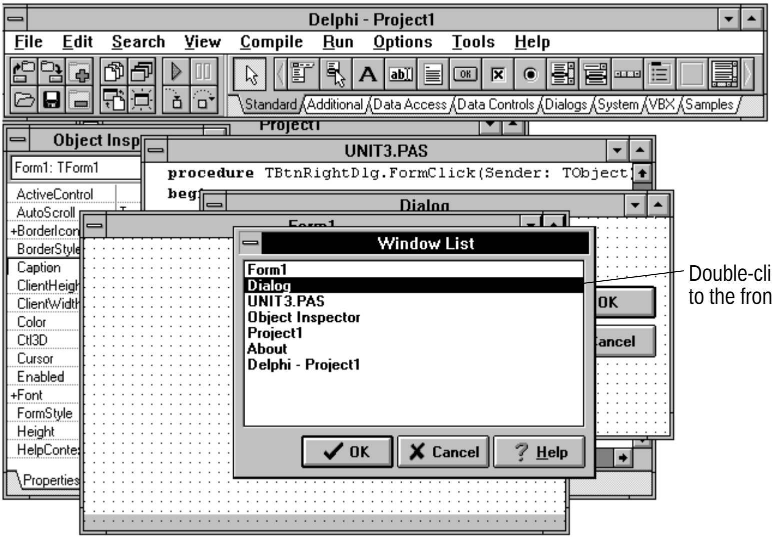
Bringing a window to the front

If you have a number of windows open, such as the Delphi Project Manager or Object Browser, you can easily get to the window you want by selecting it in the Window List dialog box. This dialog box displays a list of all open windows, and enables you to bring any of them to the front.

■ To display the Window List dialog box and bring a window to the front,

1. Press *Alt+0* (zero) or choose View | Window List from the menu.
2. Double-click the name of the window you want to bring to the front.

Figure 4.4 The Window List dialog box



```
procedure TBtnRightDlg.FormClick(Sender: TObject
beg
```

Form1
Dialog
UNIT3.PAS
Object Inspector
Project1
About
Delphi - Project1

Double-click to bring window to the front

Using the Project Manager to view or edit units

■ To view or edit a unit, in the Project Manager window, select the unit you want to view or edit, and then choose from the following methods:

- On the SpeedBar, choose the View Unit button.
- Press the *Enter* key.
- From the SpeedMenu, choose the View Unit command.
- Double-click the unit file name you want in the Unit column.

If the source code file for the selected unit is not open, a Code Editor page opens to display it. Otherwise, the appropriate Code Editor page comes to the top.

- To view or edit a form, in the Project Manager window, select the form you want to view or edit, and then choose from the following methods:

  - On the SpeedBar, choose the View Form button
  - Press *Shift+Enter.*
  - From the SpeedMenu, choose the View Form command.
  - Double-click the form name in the Form column.

  If the form is already open, it comes to the front in design mode. Otherwise, the form opens and comes to the front.

Viewing the project source code (.DPR) file

As with unit source code files, you can also open the project source code (.DPR) file in the Code Editor. The main reason to do this is so you can see the units and forms that make up the project, and which form is specified as the application's main form. As you add forms and units to the project, you can see Delphi's updates of the project source code.

Caution Manually editing the .DPR file is not recommended.

- To view the .DPR file, use either of these methods:

  - Choose View Project from the Project Manager SpeedMenu.
  - From the Delphi menu bar, choose View | Project Source.

  The contents of the .DPR file appear in a page in the Code Editor. To hide the .DPR file again, close the page in the Code Editor.

Note Closing a Code Editor page by double-clicking the Control-menu box closes*all* open units in the project. To close a single page, choose Close Page from the Code Editor SpeedMenu.

Compiling, building, and running projects

All Delphi projects have as a target a single distributable executable file, either an .EXE or a .DLL file. You can view or test your application at various stages of development by compiling, building or running it. You can also test the validity of your source code without attempting to compile the project.

Checking source code syntax

The Compile menu on the Delphi menu bar provides you the option of running a syntax check on your project's source code. The checking is identical to that for a compilation, and errors in your code generate the same error messages. However, the process is faster because Delphi makes no attempt to generate object code, and if the check succeeds, no executable file is generated.

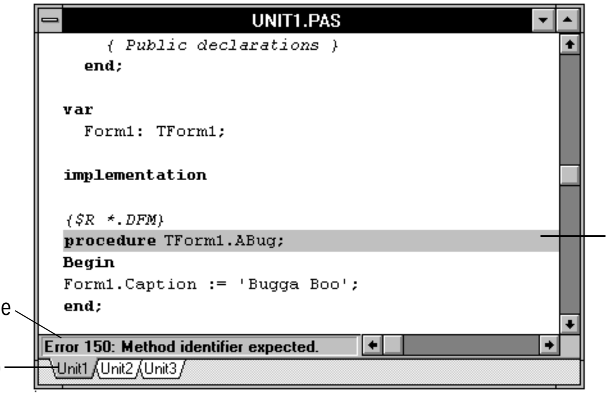
- To run a syntax check on your project source code,

1 Save the project source code (recommended but not required).
2 Choose Compile | Syntax Check from the Delphi menu bar.

The hourglass cursor appears, to indicate that syntax checking is in progress and returns to normal if the check finds no errors. If an error is found,

- The Code Editor window comes to the front.
- The unit source file page containing the error comes to the top of the Code Editor.
- The line containing the error is highlighted in the Code Editor.
- The Code Editor status bar displays an error message.
- Context-sensitive help regarding the error message is available by pressing *F1*.

Figure 4.5 Syntax or compile error display



```
    { Public declarations }
  end;

var
  Form1: TForm1;

implementation

{$R *.DFM}
procedure TForm1.ABug;
Begin
Form1.Caption := 'Bugga Boo';
end;
```

Error 150: Method identifier expected.

Line with error highlights

Status bar displays message

Unit with error comes to the top

Compiling a project

■ To compile all the source-code files that have changed since the last time you compiled them, choose Compile | Compile from the Delphi menu bar.

When you choose this command, this is what happens:

- The compiler compiles source code for each unit if the source code has changed since the last time the unit was compiled. This creates a file with a .DCU (Delphi Compiled Unit) extension for each unit.

  If the compiler can't locate the source-code file for a unit, the unit isn't recompiled.

- If the **interface** part of a unit's source code has changed, all the other units that depend on it are recompiled.

  To learn about the interface section of a unit, see "Unit source code (.PAS) files" on page 119.

- If a unit links in an .OBJ file (a file containing assembly language code), and the .OBJ file is newer than the unit's .DCU file, the unit is recompiled.

- If a unit contains an include (.INC) file, and the include file is newer than the unit's .DCU file, the unit is recompiled.

Once all the units that make up the project have been compiled, Delphi compiles the project source (.DPR) file and creates an executable file (or dynamic link library). This file is given an .EXE (or DLL) file extension and the same file name as the project source code file. This file now contains all the compiled code and forms found in the individual units, and the program is ready to run, or, in the case of a DLL, to be redistributed.

You can choose to compile only portions of your code if you use **{$ifdef}** conditional directives and predefined symbols in your code. For information about conditional compilation, see Conditional Directives in online Help.

Obtaining compile status information

You can get information about the compile status of your project by displaying the Information dialog box (Choose Information from the Compile menu). This dialog box displays information about the number of lines of source code compiled, the byte size of your code and data, the stack and heap sizes, and the compile status of the project.

You can get status information from the compiler as a project compiles by checking the Show Compiler Status box in the Environment Options dialog box. (For more information, see Environment Options in online Help.)

Building a project

■ To compile all the source-code files in your project, regardless of when they were last compiled, choose Compile | Build All from the Delphi menu bar.

The result of this command is similar to that of the Compile | Compile command, except that all units in the project are compiled, regardless of whether or not they have changed since the last compile. This technique is useful when you are unsure of exactly which files have or have not been changed, or when you simply want to ensure that all files are current and synchronized.

Running a project

You can test run a project from within Delphi, or you can run the compiled .EXE file from the Windows operating environment without having to run Delphi.

■ To compile and then run your application from within Delphi,

- Choose Run | Run command from the Delphi menu bar.
- Choose the Run button on the Delphi SpeedBar.

These actions are identical to choosing the Compile | Compile command, except that Delphi runs your application immediately if the compile operation succeeds.

Executing a project from Windows

Because the compiler always creates a fully compiled stand-alone executable file (.EXE), you can run your application from the Windows operating environment using the same techniques as you would for any other Windows application.

If you have specified an icon for your project, it will appear in the Program Manager if you create a Windows program item for your application, or if you minimize the application while it is running. (For more information, see online Help).

Managing multiple project versions and team development

When you are developing a complex programming project in a team setting, or managing several development projects, you might soon develop the need for a version control system (VCS). A version control system can archive files, control access to project files, and track multiple versions of your projects.

Delphi Client/Server has a built-in interface for Intersolv's PVCS Version Manager (available separately). It supports PVCS version 5.1 and later. Because Delphi uses an Open Tools API, it can also be used with any commercially available version-control utility.

Enabling team development support

Before using Delphi's built-in team development support, you need to have PVCS installed on your system, and the following files must reside in your \WINDOWS\SYSTEM directory:

- PVCSVMW.DLL
- NWNETAPI.DLL (If running on a Novell network; otherwise, use the appropriate network support DLL as specified in PVCS documentation.)

Consult your PVCS documentation for complete details on installing and setting up that product.

■ To enable team development support in Delphi,

1. Exit Delphi.
2. Add the following lines to the DELPHI.INI file located in your \WINDOWS directory:

```
[Version Control]
VCSManager=c:\delphi\bin\stdvcs.dll
```

Note If the location of the \DELPHI\BIN directory on your system is different from that shown, modify the VCS manager line to include the correct drive and path.

3. Restart Delphi, then choose Workgroups | Archive Manager to display the main team development window.

For information on using the team development support features of Delphi, look up PVCS or Version Control in Delphi's online Help.

Summary

This chapter has discussed these primary topic areas:

- What is a project?
- Beginning new projects
- Customizing project options
- Managing project content
- Compiling, building, and running projects
- Managing multiple project versions and team development

Part

III

Programming topics

The chapters in this part discuss how to program using the Object Pascal language.

The four chapters making up this part are

- **"Writing Object Pascal code"**
  This chapter explains how to write code to create Delphi applications.
- **"Programming with Delphi objects"**
  This chapter explains what you need to know about objects and how to use them to create Delphi applications.
- **"Writing robust applications"**
  This chapter explains how to anticipate, recognize, and handle exceptions in your Delphi applications.
- **"Using the integrated debugger"**
  This chapter explains how to debug Delphi applications using the Delphi integrated debugger.

Chapter

5

Writing Object Pascal code

Previous chapters discuss how to build a user interface for your application by adding components to forms. They describe how to create event handlers for those components, so the components can respond to events that occur as your application runs.

This chapter explains the primary features of the Object Pascal language and shows you how to use it to write code within event handlers and other parts of your application. After reading this and the following chapter, "Programming with Delphi objects," you should be able to develop useful and more sophisticated Delphi applications.

This chapter assumes you already have some programming experience. You certainly don't have to be an expert, however. If you've programmed successfully in any of the popular programming languages, you'll recognize common concepts in Object Pascal. While the chapter does show you the most common uses of Object Pascal in a Delphi application, it doesn't explain all there is to know about the language.

You can find in-depth information about Object Pascal in Delphi's online Help—look up the Language Definition topic. The information there includes syntax diagrams of all Object Pascal language constructs. You might also want to read one or more of the excellent books published about Pascal, especially those that discuss Delphi, Turbo Pascal, and Borland Pascal.

If you are familiar with Borland Pascal language already, you can probably either skim this chapter rapidly, or skip it altogether and go directly to the next chapter, "Programming with Delphi objects." You'll still want to refer to the Language Definition in Delphi's online Help to learn about the new additions to the language, however.

The primary topics in this chapter are

- Writing readable code
- Writing assignment statements
- Declaring identifiers
- Declaring constants
- Calling procedures and functions

- Controlling the flow of code execution
- Object Pascal blocks
- Understanding scope
- Writing a procedure or function
- Defining new data types
- Understanding Object Pascal units

To use this chapter effectively, you need to understand how a Delphi project is structured and how to create event handlers. If you are uncertain about these topics, review Chapter 1, Chapter 3, and Chapter 4.

Writing readable code

Although you write code for the compiler to compile and turn into an executable program, you want yourself and others to be able to read your code easily.

Coding style

As you prepare for writing your first code statements, you should realize that it doesn’t matter to the compiler how you space, indent, or capitalize your Object Pascal code, or how you break lines of code to continue on the next line. As long as the code is syntactically correct, the compiler can handle it properly. For example, this code compiles just fine:

```
PROCEDURE
  TFORM1.
Button1CLICK(SENDER        :
       TOBJECT);begin
  Edit1.Color
:=
CLRED;END;
```

You would probably find this version of the event handler easier to read, however:

```
procedure TForm1.Button1Click(Sender: TObject);
begin
  Edit1.Color := clRed;
end;
```

Choose a code indentation and capitalization style, and break lines of code where you need to, so that your code is easy for you and others to read.

Commenting your code

You can also place comments in your code anywhere you like.

■ To put comments in your code, enclose all the text of your comments in braces ({ }).

For example, you could add the following comment to the previous event handler:

```
procedure TForm1.Button1Click(Sender: TObject);   { Changes the color of the edit box }
begin
  Edit1.Color := clRed;
end;
```

Comments can extend over many lines. The compiler considers everything after the first brace ({) to be a comment until it finds the closing brace (}):

```
{ This comment runs on a bit
and really doesn't say anthing
useful, but it shows you that comments
can have multiple lines of text }

procedure TForm1.Button1Click(Sender: TObject);   { Changes the color of the edit box }
begin
  Edit1.Color := clRed;
end;
```

Don't forget to include the closing brace, or the compiler considers the rest of your code to be a comment.

The compiler ignores all comments in the code, treating them as if they were spaces. Look up the Comments topic in Delphi Help for more information about adding comments to your code.

Use comments to help the reader of your code (including yourself) understand its logic. Even though you understand how your code works when you write it, it might not seem so clear to you when you examine it later.

Writing assignment statements

The most common task you'll encounter when writing code within event handlers is assigning a new value to a property or variable. You can use the Object Inspector to change the value of a property while designing the user interface, but also you'll often want to change the value of a property while the application is running. Some properties can be changed *only* at run time; such properties are noted as run-time only in the property reference topics of online Help. To change a property or variable at run time, you need to write an assignment statement.

Assignment statements consist of two parts, separated by the Object Pascal assignment operator (**:=**). The left side of an assignment statement is a property or variable name, while the right side of the statement is the new value for the property or variable. The assignment statement, like all Object Pascal statements, ends with a semicolon (**;**).

Here is a simple assignment statement within an *OnClick* event handler for a button control. This statement assigns the value *clRed* to the *Color* property of an edit box control named *Edit1*:

```
procedure TForm1.Button1Click(Sender: TObject);
begin
  Edit1.Color := clRed;
end;
```

Assuming that an edit box control named *Edit1* and a button control named *Button1* exist on the form, the assignment statement runs and the edit box turns red when the user clicks the button.

Note that the component name precedes the property name, with a period (.) separating the component and property. If you include the component name with the property, there is no confusion as to which *Color* property should be changed. In fact, if you omit the component name, the color of the *form* changes when the user clicks the button. For more information about this topic, see the section “Understanding scope” on page 177.

Assigning values to properties and variables

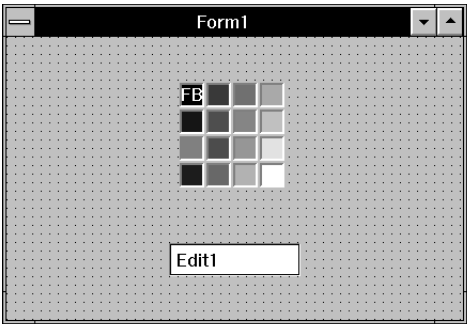
Whether you assign a value to a property or to a variable, you follow the same rules. The value on the right side of the assignment statement is assigned to the property or variable on the left side of the assignment statement. When a value is assigned, a copy of the value is placed into the property or variable. The value being assigned can be a constant, a literal value, a variable, or another property value. For example,

```
var
  Name : string;
  Number : Integer;
begin
  Name := Edit1.Text;                           { Assigns a property value to a variable }
  Number := 15;                                  { Assigns a literal value to a variable }
  Edit2.Text := ‘Welcome to Delphi ’ + Name;          { Assigns a string made up of a
                                                           string constant and a variable
                                                                    string to a property }
end;
```

The code example on page 151 shows you how to use an assignment statement to set or change the color of a component—in this case, an edit box—in response to a button click. Suppose, instead, that you want the user to be able to use a color grid to change the color of an edit box on a form. You want the edit box to change color when the user clicks a color rectangle in the color grid.

➤ Create a form with a color grid and an edit box, so that it looks similar to this:

Figure 5.1 A sample form for assigning a property value to another property



➤ Create an event handler for the *OnClick* event of the color grid:

```
procedure TForm1.ColorGrid1Click(Sender: TObject);
begin
  Edit1.Color := ColorGrid1.ForegroundColor;
end;
```

➤ Run the application and click a color on the color grid.

The assignment statement assigns the value of the *ColorGrid1.Foreground* property to the *Edit1.Color* property. In other words, the color of the edit box control becomes the color the user clicks in the color grid.

You can assign the value of a property, variable, constant, or literal to a variable or property if the assigned value is of the same *type* or is assignment-compatible with the variable or property receiving the new value. (To read about type and assignment compatibility, see page 157.)

The type of a property or variable defines the set of values the property or variable can have and the operations your code can perform on it. In the previous example, both *Color* (a property of the edit box) and *ForegroundColor* (a property of the color grid) are of type *TColor*.

You can find out the type of a property by looking up the property in online Help, or by selecting the property in the Object Inspector and pressing *F1*. The type is listed at the end of a property declaration. For example, the *Color* property declaration declares *Color* to be of type *TColor*.

```
property Color: TColor;
```

Note You can't assign new values to all properties. Some properties are read-only, which means you can find out what the value of the property is, but you can't change its value in your application. Properties that are read-only are noted as such in Delphi's online Help.

Declaring identifiers

Identifiers are names you give to any part of a Delphi application, including variables, types, procedures, functions, methods, and so on. (All identifiers are italicized in the Delphi books, except in the code examples.) Object Pascal requires that you declare identifiers before using them in your code.

If you haven't used a compiled language before, you might wonder why it is necessary to declare identifiers before you use them. As with all compiled languages, the compiler must be given explicit information about the identifiers before the compiler can create executable code that uses them.

The compiler can then check your code to ensure that the values you assign to variables or properties are of the correct type. If they aren't, Delphi displays a syntax error message, so you can correct the problem. Languages that aren't compiled can't protect you from assigning a value of a wrong type, a common programming mistake. Object Pascal is known as a strongly typed language.

Also, because Object Pascal is a compiled language, your Delphi applications will run much faster than applications you build with an interpreted language. Declaring identifiers before you use them reduces the number of programming errors and increases the efficiency of your code.

Declaring variables

A variable is a name in code that stands for a memory address, the contents of which can change as the code runs. You need to declare a variable before using it. There are two steps in declaring a variable:

1. Naming a variable
2. Giving a variable a type

Naming a variable

When you declare a variable, you need to select a name for it. You should try to select a name that reminds you of the variable's purpose, so your code is easier to read. For example, *Day*, *Name*, and *Total* are more memorable names than *X*, *Y*, and *Z*.

Beyond choosing meaningful names for your variables, you should remember a few rules that apply to variables and all other identifiers.

- Identifiers can be up to 63 characters in length.

  If your identifiers are longer than 63 characters, the compiler ignores the extra characters.

- Identifiers must begin with either a letter or an underscore (_) character.
- Subsequent characters can be letters, underscores, or the digits 0–9.
- Identifiers can't contain any other symbols, such as $, %, *, and so on.

  For example, identifiers called *Do@Noon* or *Gross%Return* result in a syntax error.

- You cannot use an Object Pascal *reserved word* for naming an identifier.

  Reserved words have special meaning to the compiler. If you use one of these reserved words to name an identifier, Delphi displays an error message. You can find a list of Object Pascal reserved words in online Help under the Reserved Words topic. All reserved words are boldfaced in the Delphi documentation.

- Avoid using identifiers already defined in the Object Pascal language to name your identifiers.

  For example, the words *Boolean* and *Integer* are predefined data types (see the section "Data types" on page 156 to read about predefined data types). You can use either of these words to name a variable without generating an error message, but if you do, you won't be able to use the *Boolean* and *Integer* types in your code.

Giving a variable a type

When declaring a variable, you must state its type. The type of a variable defines the set of values the variable can have.

In general, you declare a variable where you want to use it. For example, if you want to use a variable in an event handler, you declare the variable within the event handler. For more details about where to declare variables, read the sections “Object Pascal blocks” on page 174 and “Understanding scope” on page 177.

Precede all variable declarations with the reserved word **var.** The declaration itself is made up of two parts: the left side is the name of the new variable, and the right side declares what the variable’s type is. The two parts are separated by a colon (**:**). This example declares three variables, *Value*, *Sum*, and *Line*:

```
var
  Value: Integer;
  Sum: Integer;
  Line: string;
```

Because *Value* and *Sum* are both of type *Integer*, the variable declaration could look like this, with a comma separating the two variables of the same type:

```
var
  Value, Sum: Integer;
  Line: string;
```

The following example assumes that there is an edit box named *Edit1* and a button named *AddButton* on the form. Three variables (*X*, *Y*, and *Sum*) are declared as type *Integer.* When the user clicks the *AddButton*, two variables, *X* and *Y*, are assigned *Integer* values and added together. The result, *Sum*, appears in the edit box:

```
procedure TForm1.AddButtonClick(Sender: TObject);
var
  X, Y, Sum: Integer;
begin
  X := 100;
  Y := 10;
  Sum := X + Y;
  Edit1.Text := IntToStr(Sum);
end;
```

This line assigns the value of an expression to a variable:

```
Sum := X + Y;
```

An expression is usually two identifiers related to one another through an operator. (To read about expressions, see the Expressions topic in online Help.) Because the *Text* property of an edit box is of type **string** and the *Sum* variable is of type *Integer*, this line is not permissible and causes a type mismatch error if you try to run or compile it:

```
Edit1.Text := Sum;
```

Instead, the last line of the event handler uses the *IntToStr* function from the Delphi run-time library to convert the *Sum* value to a text string, then assigns the value of the *Sum* variable to the *Edit1.Text* property.

This variation avoids the assigning of a value to *Sum* altogether:

```
procedure TForm1.AddButtonClick(Sender: TObject);
var
  X, Y: Integer;
```

```
begin
  X := 100;
  Y := 10;
  Edit1.Text := IntToStr(X + Y);
end;
```

Using functions in your code is discussed in more detail in the section "Calling functions" on page 161, but it's useful to know that functions return a value of a particular type, and that value can then be assigned to a variable or property.

Data types

Object Pascal has several data types built into the language. You can create variables of any of these predefined types. The following table lists the predefined data types:

Table 5.1 Object Pascal predefined data types

Category	Data type	Description
Integer	*Integer*	Numbers without a fractional part, within the range of –32768 to 32767. Requires two bytes of memory.
	Shortint	Numbers without a fractional part, within the range of –128 to 127. Requires only one byte of memory.
	Longint	Numbers without a fractional part, within the range of –2147483647 to 2147483647. Requires four bytes of memory.
	Byte	Numbers without a fractional part, within the range of 0 to 255. Requires one byte of memory.
	Word	Numbers without a fractional part, within the range of 0 to 65535. Requires two bytes of memory.
Real	*Single*	A number that can contain a fractional part with 7–8 significant digits. Requires 4 bytes of memory. Available only when the 8087/80287 option {N+} is on. (Refer to Real Types in online Help for the range of each real type.)
	Double	A number that can contain a fractional part with 15–16 significant digits. Requires 8 bytes of memory. Available only when the 8087/80287 option {N+} is on.
	Extended	A number that can contain a fractional part with 19–20 significant digits. Requires 10 bytes of memory. Available only when the 8087/80287 option {N+} is on.
	Comp	A number that can contain a fractional part with 19–20 significant digits that requires 8 bytes of memory. Available only when the 8087/80287 option {N+} is on.
	Real	A number that can contain a fractional part with 11–12 significant digits. Requires 6 bytes of memory. Use *Real* only for compatibility with earlier Borland Pascal releases; otherwise use *Double* or *Extended*.
Boolean	*Boolean*	Can contain the values of *True* or *False*. Occupies one byte of memory.
Char	*Char*	An ASCII character.
String	**string**	A sequence of up to 255 ASCII characters.
Pointer	*Pointer*	An untyped pointer, that is, a pointer that doesn't point to any specific type.
PChar	*PChar*	A pointer to a null-terminated string.

Besides the predefined data types, you can define your own data types. For many Delphi applications, the predefined data types are sufficient. This chapter, however, has already discussed the use of a user-defined data type. The *Color* property is of type

TColor, which isn't a predefined data type in Object Pascal, but a type defined by the creators of the Delphi run-time library. To learn more about predefined types, see the Type Declarations topic in online Help. To read about defining your own data types, see the section "Defining new data types" on page 195.

Type and assignment compatibility

Table 5.1, "Object Pascal predefined data types," lists five different data types that make up the integer category and five data types that make up the real category. Within each category, all types are compatible with each other. You can assign a value of one type to a variable or property of a different type but within the same category as long as the value falls within the range of possible values for the target variable or property.

For example, you can assign a variable of type *Integer* with the value 7 to a variable of type *Shortint*, because a *Shortint* type can contain any value from –127 to 128. If the value of the *Integer* variable is 300, however, you can't assign it to a *Shortint* variable, because 300 is outside the *Shortint* range. If you try, and have range-checking turned on (choose Options | Project and select Range Checking on the Compiler Options page), you'll generate a range error when you try to run the code containing the assignment. If you don't have range-checking turned on, the code runs, but the assigned value won't be what you expect.

In some cases, you can assign values to a variable or property that is within a different category. In general, this process works only when assigning values from a type of a smaller range to a type of a larger range of possible values. For example, you can assign a value of type *Integer* to a property of type *Double*, a type that accepts floating-point values, making the value now 10.0. You can't assign a *Double* value to a variable or property of type *Integer*, however, because integer values don't have fractional parts.

When you are unsure which types are compatible, you can refer to a complete set of rules for type and assignment compatibility. See the topics Type Compatibility and Assignment Compatibility in Delphi's online Help.

Declaring constants

While variables contain values that can change as your application runs, *constants* contain values that can't change. Constants are given a value at the time they are declared.

Just as variables are declared in a variable declaration, constants are declared in a constant declaration. A constant declaration begins with the reserved word **const**. This example declares three constants:

```
const
  Pi = 3.14159;
  Answer = 342;
  ProductName = 'Delphi';
```

Pi, *Answer*, and *ProductName* are all constant names that describe the value of the constant. The actual value of the constants, which can't change while the application runs, are 3.14159, 342, and 'Delphi', respectively. When naming constants, follow the same rules for naming variables and other identifiers given on page 154.

Like variables, constants also have types. Unlike variables, however, constants assume the type of the value declared in the constant declaration part. For example, the constant *Pi* is of type *Real* because the value 3.14159 is real number, *Answer* is of type *Integer* because 342 is an integer, and *ProductName* is of type **string**, because 'Delphi' is a text string.

Note that the equal sign (=) in a constant declaration is different from the assignment operator (:=) in assignment statements. The equal sign in a constant declaration states that the left side and the right side of the declaration are equal values.

It's a common mistake to misuse an equal sign operator in Object Pascal code. When the compiler finds an equal sign rather than an assignment operator, it expects that the left side of the statement is a constant or that two values are being compared. If that isn't how you are using the equal sign, Delphi displays a syntax error message.

If you make the reverse mistake of using an assignment operator in a constant declaration, a syntax error occurs, and a message appears telling you that the compiler expected an equal sign.

Calling procedures and functions

Procedures and functions are modular pieces of code that perform some specific task. They are known as subroutines in other languages. The Delphi run-time library contains many procedures and functions your applications can use. You don't need to write the code—the procedures and functions are already written. While you don't need to understand the logic of the code within the procedures and functions, you need to understand what they do.

When procedures and functions are declared within objects, which include components and controls, they are called *methods.* An object is a data type you can read about in the next chapter, "Programming with Delphi objects."

Calling procedures

Perhaps you've noticed that all event handlers begin with the reserved word **procedure**. All event handlers are procedures, subroutines that divide the logic of your application into manageable chunks. Each event handler contains just the code you want executed when the event occurs.

■ To use an existing procedure, type the name of the procedure as a statement in your code. This is called "calling a procedure."

For example, the memo control has a *CutToClipboard* method that removes the text the user has selected within the memo control and stores it in the Clipboard object. Because this functionality is built into the method, you need to know only what the method does and how to use it. This is how you call the *CutToClipboard* method of a memo control named *Memo1*:

```
Memo1.CutToClipboard;
```

Note that the name of the control, *Memo1*, is part of the method call. By including the name of the control, you are specifying which *CutToClipboard* method you want to call. Separate the name of the control from the method call with a period (.). If you omit the name of the control, component, or object in a method call, Delphi usually displays this syntax error:

```
Unknown identifier
```

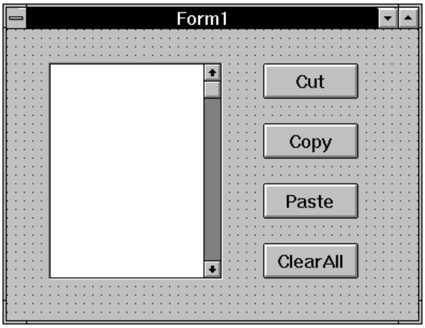
When your application calls *Memo1.CutToClipboard*, the code within the *CutToClipboard* method runs, and the user's selected text is cut to the Clipboard object.

Cut, Copy, Paste, and Clear All: An example

This is an example that calls procedures in the Delphi library.

This is how the finished form for the example should look:

Figure 5.2 A sample form for the Cut, Copy, Paste, and Clear All example



➤ Start by opening a new project (choose the Blank form template, if necessary) and adding a memo control and four buttons to a form.

➤ Use the Object Inspector to change these property settings:

- Name the buttons *Cut*, *Copy*, *Paste*, and *ClearAll* by changing their *Name* properties.

  Be sure you change the *Name* property and not the *Caption* property, or the event handlers Delphi creates for you won't have the same names as they do in this example.
- Delete the text in the *Text* property of the memo control.
- Set the *WordWrap* property of the memo control to *True.*
- Set the *ScrollBars* property of the memo control to *scVertical.*

➤ For each button, create an *OnClick* event handler. Fill in the event handlers as follows:

```
procedure TForm1.CutClick(Sender: TObject);
begin
  Memo1.CutToClipboard;
end;

procedure TForm1.CopyClick(Sender: TObject);
```

```
begin
  Memo1.CopyToClipboard;
end;

procedure TForm1.PasteClick(Sender: TObject);
begin
  Memo1.PasteFromClipboard;
end;

procedure TForm1.ClearAllClick(Sender: TObject);
begin
  Memo1.Clear;
end;
```

➤ Run the application.

You can type text into the memo control and cut, copy, paste, and clear text as you want. When you click the Cut button, the memo's *CutToClipboard* method runs. When you click the Copy button, the memo's *CopyToClipboard* method runs, and so on.

Calling procedures with parameters

Many procedures require you to specify *parameters*. The statements of the called procedure use the values passed in the parameters when the procedure's code runs; the values are treated as variables declared within the procedure. Parameters are surrounded with parentheses in a procedure call. For example, the*LoadFromFile* method is declared in a *TStrings* object like this:

```
procedure LoadFromFile(const FileName: string);
```

FileName, the sole parameter of the method, is of type **string**. When you call the *LoadFromFile* method, you specify which file you want loaded by specifying a string as the *FileName* parameter. This code would read the MYFILE.TXT file into the lines of a memo control:

```
Memo1.Lines.LoadFromFile('MYFILE.TXT');
```

Instead of directly specifying a string value, you could use a variable or expression of type **string**:

```
var
  Name: string;
begin
  Name := 'MYFILE.TXT';
  Memo1.Lines.LoadFromFile(Name);
end;
```

Finally, you could specify a property value of type **string**. In this example, the code first calls the *Execute* method of the Open dialog box, displaying the dialog box in your application. When you select a file name in the dialog box, that file name is specified as the parameter of the *LoadFromFile* method:

```
begin
  OpenDialog1.Execute;
  Memo1.Lines.LoadFromFile(OpenDialog1.FileName);     { the user specifies the parameter }
end;
```

You can read more about using the open dialog box (the *TOpenDialog* component) and the *FileName* property of an open dialog box in Delphi's online Help.

To read more about parameters, see "Passing parameters" on page 190.

Calling functions

Like a procedure, a function executes code that performs a specific task. Also like a procedure, a function that is declared within an object, component, or control is called a method.

The difference between a function and procedure is that a function returns a value when it stops running, and a procedure doesn't. Your code then uses the value returned by the function to do one of two things:

- Assign it to a property or variable
- Use the value to determine the flow of code execution

Assigning a function's returned value

This code example appears on page 155:

```
procedure TForm1.AddButtonClick(Sender: TObject);
var
  X, Y, Sum: Integer;
begin
  X := 100;
  Y := 10;
  Sum := X + Y;
  Edit1.Text := IntToStr(Sum);
end;
```

The example uses the *IntToStr* function:

```
Edit1.Text := IntToStr(Sum);
```

IntToStr converts an integer value of type *Longint* into a **string** value. This is the declaration of the *IntToStr* function in Delphi's run-time library:

```
function IntToStr(Value: Longint): string;
```

All functions begin with the reserved word **function**. The word after the final colon in a function declaration is the data type of the value that is returned. The *IntToStr* function therefore returns a value of type **string**.

Once the code in the *IntToStr* function runs, the assignment statement assigns the returned string value to the *Text* property of an edit box named *Edit1*.

Value is the only parameter of the *IntToStr* function. It has a data type of *Longint*, an integer type. To use *IntToStr*, you can specify as the *Value* parameter

- An actual integer value:

```
IntToStr(3)
```

- A variable or property that is an integer type:

  ```
  IntToStr(Sum)
  ```

- An expression that is evaluated as an integer value (assume *X* and *Y* are integer values in this example):

  ```
  IntToStr(X+Y)
  ```

■ To call a function, assign the returned value to a variable or property that is compatible with the returned value:

```
Edit1.Text := IntToStr(Sum);
```

Using functions that return a Boolean value to branch code

Some functions return a *Boolean* value, which is either *True* or *False*. Your code can use such a function to branch to various tasks and routines based upon the value returned.

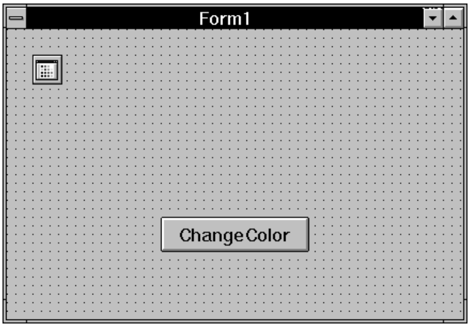
Here is an example:

➤ Add a color dialog box and a button to a form.

➤ Using the Object Inspector, change the name of the button to *ChangeColor*.

Your form should look something like this:

Figure 5.3 A form for an example that uses the Execute function



➤ Create this event handler for the *OnClick* event:

```
procedure TForm1.ChangeColorClick(Sender: TObject);
begin
 if ColorDialog1.Execute then                                { if user clicks OK button }
   Form1.Color := ColorDialog1.Color
 else
   Form1.Color := clRed;
end;
```

➤ Run the application and click the button.

The event handler uses the *Execute* method, a function that returns a *Boolean* value. You can either select a color in the dialog box and choose OK, or choose Cancel to exit the dialog box without selecting a color. If you choose OK, the *ColorDialog1.Execute* method returns *True*; if you choose Cancel, the method returns *False*. If *ColorDialog1.Execute* returns *True*, the form is colored with your color selection (*Form1.Color* is assigned the value you selected, which is *ColorDialog1.Color*); if it returns *False*, the form is colored red.

The compiler would interpret the code the same way if you wrote the *Execute* function like this:

```
if ColorDialog.Execute = True then ...
```

Controlling the flow of code execution

Object Pascal has several statements that direct the flow of code execution. Two are branching statements, and the other three are loop statements:

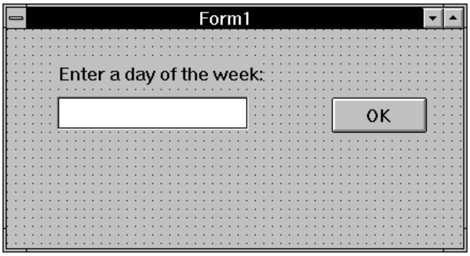
- Branching statements
  - The **if** statement
  - The **case** statement
- Looping statements
  - The **repeat** statement
  - The **while** statement
  - The **for** statement

The if statement

Object Pascal's **if** statement evaluates an expression and determines the flow of your code based on the result of that evaluation. If a certain condition is *True*, the code flow branches one way. If the condition is *False*, the flow branches in another direction. To see the syntax of an **if** statement, see the **if** reserved word topic in Delphi's online Help.

This example uses a simple **if** statement. This is how your finished form should look:

Figure 5.4 A sample form to illustrate an **if** statement



➤ To create this sample application,

1 Create a form that contains one edit box control, two label controls, and a button.

2 Place *Label1* above the edit box control, and place *Label2* below it.

3 Change these properties with the Object Inspector:

- Change the caption of *Label1* to 'Enter a day of the week:'.
- Delete the caption of *Label2* so the label isn't visible when the application runs.
- Rename the button *OK*.

4 Create this *OKClick* event handler:

```
procedure TForm1.OKClick(Sender: TObject);
begin
  if Edit1.Text = 'Saturday' then
    Label2.Caption := 'Why are you working today?';
end;
```

In this event handler, the equal sign operator (=) is used as a relational operator. It compares the value of the constant *Saturday* with the value of the *Edit1.Text* property.

➤ Run the application and enter a day of the week in the edit box.

The **if** statement in this handler is of the simplest form. The **if** statement begins with the reserved word **if** and is followed by an expression that results in a *Boolean* value: *True* or *False*. If the expression is *True*, the code following the reserved word runs. So if you type the word `Saturday` into the edit box control and click the OK button on the form, a message appears in the second label.

Using an else part in an if statement

The logic for this simple application has a flaw. What if you type `Saturday` in the edit box and click the OK button one time, but then type `Monday` and click the OK button again? The Saturday message still remains in the second label. You could add an **else** part to the **if** statement to handle strings other than Saturday typed in the edit box.

➤ For example, modify the event handler to look like this:

```
procedure TForm1.OKClick(Sender: TObject);
begin
  if Edit1.Text = 'Saturday' then
    Label2.Caption := 'Why are you working today?'
  else
    Label2.Caption := '';
end;
```

➤ Run the application, enter a day of the week in the edit box, and click OK.

This **if** statement also includes the **else** reserved word. The statement following **else** runs if the following tested condition is *False*:

```
Edit1.Text = 'Saturday'
```

The statement in the **else** part clears the caption, as `''` is an empty string.

Note In the **if** statement just shown, there is no semicolon until the end of the **else** part. If you put a semicolon before the **else** part, Delphi generates an error.

Writing multiple statements within an if statement

If you want more than one thing to happen when the tested condition in an **if** statement is *True*, you can write multiple statements in a **begin**..**end** block. This expanded handler now displays a message and also turns the form yellow:

```
procedure TForm1.OKClick(Sender: TObject);
begin
  if Edit1.Text = 'Saturday' then
  begin
    Label2.Caption := 'Why are you working today?';
    Form1.Color := clYellow;
  end
  else
    Label2.Caption := '';
end;
```

Each statement in the **begin**..**end** block ends in a semicolon. When you use multiple statements in the **if** part of an **if** statement, you still need to remember never to precede the **else** part with a semicolon. That is why no semicolon follows the first **end** reserved word in the previous code example.

Note You can use multiple statements any place that requires a statement as long as you start the statement part with **begin** and end it with **end**. Such a statement part is known as a *compound statement*. You can read more about compound statements in Delphi's online Help.

Nesting if statements

You can put **if** statements within **if** statements when the logic of your application requires it. For example, the *OKClick* handler shown here can now test three conditions:

```
procedure TForm1.OKClick(Sender: TObject);
begin
  if Edit1.Text = 'Saturday' then
    Label2.Caption := 'Why are you working today?'
  else
    if Edit1.Text = 'Sunday' then
      Label2.Caption := 'You should be resting'
    else
      if Edit1.Text = 'Monday' then
        Label2.Caption := 'Welcome to a new work week!'
      else
          Label2.Caption := '';
end;
```

As soon as a condition is met, the statement part runs and no further testing of conditions occurs. In other words, if you type `Saturday` in the edit box, the code displays the Saturday message in the label, and the rest of the **if** statement is ignored.

Note No semicolon appears until the end of the final **else** part. When you write nested **if** statements, choose a consistent, clear indentation style. This will help you and anyone else who reads your code see the logic of the **if** statement and how the code flows when your application runs.

You can also nest **if** statements containing **else** parts within **if** statements that don't have **else** parts. Your nested **if** statement might have this structure:

```
if ConditionA = True then
  if Condition B = True then
    DoThis
  else
    DoThat;
```

Be aware that if you do this, the compiler considers the **else** part to belong to the innermost **if** statement. If you want to call *DoThat* whenever *ConditionA* is *False* regardless of the value of *ConditionB*, write your code like this:

```
if ConditionA = True then
  begin
    if ConditionB = True then
      DoThis
  end
else
  DoThat;
```

In this case, using the **begin** and **end** reserved words forces the **else** part to be linked with the first **if** statement.

For more information about writing **if** statements, see Delphi's online Help.

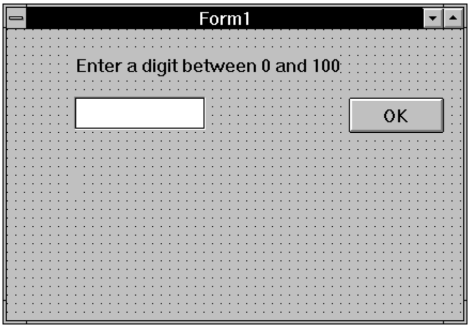
The case statement

Your application can also use a **case** statement to branch to the appropriate lines of code. The **case** statement is often preferable to a series of **if** statements when the variable or property being evaluated is an integer type (with the exception of *Longint*), a *Char* type, an enumerated type, or a subrange type. (You can read about enumerated and subrange types beginning on page 195.) The logic of a **case** statement is usually easier to see than in complex nested **if** statements, and the code runs more quickly.

To see the syntax of the **case** statement, look up the **case** reserved word topic in Delphi's online Help.

This is the form used for the following **case** statement example:

Figure 5.5 A form for a case statement example



➤ To create this application,

1 Place a button, an edit box, and a label on a form.

2 Using the Object Inspector, modify these properties:

- Delete the text from the edit box.
- Change the caption of the label to 'Enter a day of the week'.

3 Create this event handler:

```
procedure TForm1.OKClick(Sender: TObject);
var
  Number: Integer;
begin
  Number := StrToInt(Edit1.Text);
  case Number of
    1, 3, 5, 7, 9: Label2.Caption := 'Odd digit';
    0, 2, 4, 6, 8: Label2.Caption := 'Even digit';
    10..100: Label2.Caption := 'Between 10 and 100';
  else
    Label2.Caption := 'Greater than 100 or negative';
  end;
end;
```

4 Run the application.

When you enter a number and choose OK, the string representation of the number is converted to an integer and assigned to the *Number* variable. The **case** statement then uses the value of *Number* to determine which statement within the **case** statement runs. In this line of code, the statement after the colon runs, and the *Label2.Caption* receives the string `'Odd digit'` if the value of *Number* is 1, 3, 5, 7, or 9:

```
1, 3, 5, 7, 9: Label2.Caption := 'Odd digit';
```

Like the **if** statement, the **case** statement has an optional **else** part. **Case** statements end with the **end** reserved word.

Note If you want to include more than one statement in the statement part of a **case** statement (the part following the colon (:)), place the **begin** and **end** reserved words around the multiple statements. For example,

```
case Number of
  1, 3, 5, 7, 9:
  begin
    Label2.Caption := 'Odd digit';
    Form1.Color := clBlue;
  end;
  2, 4, 6, 8: Label2.Caption := 'Even digit';
  ⋮
```

Writing loops

Object Pascal has three statements that execute blocks of code repeatedly:

- The **repeat** statement
- The **while** statement
- The **for** statement

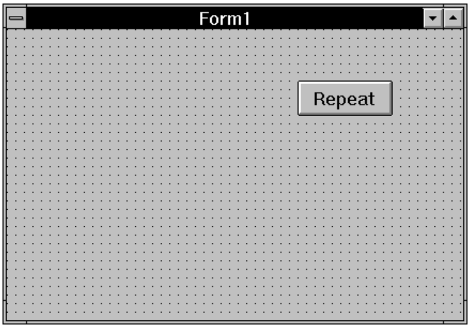
The repeat statement

The **repeat** statement repeats a statement or series of statements until some condition is *True*. The statement begins with the **repeat** reserved word and ends with the reserved word **until,** followed by the condition that is evaluated. The condition is always a *Boolean* expression.

To see the syntax of the **repeat** statement, look up the **repeat** reserved word topic in online Help.

This is the finished form for an application that uses a **repeat** statement.

Figure 5.6 A form for a repeat statement example



➤ To create this application,

1 Create a new form with one button on it.

2 Using the Object Inspector, change these properties:
- Change the button name to *RepeatButton*.
- Change the caption of the button to Repeat.

3 Create this event handler that runs when you click the button:

```
procedure TForm1.RepeatButtonClick(Sender: TObject);
var
  I: Integer;
begin
  I := 0;
  repeat
    I := I + 1;
    Writeln(I);
  until I = 10;
end;
```

4 Run the application and click the Repeat button.

The numbers 1 through 10 are written down the edge of the form. The *Boolean* expression I = 10 isn't evaluated until the end of the **repeat**..**until** block. This means that the statements within the **repeat**..**until** block *always* run at least one time.

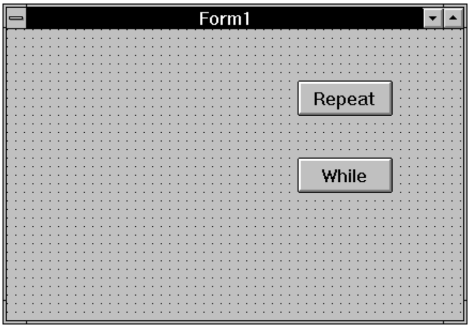
For more information about **repeat** statements, see Delphi's online Help.

The while statement

While the **repeat** statement evaluates a condition at the end of the loop, the **while** statement evaluates a condition at the beginning of the loop. It starts with the **while** reserved word and the tested condition, which must always be a *Boolean* expression. If the condition is met (the expression is *True*), the code in the **while** statement runs until it reaches the end of the statement and the expression is tested again. As soon as the expression is *False*, the **while** statement stops running, and execution continues after the **while** loop.

This example of a **while** loop uses the same sample form as the **repeat** loop did. This is how the finished form appears:

Figure 5.7 A form for a while statement example



➤ To create this application,

1 Add another button to the form and make these changes with the Object Inspector:

- Rename the second button to *WhileButton*.
- Change the caption of the button to While.

2 Create this event handler that runs when you click the While button:

```
procedure TForm1.WhileButtonClick(Sender: TObject);
var
  J: Integer;
begin
  J := 0;
  while J < 10 do
  begin
    J := J + 1;
    Writeln(J:50);
  end;
end;
```

3 Run the application and click the While button.

The following *Boolean* expression is examined first:

```
J < 10
```

If it is *True*, the remainder of the code within the **while** statement runs, and then the expression is evaluated again. If the expression is *False*, the **while** statement stops running.

When you click the While button, once again the numbers 1 through 10 are written. This time they appear 50 character spaces to the left of the edge of the form.

Note! When you try the following suggested steps, your application might appear to be in an endless loop. Be patient a moment, and the code will stop running.

➤ Change the statement I := 0 to I := 10 in the *RepeatButtonClick* handler. Then, change the statement J := 0 to J := 10 in the *WhileButtonClick* handler. Finally, run the application and click one of the buttons.

If you click the Repeat button, the statements within the **repeat** statement run, even though *I* already equals 10. This happens because the *Boolean* expression isn't evaluated until the end of the **repeat** statement. The loop keeps running until I = 10 once again.

If you click the While button, the statements within the **while** statement don't run at all. Because *J* already equals 10, the *Boolean* expression is *True*, and the **while** statement stops running.

For more information about **while** statements, see Delphi's online Help.

The for statement

So far this section has discussed two kinds of loops, the **repeat** statement and the **while** statement. The **repeat** statement runs *until* a condition is *True*, and the **while** statement runs *while* a condition is *True*. The **for** statement is the third type of loop in Object Pascal. The code within a **for** loop runs a specific number of times.

The value of a control variable, which is really just a counter, determines how many times a **for** statement runs. You need to declare a variable for each **for** loop you use in your code. The variable can be any integer, *Boolean*, *Char*, enumerated, or subrange type.

The simplest way to understand a **for** statement is to look at an example. The code shown here would print the numbers 1 to 5, each on a separate line. *X* is the control variable:

```
var
  X: Integer;
for X := 1 to 5 do
  Writeln(X);
```

The **for** statement defines an initial value (1) and a final value (5) for variable *X*. When the **for** statement begins running, *X* is assigned the initial value, and the *Writeln* procedure runs, displaying the current value of *X*. The value of *X* is then incremented by 1. Because the value of *X*, now 2, is not greater than the final value (5), the *Writeln* procedure runs again, this time displaying the value of *X* as 2. This process continues until the value of *X* becomes greater than the final value, 5, and the execution of the **for** statement ends.

A counting example

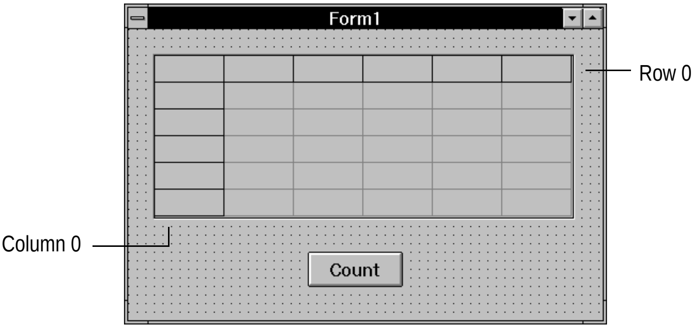
This is a variation of the same **for** loop just discussed. It uses a string grid control and a button the user clicks to start the counting process.

➤ To create the form,

1. Place a string grid control and a button on the form.
2. Use the Object Inspector to
   - Change the value of the button's *Name* property to *CountButton.*
   - Change the caption of the button to Count.
   - Change the *ColCount* property for the string grid to 6.
   - Change the *RowCount* property for the string grid to 6.

You might have to resize the form and the string grid so that you can see all six columns. Your form should look like this:

Figure 5.8 A sample form to illustrate a for loop



➤ Create this *CountButtonClick* event handler:

```
procedure TForm1.CountButtonClick(Sender: TObject);
var
  Col: Integer;
begin
  for Col := 1 to 5 do
      StringGrid1.Cells[Col, 1] := IntToStr(Col);
end;
```

➤ Run the application and click the Count button.

This event handler uses the *Cells* property, which is a two-dimensional array of strings indexed by a column and row value. (If you are unfamiliar with arrays, you can read about them starting on page 199.) Each cell in the string grid is represented in the *Cells* property array. To access a particular cell in the grid, you specify the cell's column and row value. For example, the top left cell in the grid is *Cells*[0,0], meaning that the cell is in column 0 and row 0 (the first position in the *Cells* array is 0).

The **for** statement in the *CountButtonClick* handler displays the numbers 1 through 5, one in each cell, in row 1 of the string grid, starting with column 1. As the **for** statement runs, the column number increases, but the row number remains the same (1).

The **for** statement can also decrement values using the **downto** reserved word.

➤ Change the *CountButtonClick* handler to look like this:

```
procedure TForm1.CountButtonClick(Sender: TObject);
var
  Col: Integer;
begin
  for Col := 5 downto 1 do
      StringGrid1.Cells[Col, 1] := IntToStr(Col);
end;
```

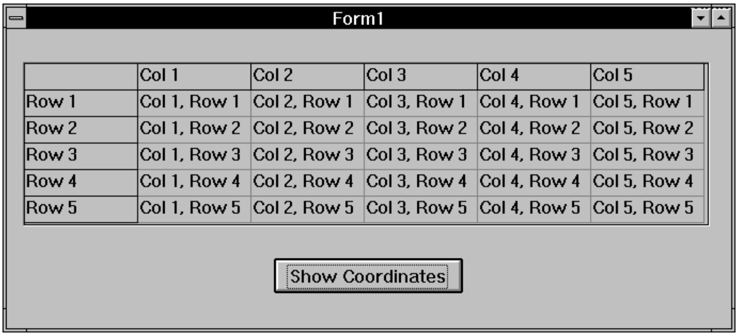
➤ Run the application and click the Count button.

Although the end result is the same as before, the handler displays the numbers beginning with column 5 and proceeding to column 1. As the code runs, the *Col* variable is assigned the initial value of 5, which is then decremented until the value of *Col* is less than the final value (1).

Using nested for loops

Writing a **for** loop within another **for** loop is very useful when you want to display data in a table or a grid. This example uses the string grid. The code displays simple column and row titles in the nonscrolling or fixed regions of the grid, and then displays the column and row coordinates for each cell. When you click the Show Coordinates button, this appears in the grid:

Figure 5.9 A form with string grid displaying column and row coordinates



	Col 1	Col 2	Col 3	Col 4	Col 5
Row 1	Col 1, Row 1	Col 2, Row 1	Col 3, Row 1	Col 4, Row 1	Col 5, Row 1
Row 2	Col 1, Row 2	Col 2, Row 2	Col 3, Row 2	Col 4, Row 2	Col 5, Row 2
Row 3	Col 1, Row 3	Col 2, Row 3	Col 3, Row 3	Col 4, Row 3	Col 5, Row 3
Row 4	Col 1, Row 4	Col 2, Row 4	Col 3, Row 4	Col 4, Row 4	Col 5, Row 4
Row 5	Col 1, Row 5	Col 2, Row 5	Col 3, Row 5	Col 4, Row 5	Col 5, Row 5

➤ To set up the example,

1 Place a string grid control and a button control on the form.

2 With the Object Inspector, change these property values for the grid:

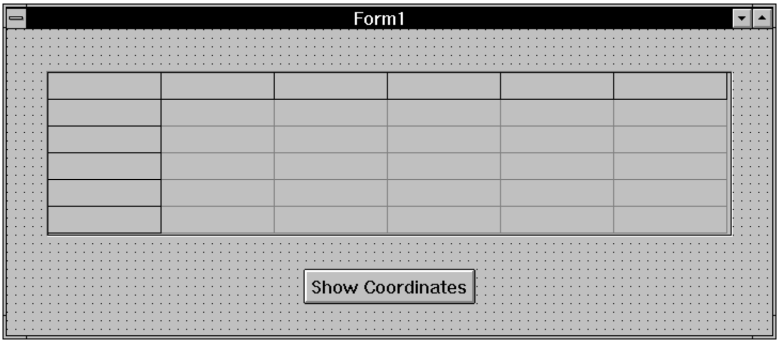
- Change *RowCount* to 6.
- Change *ColCount* to 6.
- Change *DefaultColWidth* to 105.

You might have to enter a different *DefaultColWidth* value depending on your screen resolution. Make the columns wide enough to display the coordinates of the cells.

- Change the name of the button to *ShowCoordinatesButton*.
- Change the caption of the button to Show Coordinates.

You probably also want to increase the size of the form and the grid to display all the rows and columns.

Figure 5.10 A form for a nested for loop example



3 Create this event handler that runs when you click the Show Coordinates button:

```
procedure TForm1.ShowCoordinatesButtonClick(Sender: TObject);
var
  Col, Row: Integer;
begin
  for Col := 1 to 5 do
    StringGrid1.Cells[Col, 0] := 'Col ' + IntToStr(Col);
  for Row := 1 to 5 do
    StringGrid1.Cells[0, Row] := 'Row ' + IntToStr(Row);
  for Col := 1 to 5 do
    for Row := 1 to 5 do
      StringGrid1.Cells[Col, Row] :=
        'Col ' + IntToStr(Col) + ', ' + 'Row ' + IntToStr(Row);
end;
```

4 Run the application and click the Show Coordinates button.

This event handler contains four **for** statements. The first **for** statement writes the string 'Col ' plus the current value of the *Col* variable in the row 0 once the value of *Col* is converted to a string:

```
for Col := 1 to 5 do
  StringGrid1.Cells[Col, 0] := 'Col ' + IntToStr(Col);
```

The second **for** statement writes the string 'Row ' plus the current value of the *Row* variable in the column 0 once the value of *Row* is converted to a string:

```
for Row := 1 to 5 do
  StringGrid1.Cells[0, Row] := 'Row ' + IntToStr(Row);
```

The fourth **for** statement is nested within the third **for** statement. Together, the two **for** statements display each cell's column and row coordinates within the cell:

```
for Col := 1 to 5 do
    for Row := 1 to 5 do
      StringGrid1.Cells[Col, Row] :=
        'Col ' + IntToStr(Col) + ', ' + 'Row ' + IntToStr(Row);
```

Col receives the initial value of 1, indicating the first scrolling column of the grid. Before the **for** statement actually does something, the second **for** loop begins. *Row* is assigned the initial value of 1, indicating the first row of the scrolling column of the grid. The code then writes a string in the column 1 and row 1. The string consists of the substring 'Col ', the string value of the *Col* variable, the substring ', ', the substring 'Row ', and the string value of the *Row* variable. The actual value in *Cells[1, 1]* is this string: 'Col 1, Row 1'.

The code continues to execute the nested **for** loop, moving to the next row within the same column as the value of the *Col* variable is still 1. The nested **for** loop ends when the value of *Row* has increased from 1 to 5 and a value is written within each row of column 1. Then the third **for** loop continues to run as the *Col* variable is assigned the next highest value, at which time the nested **for** loop begins again with the new *Col* value.

For more information about **for** statements, see Delphi's online Help.

Deciding which loop to use

This section has described several kinds of Object Pascal loops. How do you decide which kind to use? Here are some guidelines to help you decide:

- Use the **for** loop if you know how many times you want a loop to repeat. The **for** loop is very fast and efficient.
- Use the **repeat**..**until** loop if you don't know how many times you want the loop to repeat, but you do know it must run at least once.
- Use the **while**..**do** loop if you don't know how many times you want the loop to repeat, and it's possible you don't want the loop to run at all.

Object Pascal blocks

Blocks are an important concept in Object Pascal. They provide the structure of your application, and they determine the scope of variables, properties, and so on. You can read about scope in the section "Understanding scope" on page 177.

An Object Pascal block is made up of two parts: an optional declaration part and the statement part. If there is a declaration part, it always precedes the statement part.

A declaration informs the compiler of the item being declared. Object Pascal has

- Variable declarations
- Constant declarations
- Type declarations

- Label declarations
- Procedure, function, and method declarations

Following the declaration part is the statement part of the block. The statements of a block describe algorithmic actions that can be executed. If a block contains a declaration part, the statement part uses the items declared in the declaration part of the same block.

Blocks within event handlers

One of the most common kinds of blocks you encounter in Delphi are the blocks within event handlers. The following simple event handler doesn't have a declaration part, but it does have a statement part:

```
procedure TForm1.Button1Click(Sender: TObject);
begin                                { The block starts here with the statement part }
  Edit1.Text := 'Welcome to Delphi';
end;                          { The block ends here at the end of the statement part }
```

The beginning of the statement part is marked with the reserved word **begin**. The end of the statement part is marked with the reserved word **end**.

Blocks can contain optional declaration parts. This is a revised version of the event handler that now includes a variable declaration part:

```
procedure TForm1.Button1Click(Sender: TObject);
var                   { The block begins here with the start of the declaration part }
  Name: string;
begin                                     { The statement part of the block begins }
  Name := Edit1.Text;
  Edit2.Text := 'Welcome to Delphi, ' + Name;
end;                                                            { The end of the block }
```

As shown in this event handler, the variable declaration part starts with the reserved word **var** and continues until the beginning of the statement part.

As described earlier, event handlers are Object Pascal procedures. Procedures that aren't event handlers also have blocks that look exactly like the blocks in event handlers. You can read more about procedures and also about functions, which are very similar to procedures, in the section "Writing a procedure or function" on page 183.

Blocks within units

Units also have blocks that are made up of a declaration part and a statement part. While units have a few unique parts of their own, the notion of a block is still present. For example,

```
unit Unit1;

interface

uses WinTypes, WinProcs, Classes, Graphics, Forms, Controls, Apps;

type                         { Beginning of the declaration part and the unit block }
  TForm1 = class(TForm)
```

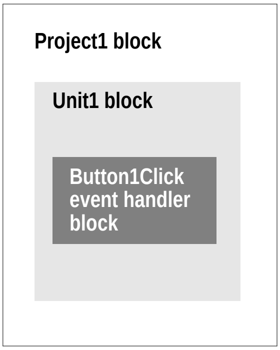
```
    Edit1: TEdit;
    Edit2: TEdit;
    Button1: TButton;
    procedure Button1Click(Sender: TObject);
  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
  Form1: TForm1;                                       { The end of the declaration part }

implementation

{$R *.DFM}

procedure TForm1.Button1Click(Sender: TObject);   { Beginning of the event handler block }
var
  Name: string;
begin
  Name := Edit1.Text;
  Edit2.Text := 'Welcome to Delphi, ' + Name;
end;                                                    { End of the event handler block }

end.                                                         { The end of the unit block }
```

For more information about units, see "Understanding Object Pascal units" on page 206. You can also read about units and study the accompanying syntax diagrams in online Help.

Blocks within blocks

Blocks can contain other blocks. For example, in the previous example, the block of the *Button1Click* event handler exists within the unit block, which exists within the project block. Here is a visual representation of the blocks within the application so far:

Figure 5.11 Blocks within blocks



All Delphi applications have the same basic structure. As your application becomes more complex, you are adding new blocks of code, such as new event handlers to a unit, or new units to a project.

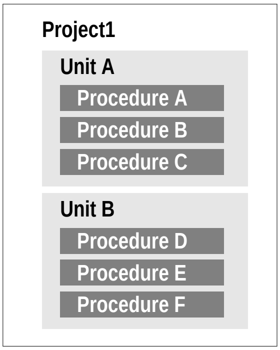
Understanding scope

The *scope* of a variable, constant, method, type, or other identifier defines where the identifier is active. The identifier is *local in scope* to the smallest block in which it is declared.

When your application is executing code outside the block in which an identifier is declared, that identifier is no longer in scope. That means the identifier is no longer available to the executing code. Only when code execution reenters the same block as the identifier declaration can the code access the identifier again.

You were introduced to blocks in the previous section. Imagine that you have a project that contains two units. Each of those units contains three event handlers, or procedures. Here is your project depicted graphically:

Figure 5.12 Blocks within a simple project



Each rectangle in the diagram represents a block. If you declare a variable within procedure D, only the code within procedure D can access that variable, as that variable is local in scope to procedure D. If you declare a variable in unit B that is not in any procedure, all procedures D, E, and F can use the variable, because all these procedures are within the scope of unit B. The variable is now global in scope to the procedures, but local in scope to unit B.

In general, declare identifiers that are as local in scope as possible. This gives the data in your application increased protection from being modified when you do not intend it to be. Only when you need to share data between different blocks should you consider using a more global scope.

Accessing declarations that are not within scope

You can refer to declarations in blocks that are not within the scope of the current block. For example, if you create an event handler that calculates an interest payment in one unit, it is possible for another unit to access that event handler.

■ To access a declaration that is not within scope, preface the declaration name with the name of the block in which it is declared and a period(.).

For example, to call the *CalculateInterest* procedure that is declared in *Unit1* from *Unit2*, make the call like this:

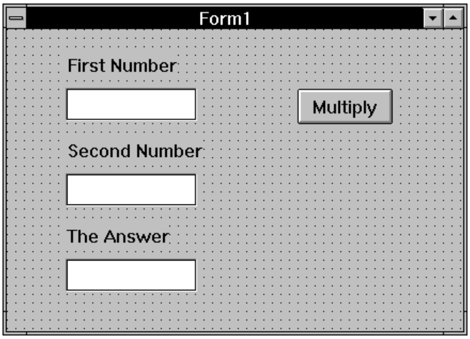
```
Unit1.ComputeInterest(Principal, InterestRate: Double);
```

You would also need to add *Unit1* to the **uses** clause of *Unit2*. For more information about adding units to a **uses** clause, see "How units are used" on page 209.

A scope example

This is an example that illustrates local and global scope. Your finished form should look something like this:

Figure 5.13 A form for multiplying two numbers together



Each time the user enters two numbers in the first two edit boxes and chooses Multiply, the application multiplies the two numbers together and displays it in the The Answer edit box.

➤ To create this application,

1 Put three edit box controls and a button control on a form.

2 Place a label control above each of the three edit boxes.

3 Using the Object Inspector, change these property settings:

- Change the caption of *Label1* to *First Number*.
- Change the caption of *Label2* to *Second Number*.
- Change the caption of *Label3* to *The Answer*.
- Change the value of the *Name* property of *Button1* to *Multiply*.
- Delete the text in all the edit boxes.

4 Create this *OnClick* event handler for the *Multiply* button:

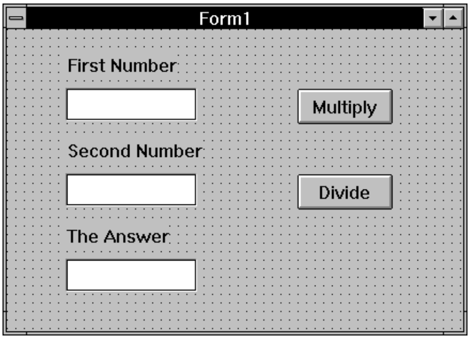
```
procedure TForm1.MultiplyClick(Sender: TObject);      { Multiplies two numbers together }
var
  FirstNumber, SecondNumber: Integer;
begin
  FirstNumber := StrToInt(Edit1.Text);
  SecondNumber := StrToInt(Edit2.Text);
  Edit3.Text := IntToStr(FirstNumber * SecondNumber);         { Displays answer in Edit3 }
end;
```

5 Run your application.

You can put one integer in the first edit box and a second integer in the second edit box. When you click the *Multiply* button, the third statement multiplies the two numbers together and displays the result in the third edit box.

➤ Add another button to the form and rename it *Divide*:

Figure 5.14 A form for a scope example



➤ Create this event handler:

```
procedure TForm1.DivideClick(Sender: TObject);
begin
  FirstNumber := StrToInt(Edit1.Text);
  SecondNumber := StrToInt(Edit2.Text);
  Edit3.Text := IntToStr(FirstNumber div SecondNumber);
end;
```

➤ Try to compile or run your application.

You get an Unknown Identifier error message. Even though you already declared the *FirstNumber* and *SecondNumber* variables in the *MultiplyClick* event handler, the *DivideClick* event handler can't use them. Code in your application can't access variables outside the event handler in which they were declared. In fact, these variables cease to exist in memory when code execution continues outside the event handler. This is true for all identifiers declared within any routine, whether it is an event handler, procedure, function, or method. Such identifiers are called local in scope.

You can choose one of these two methods to make your application run correctly:

- You can redeclare the *FirstNumber* and *SecondNumber* variables in the *DivideClick* event handler. Again, the variables are local in scope:

```
procedure TForm1.DivideClick(Sender: TObject);
var
  FirstNumber, SecondNumber: Integer;
begin
  FirstNumber := StrToInt(Edit1.Text);
  SecondNumber := StrToInt(Edit2.Text);
  Edit3.Text := IntToStr(FirstNumber div SecondNumber);
end;
```

- You can move the variable declaration part out of the *MultiplyClick* event handler to an area above all event handlers, but after the **implementation** line and the {**$R** *.DFM} directive. Your code should look like this, beginning with the **implementation** part:

```
implementation

{$R *.DFM}

var
  FirstNumber, SecondNumber: Integer;        { Variables global to the event handlers }

procedure TForm1.MultiplyClick(Sender: TObject);    { Multiplies two numbers together }
begin
  FirstNumber := StrToInt(Edit1.Text);
  SecondNumber := StrToInt(Edit2.Text);
  Edit3.Text := IntToStr(FirstNumber * SecondNumber);      { Displays result in Edit3 }
end;

procedure TForm1.DivideClick(Sender: TObject);   { Divides first number by the second }
begin
  FirstNumber := StrToInt(Edit1.Text);
  SecondNumber := StrToInt(Edit2.Text);
  Edit3.Text := IntToStr(FirstNumber div SecondNumber);    { Displays result in Edit3 }
end;
⋮
```

If you choose the second method, *FirstNumber* and *SecondNumber* are no longer local in scope to the event handlers. Because any event handler can now access these variables, even those you might add in the future, they are called *global in scope*, or *global variables.* The variables are local in scope to the unit, however, because the variables are declared within the unit block.

As stated earlier, you should try to keep your variables as local as possible. This protects you from forgetting where a variable is used and getting side effects you don't want when your code changes the value of the variable. Therefore, the first method discussed earlier is probably the best choice. You should consider variables with a broader scope only when your application needs to share data between different blocks.

Because the code now can access the necessary variables, regardless of which method you chose, the example works correctly—almost. If the *FirstNumber* value isn't evenly divisible by the *SecondNumber* value, the fractional part of the result is discarded, because the example is using only integer values.

Redeclaring identifiers in a different scope

It's perfectly legal to declare an identifier in more than one place in your application, as long as the scope of the identifier differs. The compiler always accesses those variables that are the most local in scope.

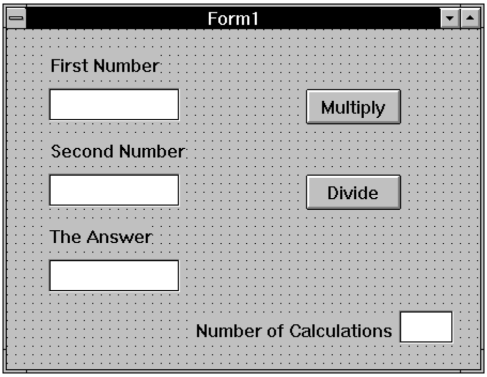
This section has already discussed how two event handlers can declare the same variables, *FirstNumber* and *SecondNumber*. Because any identifiers declared within *MultiplyClick* and *DivideClick* are not within the same scope, the two can have identifiers with the same name declared within them.

If *FirstNumber* were declared globally within the scope of the unit *and* also declared locally within the scope of an event handler within the unit, your application would compile without problems. The compiler, however, uses the most local variable to which it has access each time it encounters a *FirstNumber* variable in code.

Using a global variable

Suppose you wanted to keep track of the number of calculations performed while your application was running. You could modify your form to look like this:

Figure 5.15 A form that uses a global variable



➤ To create this application,

1 Add a fourth edit box to the form and a label to the left of the new edit box.

2 With the Object Inspector, make these changes:

- Change the value of the edit box *Name* property to *Counter*.
- Change the caption of the new label to *Number of Calculations*.

3 Add these lines of code to each event handler:

```
Count := Count + 1;
Counter.Text := IntToStr(Count);
```

These lines of code add one to the *Count* variable each time you click one of the buttons on the form, and display the result in the Counter edit box.

If you try to run your application now, Delphi reminds you that you haven't declared the *Count* variable yet. You could declare *Count* in each of the event handlers and give it an initial value of 0. This is how the *DivideClick* event handler would look:

```
procedure TForm1.DivideClick(Sender: TObject);
var
  FirstNumber, SecondNumber, Count: Integer;
begin
  Count := 0;
  FirstNumber := StrToInt(Edit1.Text);
  SecondNumber := StrToInt(Edit2.Text);
  Edit3.Text := IntToStr(FirstNumber div SecondNumber);
  Count := Count + 1;
  Counter.Text := IntToStr(Counter);
end;
```

The problem is that each time one of the event handlers runs, *Count* is reset to 0, and then incremented by one. Your application would never display the number of calculations as greater than one!

In this case, your application really needs a global variable to function as you want it to.

➤ Declare *Count* outside of the scope of the event handlers, and within the scope of the unit in the unit's **implementation** part.

```
⋮
implementation

{$R *.DFM}

var
  Count: Integer;

procedure TForm1.MultiplyClick(Sender: TObject);
⋮
```

➤ Because you don't want to reset *Count* to 0 each time you click the Multiply or Divide button, initialize *Count* in the **initialization** part of the unit. To create an **initialization** part, add the reserved word **initialization** and the code that initializes *Count* above the final **end** reserved word at the bottom of the unit. The block should look like this:

```
initialization                                  ( Add initialization reserved word here }
  Count := 0;                                                  { Initializes Count to 0 }
end.
```

➤ Now run your application and enter values in *Edit1* and *Edit2*. Each time you click one of the buttons, one is added to the number of calculations.

Because both event handlers need to access and change the value of *Count*, you need to declare *Count* as a global variable to the event handlers.

Note A more object-oriented way of accomplishing the same goal would be to make *Count* a field of the form object. All the event handlers of the form could then access the *Count* field. You can read about objects and fields in Chapter 6.

The next section uses the same sample application, so don't delete the work you have just done if you are working through the examples.

Writing a procedure or function

Much of the code you write while developing a Delphi application is contained within event handlers Delphi creates for you. Still, there are times when you want to write your own procedures and functions that aren't event handlers.

For example, if you find yourself writing the same code over and over to perform some common task within event handlers, consider moving that code from the event handlers into a procedure or function outside the handlers. Then any event handler can call the procedure or function as it does any other existing procedure or function. You derive two benefits: you need to write the code only once, and the code in your event handlers is less cluttered.

This example continues with the scope example presented in the previous section. Here is the code of the example as it should exist currently, beginning with the **implementation** part:

```
⋮
implementation

{$R *.DFM}

var
  Count: Integer;

procedure TForm1.MultiplyClick(Sender: TObject);
var
  FirstNumber, SecondNumber: Integer;
begin
  FirstNumber := StrToInt(Edit1.Text);
  SecondNumber := StrToInt(Edit2.Text);
  Edit3.Text := IntToStr(FirstNumber * SecondNumber);
  Count := Count + 1;
  Counter.Text := IntToStr(Count);
end;

procedure TForm1.DivideClick(Sender: TObject);
var
  FirstNumber, SecondNumber: Integer;
begin
  FirstNumber := StrToInt(Edit1.Text);
  SecondNumber := StrToInt(Edit2.Text);
  Edit3.Text := IntToStr(FirstNumber div SecondNumber);
  Count := Count + 1;
  Counter.Text := IntToStr(Count);
end;

initialization
  Count := 0;
end.
```

So far, the application doesn't allow users to make any data entry errors. For example, if a user neglects to enter a value in one of the two edit boxes before clicking a button, the application stops running. To ensure that this doesn't happen, you'll write some code to check for a value in the edit boxes and, if there is none, prompt the user to enter one. Instead of writing this code twice—once in each event handler—you could write it once and call the routine from the event handler.

➤ Write a new *NoValue* function in the **implementation** part of the unit, placing it above all event handlers:

```
function NoValue(AnEditBox: TEdit): Boolean;
begin
  if AnEditBox.Text = '' then
  begin
    AnEditBox.Color := clRed;
    AnEditBox.Text := 'Enter a value';
    Result := True;
  end
  else
  begin
    AnEditBox.Color := clWindow;
    Result := False;
  end;
end;
```

The *NoValue* function determines if the edit box passed to the function is empty or not. If it is, the edit box color turns red, the user is prompted to enter a value, and the function returns *True*. If the edit box isn't empty, the edit box color is set to the Windows system window color, thereby changing the edit box color back to normal if it happened to be red, and the function returns *False*.

➤ Call the *NoValue* function from the two event handlers. Here is the call (actually two of them) from the *MultiplyClick* event handler:

```
procedure TForm1.MultiplyClick(Sender: TObject);
var
  FirstNumber, SecondNumber: Integer;
begin
  if NoValue(Edit1) or NoValue(Edit2) then              { This line calls NoValue twice }
    Exit;                            { If an edit box is empty, quit this event handler }
  FirstNumber := StrToInt(Edit1.Text);
  SecondNumber := StrToInt(Edit2.Text);
  Edit3.Text := IntToStr(FirstNumber * SecondNumber);
  Count := Count + 1;
  Counter.Text := IntToStr(Count);
end;
```

If either function call returns *True* (one or both of the edit boxes are empty), the *Exit* procedure runs. *Exit* is a routine in the run-time library that stops executing the code in the current block. This means that none of the remaining lines of code in the *MultiplyClick* event handler run.

➤ Run your application.

Now when either edit box is left empty, the user is notified.

A procedure or function consists of

- A procedure or function heading
- A block of code

Writing a procedure or function header

Every procedure or function begins with a header that identifies the procedure or function and lists the parameters the routine uses, if any. A procedure begins with the **procedure** reserved word. A function begins with the **function** reserved word.

The parameters are listed within parentheses. Each parameter has an identifying name and usually has a type. Parameters in a parameter list are separated from one another by a semicolon. For example,

```
procedure ValidateDate(Day: Integer; Month: Integer; Year: Integer);
```

You can combine parameters of the same type, like this:

```
procedure ValidateDate(Day, Month, Year: Integer);
```

You can read more about using parameters in the section “Passing parameters” on page 190.

Functions have one additional element in their headers: a return value type. Specify the type of the value returned by the function, separated from the rest of the header with a colon. For example, this function returns a value of type *Double*:

```
function CalculateInterest(Principal, InterestRate: Double): Double;
```

End all headers with a semicolon.

Writing a procedure or function block

As discussed in the section “Object Pascal blocks” on page 174, all blocks have two parts: an optional declaration part and a statement part.

Declarations within a procedure or function block

Declaration parts within a procedure or function block can contain

- Type declarations
- Variable declarations
- Constant declarations

Type declarations

Delphi applications can create new types beyond the predefined data types that are part of the Object Pascal language. You can read about creating user-defined types in the section “Defining new data types” on page 195, but here you can see what a type declaration part can look like. A type declaration part begins with the reserved word **type**. These are some type declarations:

```
type
  TCount = Integer;
  TPrimaryColor = (Red, Yellow, Blue);
  TTestIndex = 1..100;
  TTestValue = -99..99;
  TTestList = array[TTestIndex] of TTestValue;
  TCharVal = Ord('A')..Ord('Z');
  TDays = (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday);
```

An equal sign (=) follows the type identifier. The rest of the declaration defines the values that make up the new type. A variable of type *TNumber* must be an *Integer* value. A variable of type *TPrimaryColor* can be only red, yellow, or blue. A variable of type *TCharVal* must fall within the range of values returned by the *Ord* function on the capital letters A through Z, and so on.

Note that each type has a name that begins with the letter *T*. This isn't necessary, but it's the convention the Delphi documentation uses, and you'll find it helpful in distinguishing type names from other identifiers if you use it, too.

Just like variable and constant declarations, type declarations can be global or local in scope, depending on where you place the declaration. For example, if you declare the type *TDays* within a procedure, the *TDays* type exists only when that procedure runs, and it is therefore local in scope. If you place a type declaration at the top of the **implementation** part, all event handlers and other procedures and functions can use it.

Variable and constant declarations

Declaring variable and constants within event handlers is discussed in the section "Declaring variables" on page 154, and in the section "Declaring constants" on page 157. Because event handlers are procedures, you should already know how to create variable and constant declarations for procedures and functions.

Ordering the declaration parts

Traditionally, any type declarations appear in a procedure or function before variable declaration parts, and any variable declarations appear before constant declarations. This isn't required, though, and you can mix declaration parts any way you choose. You can also have more than one declaration part of the same kind. For example, you can have two or more variable declaration parts. The only rule you must remember is that declarations occur after the procedure or function header and before the statement or code part of the routine.

Writing the statement part

The statement part of a procedure or function begins with the reserved word **begin** and ends with the reserved word **end**, followed by a semicolon. All the code within the **begin** and **end** block are the statements of a procedure or function. As discussed earlier, statements can be assignment statements, procedure or function calls, **if** or **case** statements, or loops.

Assigning a return value in a function

Because a function returns a value, you need to ensure that you assign that return value. You can do this in either of two ways:

- Assign the value to be returned to the name of the function.
- Assign the value to be returned to the *Result* variable.

The following example shows you the first way; the value to be returned is assigned to the name of the function:

```
function CalculateInterest(Principal, InterestRate: Double): Double;
begin
  CalculateInterest := Principal * InterestRate;
end;
```

The next example accomplishes the same thing, but the value is assigned to a *Result* variable that all functions have:

```
function CalculateInterest(Principal, InterestRate: Double): Double;
begin
  Result := Principal * InterestRate;
end;
```

You don't have to declare the *Result* variable—it is automatically available for you to use. Using *Result* is a shortcut that makes your code just a little easier to understand.

No matter which method you choose, the function call is still the same. For example, this function call is the same regardless of whether the *CalculateInterest* function internally assigns a value to *CalculateInterest* or *Result*:

```
InterestEarned := CalculateInterest(1000, 0.08);
```

Positioning a procedure or function in your code

Procedures and functions are placed in the **implementation** part of a unit. All identifiers declared in the **implementation** part can be used only by the code contained within that unit.

You can set up procedures and functions so that code in other units can use the procedures and functions you write.

■ To make a procedure or function available to other units,

1. Put the header of the procedure or function in the **interface** part of the unit.

   By placing the header in the **interface** part, you are declaring the routine in the **interface** part, thereby making the routine available to any unit that uses this unit.

2. Place the entire procedure or function, repeating the header, in the **implementation** part of the unit.

3. Add the name of the unit in which you declared the routine to the **uses** clause of the unit that needs to access the routine.

You can read more about units, the **uses** clause, and how to use routines declared in other units in the section "Understanding Object Pascal units" on page 206.

For example, the *NoValue* function described on page 184 could be declared in the **interface** part of the unit. Then you could place the body of the routine, or its implementation, in the **implementation** part of the unit. This is a skeleton of how the unit would look:

```
unit Unit1;

interface

uses
⋮

type
  TForm1 = class(TForm)
    Multiply: TButton;
    Divide: TButton;
    procedure MultiplyClick(Sender: TObject);
    procedure DivideClick(Sender: TObject);
  ⋮
  end;

var
  Form1: TForm1;

function NoValue(AnEditBox: TEdit): Boolean;

implementation

function NoValue(AnEditBox: TEdit): Boolean;
⋮
end;

procedure TForm1.MultiplyClick(Sender: TObject);
⋮
end;

procedure TForm1.DivideClick(Sender: TObject);
⋮
end;

end.
```

If the *NoValue* function is not declared in the **interface** part, but in the **implementation** part instead, only this unit and no other can use *NoValue*.

When Delphi creates an event handler, the event handler procedure is declared in the object type declaration. Because the object type declaration is in the **interface** part of the unit, any other unit can call the event handler. For more information about the **interface** and **implementation** parts of a unit, see the section "Understanding Object Pascal units" on page 206.You can also read more about object type declarations in Chapter 6.

The *NoValue* function as it appears on page 184 is an example of a routine that is *not* declared separately from its implementation. Because you want only the code within the event handlers to be able to use *NoValue*, you would not declare it in the **interface** part, but in the **implementation** part, as the code in the event handlers is in the **implementation** part.

Note *NoValue* appears before the event handlers that use it. If the *NoValue* function is declared and implemented after the event handlers, the compiler reports the *NoValue* call in the handlers to be an unknown identifier.

Wherever you first declare a procedure or function, you should place either the declaration or the procedure or function itself above all routines that use them, whether they are event handlers or routines you write entirely on your own. In other words, a routine can't use another routine unless the second routine has already been declared. This is in keeping with the Object Pascal rule that states you can't use an identifier until you have declared it.

Forward declarations

There is an exception to this rule, however, that allows routine A to call routine B, and then while routine B is running, routine B calls routine A. This type of calling is called *mutual recursion.*

To make such mutual recursion possible, you need to declare a routine as a **forward** declaration. When you declare a routine using the **forward** standard directive, you can place the implementation of the procedure or function anywhere you choose—between event handlers, after other procedures and functions that call the routine, and so on. If the *NoValue* declaration is declared as a **forward** declaration, it looks like this:

```
function NoValue (AnEditBox: TEdit): Boolean; forward;
```

A forward declaration uses the **forward** standard directive. The declaration doesn't include the implementation of the procedure. Instead, the *NoValue* implementation has to appear somewhere after the **forward** declaration.

The implementation of *NoValue* can appear after other procedures, functions, event handlers, and methods that might call it, however.

This is an example of two procedures that call each other recursively. The form in this application has one button on it. When you click the button, the two procedures begin calling one another:

```
unit Unit1;

interface

uses WinTypes, WinProcs, Classes, Graphics, Forms, Controls, Apps;

type
  TForm1 = class(TForm)
    Button1: TButton;
    procedure Button1Click(Sender: TObject);
  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
  Form1: TForm1;
```

```
implementation

{$R *.DFM}

var
  Alpha: Integer;

procedure Test2(var A : Integer); forward;    { Test2 is declared as a forward procedure }

procedure Test1(var A: Integer);
begin
  A := A - 1;
  if A > 0 then
    Test2(A);                                             { A call to the Test2 procedure }
  Writeln(A);
end;

procedure Test2(var A: Integer);
begin
  A := A div 2;
  if A > 0 then
    Test1(A);                                           { A call to the Test1 procedure }
  Writeln(A);
end;

procedure TForm1.Button1Click(Sender: TObject);
begin
  Alpha := 15;                            { The Alpha variable receives a starting value }
  Test1(Alpha);                                  { The first call to the Test1 procedure }
end;

end.
```

The code in the *OnClick* event handler for the button gives the *Alpha* variable a value and then calls the *Test1* procedure. *Test1* subtracts one from the value of the *Alpha* variable and then tests *Alpha* to determine if it is greater than 0. If it is, *Test1* calls the *Test2* procedure. *Test2* divides the value of the *Alpha* variable by 2 and then tests *Alpha* to determine if it is greater than 0. If it is, *Test* 2 calls *Test1*. The two procedures continue to call each other until *Alpha* is no longer greater than 0, at which time the *Writeln* statements of the procedures run.

A more detailed discussion of mutual recursion and how it works is beyond the scope of this chapter. The important point to note is that the *Test2* procedure is declared as a **forward** procedure before the implementations of *Test1*, *Test2*, and the *Button1Click* event handler. If *Test2* is not declared as a **forward** procedure, the project will not compile, because the code would then be calling *Test2* before it is declared.

Passing parameters

When your code calls a procedure or function, it often uses parameters to pass data to the called procedure or function. The section “Calling procedures with parameters” on page 160, describes how to use a parameter in calling a procedure; the section “Writing a procedure or function header” on page 185, describes how to create a parameter list in a procedure or function header. This section describes the most common kinds of parameters your procedures and functions can use:

- Value parameters
- Variable parameters
- Constant parameters

Any parameters specified by the calling procedure or function are called the*actual* parameters. The corresponding parameters in the called procedure of function are called the *formal* parameters. So, in this procedure call, the *Edit1* parameter is the actual parameter:

```
ColorIt(Edit1);
```

The corresponding *AnEditBox* parameter in the called procedure declaration is the formal parameter

```
procedure ColorIt(AnEditBox: TEdit);
```

Value parameters

With the exception of the code example in the previous section, “Forward declarations,” *value* parameters are the only type of parameters discussed in this chapter so far. A formal value parameter is a copy of the actual value parameter. In other words, the compiler puts the actual parameter at one memory address, and the formal parameter at another memory address. Therefore, the called procedure or function can change the value of the formal parameter, yet the value of the actual parameter remains unchanged.

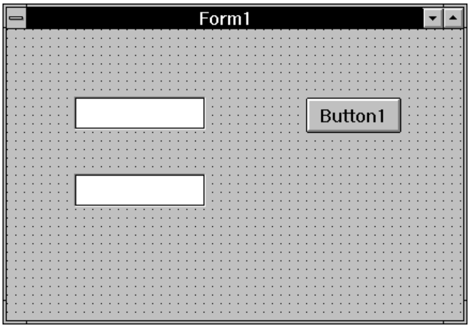
➤ To see an example of this,

1 Put two edit box controls and a button on a form.

2 Using the Object Inspector, delete the text specified as the value of the*Text* property for the two edit box controls.

Your form should look something like this:

Figure 5.16 A form for a value parameter example



3 Create this *OnClick* event handler for the button:

```
procedure TForm1.Button1Click(Sender: TObject);
var
  Number: Integer;
```

```
begin
  Number := StrToInt(Edit1.Text);
  Calculate(Number);
  Edit2.Text := IntToStr(Number);
end;
```

The handler retrieves the number the user enters in the first edit box and assigns it to the *Number* variable. This variable is passed to the *Calculate* procedure as *Calculate* is called. The last line displays the value of *Number* in the second edit box.

➤ Place this *Calculate* procedure above the event handler in your code, but below the **implementation** reserved word:

```
procedure Calculate(CalcNo: Integer);
begin
  CalcNo:= CalcNo * 10;
end;
```

In the *Calculate* procedure, the value in the *CalcNo* parameter changes. By the end of the procedure, the value of *CalcNo* is ten times greater than it was when *Calculate* began.

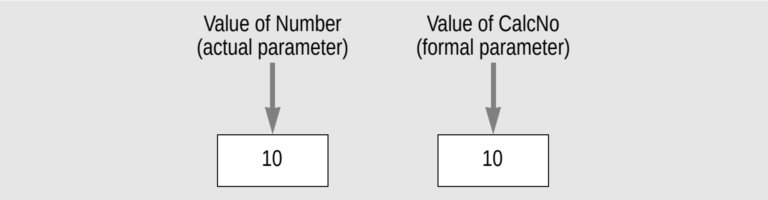
➤ Run the application and enter a number in the *Edit1* edit box.

The value you enter in the *Edit1* edit box is the value of *Number* before *Number* is passed to the *Calculate* procedure. The value that appears in the *Edit2* edit box is the value of *Number* after the *Calculate* procedure runs. The two values of *Number* are the same!

Because the *CalcNo* parameter is only a copy of the *Number* parameter, *Number* remains unchanged, while the value of *CalcNo* changes considerably. The application never displays the value of *CalcNo*.

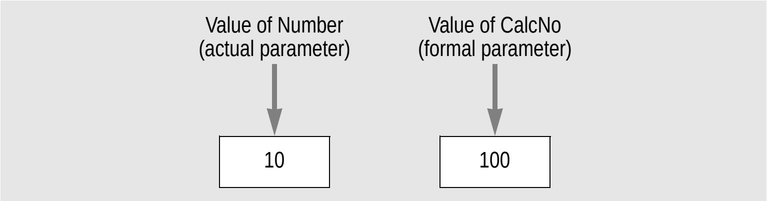
A couple of simple illustrations can demonstrate what is happening. *Number* and *CalcNo* each have a separate address in your computer's memory. The boxes in the following drawings represent memory locations. When *Calculate* is called, the value of *Number* is copied into the *CalcNo* memory location.

Figure 5.17 The value of Number and CalcNo when Calculate begins running



Because the *Calculate* procedure changes the value of the *CalcNo* parameter, the values of *Number* and *CalcNo* are no longer the same when *Calculate* stops running.

Figure 5.18 The values of Number and CalcNo after Calculate runs



Value parameters can be any expression. To read about what constitutes an expression, see the Expressions topic in online Help.

Variable parameters

Sometimes you want the value of a passed parameter to change as the called procedure or function processes it. In these cases, you need to use a *variable* parameter. Precede the formal parameter in the called routine with the reserved word **var** in the parameter list. For example,

```
procedure Calculate(var CalcNo: Integer);
```

This variable parameter is a reference to the actual parameter, which is *Number* in the example. It does *not* occupy a separate location in memory, but instead, points to the actual parameter.

When a variable parameter is passed, any changes made to the formal parameter are reflected in the actual parameter because both parameters refer to the same value.

➤ To see how this works, add the word **var** in front of the *CalcNo* parameter in the *Calculate* procedure declaration. The *Calculate* procedure should now look like this:

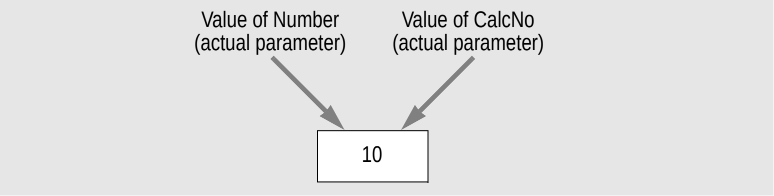
```
procedure Calculate(var CalcNo: Integer);
begin
  CalcNo := CalcNo * 10;
end;
```

➤ Run the application and enter a number in the *Edit1* edit box.

You can see that the *Calculate* procedure does indeed change the value of the *Number* variable in the *OnClick* event handler. Because the *Number* actual parameter and the formal *CalcNo* parameter now refer to the same variable, the *Number* value changes in the second edit box when *Calculate* runs.

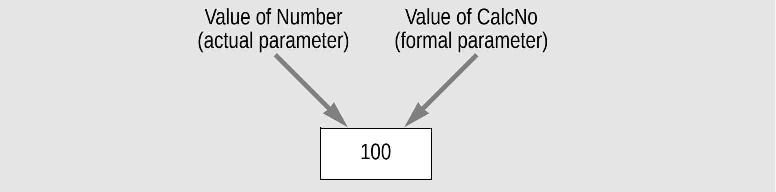
These drawings demonstrate what happens. When *Calculate* is called, the value of *Number* and the value of *CalcNo* are the same, because both the actual and the formal parameters refer to the same memory location.

Figure 5.19 The value of Number and CalcNo when Calculate begins running



After the *Calculate* procedure runs, the *Number* and *CalcNo* parameters still refer to the same value, even though that value has changed.

Figure 5.20 The value of Number and CalcNo after Calculate runs



Constant parameters

If a formal parameter never changes its value when a procedure or function runs, you should consider using a constant parameter instead of a value parameter. Make a formal parameter a constant parameter by typing the reserved word **const** before the name of the parameter in the parameter list.

Like a value parameter, a constant parameter can be any expression. Using a constant parameter instead of a value parameter, however, protects you from accidentally assigning a new value to the parameter when you don't want the parameter to change. If you try to assign a value to a constant parameter, you'll receive an Invalid Variable Reference message because the value of a constant isn't allowed to change.

Deciding which kind of parameter to use

Keep these points in mind when you use parameters:

- Use a value parameter when you *don't* want the value of the actual parameter to change. Because the formal parameter is only a copy of the actual parameter, the value of the actual parameter never changes.

  (Remember, the actual parameter is the parameter specified in the procedure or function call. The formal parameter is the parameter specified in the called routine.)

- Use a variable parameter when you *do* want the called routine to change the value of the passed parameter. Because both the actual and the formal parameters refer to the same value, the value of an actual variable parameter can change when it is processed in the called routine.

- Use a constant parameter as the formal parameter in the called routine when the routine never changes the formal parameter. This protects you from inadvertently assigning a new value to the formal parameter when you really don't want the formal parameter to change.

Defining new data types

The Object Pascal language comes with a number of predefined data types (see Table 5.1 for a list of them). You can use these data types to create new data types that meet the specific needs of your application. This section briefly describes the primary kinds of data types you can create:

- Enumerated types
- Subrange types
- Array types
- Set types
- Record types
- Object types

Object Pascal has other user-defined data types that aren't discussed in this chapter: file, pointer, and procedural types. For more information about these types, see the corresponding topics in online Help.

Enumerated types

An enumerated type declaration lists all the values the type can have. These are some examples of enumerated type declarations:

```
type
  TDays = (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday);
  TPrimaryColor = (Red, Yellow, Blue);
  TDepartment = (Finance, Personnel, Engineering, Marketing, MIS);
  TDog = (Poodle, GoldenRetriever, Dachshund, NorwegianElkhound, Beagle);
```

These are some variables of those enumerated types:

```
var
  DayOfWeek: TDays;
  Hue: TPrimaryColor;
  Department: TDepartment;
  DogBreed: TDog;
```

Each value listed in parentheses in an enumerated type declaration has an underlying integer value determined by the position of the value in the list. For example,*Monday* in the *TDays* type declaration has the value 0,*Tuesday* has the value 1, and so on. You could achieve the same result by declaring the *DayOfWeek* variable to be of type *Integer* and then assign an *Integer* value to represent each day of the week. While this system might work in an orderly and predictable series such as days of the week or months of the year, it's less useful when the order of represented values is arbitrary. Most people are not very good at remembering what a number stands for. For example, the assignment

```
DogBreed := Dachshund;
```

means much more to people than

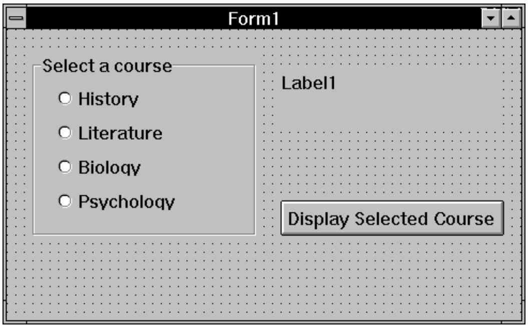
```
DogBreed := 2;
```

When you list a value in an enumerated type, you are declaring the value as an identifier. If the previous enumerated type declarations and variable declarations were in your application, you could not, therefore, declare a *Finance* variable, because a *Finance* identifier already exists.

➤ To experiment using an enumerated type,

1 Create this form containing four radio buttons (in a group box), a label, and a button:

Figure 5.21 A form for an enumerated type example



2 Change these properties using the Object Inspector:

- Change the group box caption to Select A Course.
- Name the first radio button *HistoryButton*, and change the caption to History.
- Name the second radio button *LiteratureButton*, and change the caption to Literature.
- Name the third radio button *BiologyButton*, and change the caption to Biology.
- Name the fourth radio button *PsychologyButton*, and change the caption to Psychology.
- Change the caption of the button to Display Selected Course.

3 Declare a *TCourse* type below the **implementation** reserved word and the resource directive ({**$R** *.DFM}), and declare a *SelectedCourse* variable of type *TCourse*:

```
type
  TCourse = (Nothing, History, Literature, Biology, Psychology);

var
  SelectedCourse: TCourse;
```

4 Create an *OnClick* event handler for each radio button. When you have finished, your code should look like this:

```
⋮

implementation

{$R *.DFM}
```

```
type
  TCourse = (Nothing, History, Literature, Biology, Psychology);

var
  SelectedCourse: TCourse;

procedure TForm1.HistoryButtonClick(Sender: TObject);
begin
  SelectedCourse := History;
end;

procedure TForm1.LiteratureButtonClick(Sender: TObject);
begin
  SelectedCourse := Literature;
end;

procedure TForm1.BiologyButtonClick(Sender: TObject);
begin
  SelectedCourse := Biology;
end;

procedure TForm1.PsychologyButtonClick(Sender: TObject);
begin
  SelectedCourse := Psychology;
end;

procedure TForm1.Button1Click(Sender: TObject);
begin
 case SelectedCourse of
   History: Label1.Caption := 'You are taking history';
   Literature: Label1.Caption := 'You are taking literature';
   Biology: Label1.Caption := 'You are taking biology';
   Psychology: Label1.Caption := 'You are taking psychology';
  else
    Label1.Caption := 'You are taking nothing';
 end;
end;

⋮
```

5 Run the application.

When you select a radio button to choose a course, an enumerated value is assigned to the *SelectedCourse* variable. The *OnClick* event handler for the button uses a **case** statement to display an appropriate message, based on the value of the *SelectedCourse* variable.

Subrange types

A subrange type is a range of values of any of these types: integer, *Boolean*, *Char*, or enumerated types. Subranges are useful when you want to limit the number of values a variable can have. To create a subrange, specify the minimum and maximum values in the range with two periods in between them. For example,

```
1..100
```

Declare the subrange as a new type in a type declaration. Here are some examples:

```
type
  TCompassRange  = 0..360;
  TValidLetter   = 'A'..'F';
  TMonthlyIncome = 10000..30000;
  THours         = 0..23;
  TPrecipitation = (Drizzle, Showers, Rain, Downpour, Thunderstorm); {an enumerated type}
  TRain          = Drizzle..Downpour;                              {a subrange of TPrecipitation}
```

➤ Here is a simple application that uses a new subrange type.

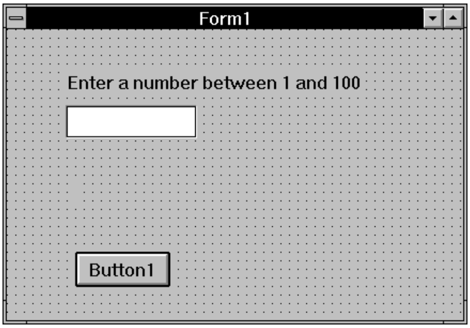
1 Place an edit box and a button on a form. Place a label above the edit box, and put a second label beneath the edit box.

2 Using the Object Inspector, change these properties:

- Delete the text specified as the value of the *Text* property for the edit box.
- Change the *Caption* value for the *Label1* label to 'Enter a number between 1 and 100'.
- Delete the text specified as the value of the *Caption* property for the *Label2* label.
- Change the *Default* property of the button to *True*.

Your form should look like this:

Figure 5.22 A form for a subrange example



3 Create this event handler for the button's *OnClick* event:

```
procedure TForm1.Button1Click(Sender: TObject);
{$R+}
type
  TValidEntry = 1..100;
var
  Entry: TValidEntry;
begin
  Entry := StrToInt(Edit1.Text);
  Label2.Caption := 'Excellent!';
end;
```

4 Run the application, enter a number in the edit box, and click the button.

Try putting a number greater than 100 in the edit box. You'll get a run-time error that informs you a range-check error has occurred. If you enter a number within 1 to 100, the application runs as expected.

Note the use of the **$R** directive. {**$R+**} turns on range checking while the event handler runs. If you omit the **$R** directive, the compiler won't catch out-of-range errors. To read about compiler directives, see the Compiler Directives topic in the Help system. You can also turn on range checking by choosing Options | Project | Compiler Options and selecting Range Checking.

Array types

An *array* is an ordered collection of a data type, with each element of the collection specified by its numeric position within the collection. When the array is created, the elements don't contain useful values at first, but you can fill them with data and manipulate that data as you need to. For example, here is a variable declaration for an array of *Double* types:

```
var
  Check : array{1..10] of Double;
```

This declaration tells Delphi that the variable *Check* refers to a list of ten variables of type *Double*, each with a number (called its *index*) from 1 to 10.

Each item of an array is referred to by the name of the array, followed by its index enclosed in brackets ([ ]). So the array *Check* contains the ten variables *Check[1]*, *Check[2]*, *Check[3]*, *Check[4]*, and so on, up to *Check[10]*. You can use any of these variables wherever you would use a regular *Real* variable. Also, the index value doesn't have to be a constant. It can be any expression that yields an integer in the range 1 to 10. For example,

```
J := 5;
Check[J] := 0.0;
```

These statements assign the value 0.0 to variable *Check[5]*. (Because *Check* is an array of type *Double*, the value you assign must be *Real* and contain a decimal point. Also, all *Double* values must begin with a digit, not a decimal point, so you can't write 0.0 as .0)

If you want to assign a value of zero to all the *Check* variables in the array, you could use a **for** loop to do it. Because an index can be a variable, a **for** loop is easier to use than assigning a value to each item in an array with separate assignment statements. This **for** loop assigns the 0.0 amount to all ten checks:

```
for J := 1 to 10 do
  Check(J) := 0.0;
```

You can define arrays as types. For example,

```
type
  TCheck = array[1..100] of Double;
```

You can then declare variables of the array type. For example, this code declares a *CheckingAccount* to be a variable of type *TCheck*, which is an array of 100 real numbers.

```
var
  CheckingAccount: TCheck;
```

Multidimensional arrays

The arrays discussed so far are one-dimensional lists. Arrays can have many dimensions. Two-dimensional arrays can be used to hold all the values in a table, for example.

This is how you would create a two-dimensional array that can hold all the values in a table that contains 20 columns and 20 rows:

```
type
  TTable = array[1..20, 1..20] of Double;
```

Then you can declare a variable of the *TTable* type:

```
var
  BigTable: TTable;
```

To initialize all the values in the table to 0.0, you could use nested **for** loops:

```
var
  Col, Row: Integer;
⋮
for Col := 1 to 20 do
  for Row:= 1 to 20 do
    BigTable[Col, Row] := 0.0
```

String types: Arrays of characters

Strings, such as the text you enter for the caption on a control, are actually one-dimensional arrays of characters (an array of type *Char*). When you declare a variable of type **string**, you specify the size of the string, much as you specify the size of an array when you declare an array type.

These are some string type declarations:

```
type
  MyString: string[15];
  BigString: string;
  LittleString: string[1];
```

These declarations declare the *MyString* type to contain 15 characters and the *LittleString* type to contain 1 character. If no size is specified, the string contains 255 characters, the maximum size, as is the case with the *BigString* type.

You can then declare variables of these character arrays just as you would with any other data type:

```
var
  MyName: MyString;
  Letter, Digit: LittleString;
```

You can assign a value to a string variable or property by enclosing the sequence of characters that make up the string in single quotation marks or apostrophes ('). For example,

```
MyName := 'Frank P. Land';
Label1.Caption := 'File name';
```

Because *MyName* is a variable of type *MyString*, which holds 15 characters, the *MyName* variable is stored in memory as if the string were ‘Frank P. Land ’. If you assigned the string 'Frank P. Borland' to the *MyName* variable, *MyName* would contain the string 'Frank P. Borlan', because the *MyName* variable can hold only 15 characters.

Object Pascal strings are stored as arrays of characters in memory, but the arrays are actually one byte bigger than size of the specified string. The first position of the string, [0], is a byte that contains the size of the string.

Because strings are arrays of characters, you can access characters within a string with an index value, just as you would in an array. For example,

```
MyName[1]
```

refers to the first letter contained in the *MyName* string variable.

You can use Object Pascal’s rich assortment of operators, procedures, and functions to manipulate variables and properties of string types. Here are some examples of string-handling routines in the run-time library:

Table 5.2 String procedures and functions

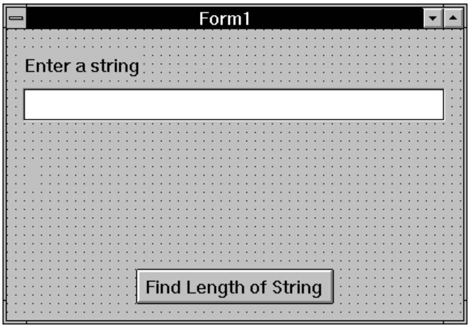
Routine	Description
Concat	Concatenates multiple strings, creating a larger string. You can also concatenate strings together using the plus sign (+).
Copy	Returns a substring within a string.
Delete	Deletes a specified number of characters from a string beginning at specified position within the string.
Insert	Inserts another string within a string.
Length	Returns the length of the string.
Pos	Returns the position (index) of a substring within a string.

You can find information about using these string procedures and functions in online Help.

Finding the length of a string

This is a simple example that finds the length of a string the user enters in an edit box. Your finished form should look something like this:

Figure 5.23 A form for a string-handling example



➤ To create this application,

1 Add an edit box, a button, and two labels to a form. Put *Label1* above the edit box control, and put *Label2* below the edit box control.

2 Using the Object Inspector, change these properties:

- Change the caption of *Label1* to 'Enter a string'.
- Delete the caption of *Label2* so the label becomes invisible.
- Delete the text of the edit box.
- Rename the button to *FindLength*.
- Change the caption of the button to *Find Length*.

3 Create this event handler:

```
procedure TForm1.FindLengthClick(Sender: TObject);
type
  TEditString = string;
var
  UserString: TEditString;
begin
  UserString := Edit1.Text;
  Label2.Caption := 'This string is ' + IntToStr(Length(UserString)) +
    ' characters in length';
end;
```

4 Run the application.

When you click the button, the length of the string you entered in the edit box is reported in the *Label2* control.

The text you entered in the edit box is assigned to the *UserString* variable:

```
UserString := Edit1.Text;
```

Because *UserString* is of type *TEditString*, it can contain as many as 255 characters.

The *Length* function returns the number of characters in *UserString*:

```
Length(UserString)
```

Because *Length* returns an *Integer* value, it needs to be converted to a string value. The *IntToStr* function does this:

```
IntToStr(Length(UserString))
```

The string that is assigned to *Label2.Caption* is a string made up of three substrings:

- 'This string is '
- IntToStr(Length(UserString))
- ' characters in length'

These substrings are concatenated with the **+** operator into one string.

The previous example declares a **string** type and uses a variable of that type. You could write the event handler more concisely:

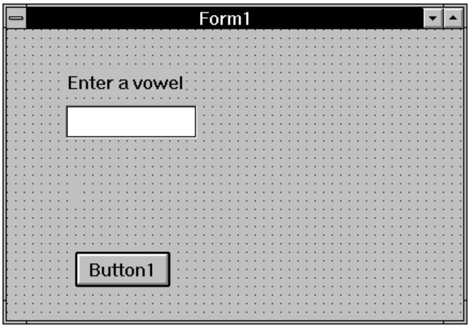
```
procedure TForm1.FindLengthClick(Sender: TObject);
begin
  Label2.Caption := 'This string is ' + IntToStr(Length(Edit1.Text)) +
    ' characters in length';
end;
```

Set types

A set is a collection of elements of one type. That one type must be either an integer, *Boolean*, *Char*, enumerated, or subrange type. Sets are useful for checking if a value belongs to a particular set.

Here is a simple application that uses a new set type. This is the finished form:

Figure 5.24 A form for a set type example



➤ To create this application,

1 Place an edit box and a button on a form. Add a label above the edit box, and put a second label beneath the edit box.

2 Using the Object Inspector, change these properties:

- Delete the text specified as the value of the *Text* property for the edit box.
- Change the *Caption* value for the *Label1* control to 'Enter a vowel'.

- Delete the text specified as the value of the *Caption* property for the *Label2* control.
- Change the *Default* property of the button to *True*.

3. Create this event handler for the button’s *OnClick* event:

```
procedure TForm1.Button1Click(Sender: TObject);
type
  TVowels = set of Char;
var
  Vowels: TVowels;
begin
 Vowels := ['A','E','I','O','U'];
 if Edit1.Text[1] in Vowels then
    Label2.Caption := 'You are clever'
 else
    Label2.Caption := 'Please try again';
end;
```

4. Run the application and enter a letter in the edit box.

The new type *TVowels* is a set of type *Char*. *Vowels* is declared as a variable of type *TVowels*. The first line of code after the **begin** reserved word builds the vowel set (puts values into it) and assigns this new set to the *Vowels* variable. If the *Vowels* assignment looked like this,

```
Vowels := [];
```

then the *Vowels* set would contain no values and would be called an empty set.

The **if** statement uses the **in** operator to see if the value you entered into the edit box is in the *Vowels* set. The expression *Edit1.Text[1]* in *Vowels* is a *Boolean* expression that evaluates to either *True* or *False*. It tests if the first character in the *Text* string is in the *Vowels* set.

Record types

Records are collections of data that your application can refer to as a whole. For example, your application could use a *TEmployee* record type that is declared like this:

```
type
  TEmployee = record
    LastName : string[20];
    FirstName: string[15];
    YearHired: 1990..2000;
    Salary: Double;
    Position: string[20]
  end;
```

Records contain *fields* that hold data values. Each field has a data type. The fields of a *TEmployee* type are *LastName*, *FirstName*, *YearHired*, *Salary*, and *Position*. You can access these fields individually, or you can refer to the record as a whole.

For example, here are the declarations of two record variables:

```
var
  NewEmployee, PromotedEmployee: TEmployee;
```

Your code can refer to the *Salary* field of a *NewEmployee* record, like this:

```
NewEmployee.Salary := 43500.00
```

Or your code can manipulate the record as a single entity:

```
PromotedEmployee := NewEmployee;
```

When you refer to a field within a record, you need to type the name of the record, a period (**.**), and the name of the field:

```
PromotedEmployee.Position
```

If you are going to assign values to fields within a record, you can use the**with** statement. Instead of writing this code,

```
PromotedEmployee.LastName := 'Jeffries';
PromotedEmployee.FirstName := 'Richard';
PromotedEmployee.YearHired := 1990;
PromotedEmployee.Salary := 100000.00;
PromotedEmployee.Position := 'Senior technical writer';
```

you could assign the values like this:

```
with PromotedEmployee do
  begin
    LastName := 'Jeffries';
    FirstName := 'Richard';
    YearHired := 1990;
    Salary := 100000;
    Position := 'Senior technical writer';
  end;
```

A few words about objects

Objects are user-defined data types that are very important in programming for Delphi. Like records, objects are structured data types that contain fields that hold values. Objects, however, also contain *methods*. Methods are procedures and functions that act on the data in the object's fields.

Each time you time you add a new component to a form, you are adding a field to a form object. Each component is also an object, and each time you create an event handler so the component can respond to an event, you are automatically creating a method within the form object. All this happens automatically when you build the user interface for your application and create event handlers using the Object Inspector. Nevertheless, it is helpful to understand how Delphi uses objects to build your application. You can read more about objects in Chapter 6.

Understanding Object Pascal units

This section explains what a unit is, how you use it, and how to write your own units that aren't associated with forms.

What is a unit?

A *unit* is a collection of constants, data types, variables, and procedures and functions that can be shared by several applications. Delphi comes with a large number of predefined units you use to construct your Delphi applications. The Delphi Visual Component Library is made up of several units that declare the objects, components, and controls you use to design the interface for your application. Each time you add a check box to a form, for example, you are using the *StdCtrls* unit automatically because the *TCheckBox* component is declared in *StdCtrls*.

As you design the forms for your application, you are automatically creating new units that are associated with the forms. Units don't have to be associated with forms, however. You can use a predefined unit that contains only mathematical routines, for example. Or you can write your own unit of math functions.

All the declarations in a unit are related to one another. For example, the *CDialogs* unit contains all the declarations for using common dialog boxes in your applications.

The structure of a unit

Regardless of whether a unit is associated with a form, the basic structure of a unit is the same. The parts of a unit are

```
unit <identifier>;

interface

uses <list of units>;                              { optional }

{ public delcarations }

implementation

uses <list of units>;                              { optional }

{ private declarations }

{ implementation of procedures and functions }

initialization                                     { optional }
{ optional initialization code}
end;
```

The unit header starts with the reserved word **unit**, followed by the unit's name (an identifier). The next item in a unit is the reserved word **interface**, which indicates the beginning of the **interface** part of the unit—the part visible to other units or applications that use this unit.

A unit can use the declarations in other units by specifying those units in a **uses** clause. The **uses** clause can appear in two places:

- It can appear immediately after the reserved word **interface**.

  Any code in the current unit can use the declarations declared in the **interface** parts of the units specified in the **uses** clause.

  For example, suppose you are writing code in unit A, and you want to call a procedure declared in the **interface** part of unit B. Once you add the name of unit B to the **uses** clause in the **interface** part of unit A, any code in unit A can call the procedure declared in unit B.

  Also, any unit that uses the current unit can also use any of the units listed in the current unit's **uses** clause.

  For example, if unit C is in the **uses** clause in the **interface** part of unit B, and unit B is in the **uses** clause in the **interface** part of unit A, unit A can use any declarations in the **interface** parts of both C and B, even if unit C is not in the **uses** clause of unit A.

  If unit B is in the **uses** clause in the **interface** part of unit A, unit A *cannot* be in the **uses** clause in the **interface** part of unit B. This creates a circular unit reference, and when you attempt to compile, Delphi generates an error message.

- It can appear immediately after the reserved word **implementation**.

  Only declarations in the current unit can use the declarations in the **interface** parts of the units specified here. Any other units that use the current unit won't be able to use the units listed in this **uses** clause.

  For example, if unit C is in a **uses** clause in the **implementation** part of unit B, and unit B is in a **uses** clause of unit A, unit A can use only the declarations in the **interface** parts of unit B. Unit A can't access the declarations in unit C, unless unit C is in a **uses** clause of unit A.

  If unit B is in the **uses** clause in the **implementation** part of unit A, unit A *can* be in the **uses** clause in the **implementation** part of unit B. While circular unit references are not allowed in the **interface** part, they are fine in the **implementation** part.

Interface part

The **interface** part of a unit begins with the reserved word **interface**, which appears after the unit header and ends at the reserved word **implementation**. The **interface** determines what is "visible" (accessible) to any application or other unit using this unit.

In the unit **interface** part, you can declare constants, data types, variables, procedures, and functions. If Delphi builds a unit for you as you design a form, the form data type, the form variable that creates an instance of the form, and the event handlers are declared in the **interface** part. You can see examples of these in Chapter 6.

The procedures and functions visible to any unit or application using the unit are declared in the **interface** part. Their actual bodies—their implementations—are found in the **implementation** part. You don't need to use **forward** declarations, and they aren't allowed in the **interface** part. The **interface** part lists all the procedure and function headers; the **implementation** part contains the coded logic of the procedures and functions, including those that are event handlers.

An optional **uses** clause can appear in the interface and must immediately follow the **interface** reserved word.

Implementation part

The **implementation** part of a unit begins with the reserved word **implementation**. Everything declared in the **interface** part is accessible to the code in the **implementation** part.

The **implementation** can have additional declarations of its own, although these declarations aren't accessible to any other application or unit. These declarations are used by the procedures, functions, and event handlers declared in this unit.

An optional **uses** clause can appear in the **implementation** part and must immediately follow the **implementation** reserved word.

The bodies of the routines declared in the **interface** part must appear in the **implementation** part. The procedure or function header that appears in the **implementation** part can be identical to the declaration that appears in the **interface** part, or it can be in the *short form*.

To use the short form, type the **procedure** or **function** reserved word and follow it with the routine's name. You can omit any list of parameters, and, if the routine is a function, the return type. For example, suppose you declare this function in the **interface** part:

```
function CalculateInterest(Principal, InterestRate: Double): Double;
```

When you write the body of the function in the **implementation** part, you can choose to write the function like this:

```
function CalculateInterest;
begin
  Result := Principal * InterestRate;
end;
```

Note that the parameter and the return type have been omitted.

If you declare any routines in the **implementation** part (not in the **interface** part), you must use the long form of the procedure or function header.

Initialization part

If you want to initialize any data the unit uses or makes available through the **interface** part to the application or unit using it, you can add an **initialization** part to the unit. Above the final **end** reserved word at the bottom of the unit, add the reserved word **initialization**. Between the **initialization** and **end** reserved words, you write the code that initializes the data. For example,

```
initialization
  { Your initialization code goes here }
end.
```

When an application uses a unit, the code within the unit's **initialization** part is called before the any other application code runs. If the application uses more than one unit, each unit's **initialization** part is called before the rest of the application runs.

How units are used

To use another unit, you need to add the name of that unit to the **uses** clause of your current unit. Delphi does this automatically when you add new components to a form you are designing. If you add a component declared in a unit that isn't already in the standard Delphi **uses** clause, Delphi adds the unit name to the **uses** clause for you.

For example, if you add a color grid to a form, Delphi attaches *ColorGrd* to the end of the unit's **uses** clause. This makes all the declarations in the *ColorGrd* unit available to the unit associated with the form.

A few objects declared in units have no corresponding visual components in the Delphi environment, however. For example, if you want to use predefined message boxes in the code within a unit, you must add the *MsgDlg* unit to the **uses** clause yourself. The same is true if you want to use the *TPrinter* object in the *Printers* unit.

- To add a unit name to the **uses** clause, put the unit name before the semicolon (**;**) that ends the **uses** clause, separating the unit name from the previous unit name in the clause with a comma.
- To use a routine declared in another unit, preface the name of the routine with the name of the unit in which it is declared.

For example, to call a *ComputePayment* function declared in *Unit1* from *Unit2*, make the call like this:

```
Amount := Unit1.ComputePayment(1000, .085, 242);
```

You can preface any identifier—property, constant, data type, variable, or routine—with the unit name.

The uses clause in the implementation part

Object Pascal allows you to put an optional **uses** clause in a unit's **implementation** part. If you put it in, it must appear immediately following the **implementation** reserved word.

A **uses** clause in the **implementation** part lets you hide the inner details of a unit, because units specified in the **implementation** part aren't visible (accessible) to the users of the unit.

Writing a unit "from scratch"

You are free to add code to any unit that Delphi creates. You must not alter the code that Delphi generates, however.

If you want to create a new unit in your project that is not associated with a form, Delphi gets you started.

- To create a new unit, choose File | New Unit.

A new unit is added to your current project. The source code of the new unit looks like this:

```
unit Unit2;

interface

implementation

end.
```

The name Delphi selects for your unit depends on how many units are already in your project. You can then fill in this skeleton unit to include the code that you want.

Note that the **end** reserved word is not paired with a **begin** reserved word. If you like, you can add an **initialization** reserved word above the find **end** reserved word to create an **initialization** part. Many of the units you write don't require any initialization code, as they are often collections of related procedures, functions, and data types. If you do want to include initialization code, add the **initialization** reserved word and put the initializing code between between **initialization** and **end**.

When you choose to compile or build your project, the new units you added are compiled into files with .DCU file extensions. When the MYUNIT.PAS file is compiled, for example, the resulting file is MYUNIT.DCU. This newly created file is machine code that is linked into your project executable file.

Adding an existing unit to a project

If you want to use a unit that is already complete, whether it is a unit Delphi created that is associated with a form, or whether you or someone else wrote the unit from scratch, you can simply add it to your project.

■ To add an existing unit to your project,

1. Open the project you want to add the unit to.
2. Choose File | Open File, select the source code (the .PAS file) of the unit you want added, and choose OK.

Summary

This chapter presented these topics:

- Writing readable code

  It doesn't matter to the compiler how you space, indent, or capitalize your code, or where you break lines of code. As long as the syntax of your code is correct, the compiler can handle it. You should, however, choose a style that makes your code easily readable by you and others.

  Enclose all comments in your code within braces ({ }).

- Writing assignment statements

  Assignment statements assign the value on the right side of the statement to the property or variable on the left side of the assignment statement. The assignment operator is a combination of a colon and an equal sign (**:=**). Assignment statements look like this:

```
Edit1.Color := clRed;
```

Object Pascal statements end with a semicolon (**;**).

- Declaring variables

  Before you can use a variable, you need to declare it. To declare a variable, you give it a name and a type. For example, the following code declares the variable named *MyVariable* to be of type *Double*:

  ```
  var
    MyVariable: Double;
  ```

  Variable declaration sections begin with the reserved word **var**.

  Object Pascal has several data types built into the language. You can create variables of any of these predefined types. In general, you can assign values of a particular type to a variable or property of the same type, or within the same category of types.

- Declaring constants

  Before you can use a constant, you need to declare it. To declare a constant, you give it a name and a value. For example, the following code declares the constant *MyApp* to contain the string 'Financial Calculator':

  ```
  const
    MyApp = 'Financial Calculator';
  ```

  Constants assume the type of the value declared in the constant declaration. Constant declaration sections begin with the reserved word **const**.

- Calling procedures and functions

  To call an existing procedure, type the name of the procedure as a statement in your code. For example, the following statement calls the *CutToClipboard* method of the memo control called *Memo1*:

  ```
  Memo1.CutToClipboard;
  ```

  You can pass parameters to procedures and functions. Parameters are surrounded by parentheses in a procedure or function call. For example, this statement calls the *LoadFromFile* procedure of a memo control named *Memo1* and passes it the string 'MYFILE.TXT'.

  ```
  Memo1.Lines.LoadFromFile('MYFILE.TXT');
  ```

  To call a function, you assign the return value of the function to a variable or property in your code. For example,

  ```
  Edit1.Text := IntToStr(Sum);
  ```

  In this example, the compiler executes the *IntToStr* function, passing it the value in the *Sum* parameter. *IntToStr* converts the *Sum* value to a string, and this string return value is assigned to the *Text* property of an edit box named *Edit1*.

- Controlling the flow of code execution

  Object Pascal has several statements that direct the flow of code execution.

  - The **if** statement evaluates an expression and determines the flow of your code based upon the result of that evaluation. For example,

    ```
    if Edit1.Color := clLime then
      Edit1.Text := 'Lime green';
    ```

    An **if** statement can contain an **else** part. For example,

    ```
    if Edit1.Color := clLime then
      Edit1.Text := 'Lime green'
    else
      Edit1.Text := 'Some shade of blue';
    ```

    An **if** statement can be nested within other **if** statements.

  - The **case** statement can be used to branch to code in place of a series of **if** statements if the expression being evaluated is an integer type (but not *Longint*), a *Char* type, or an enumerated or subrange type. The logic of a **case** statement is usually easier to see, and the code runs more quickly.
  - The **repeat** statement is a looping statement that repeats a statement, or a series of statements, until some condition is *True*. This condition is evaluated at the end of the loop. A **repeat** statement always runs at least once.
  - The **while** statement is a looping statement that evaluates a condition at the beginning of the loop. Because a **while** statement doesn't loop if the condition evaluates to *True*, it is possible a **while** statement might not loop at all.
  - The **for** statement is a looping statement that runs a specific number of times depending on the value of a control variable. **For** loops are fast and efficient.

- Object Pascal blocks

  Blocks are made up of an optional declaration part and a statement part. The statement part is made up of code statements. The declaration part declares the identifiers that are used by the code in the statement part.

  Blocks can exist within other blocks. For example, a project block contains one or more unit blocks, which contain one or more event handler blocks.

- Understanding scope

  The scope of an identifier defines where the identifier is active. The identifier is local in scope to the block in which it is declared. Once the execution of your code is outside that block, the identifier is no longer within the same scope of the executing code, so the code cannot directly use the identifier. Such an identifer that is not in scope can be accessed if you preface the identifer name with the name of the block and a period (**.**).

  Identifiers declared in top-level blocks are local to the blocks they are declared in, but global in scope to the blocks contained within the block.

- Writing a procedure or function

  A procedure or function is made up of a header and a block.

A procedure or function begins with a header that identifies the procedure and function, and lists the parameters the routine uses, if any.

The block contains optional type, variable, and constant declarations, and the statement part, the code that implements the logic of the routine.

Functions must assign a return value in the statement part of the function. The value can be assigned to the name of the function, or to the *Result* variable.

Procedures and functions appear in the **implementation** part of a unit. They can be declared in either the **interface** or **implementation** part, however, depending whether they are to be used only by the current unit or by other units also.

The parameters of procedures and functions can be value, variable, or constant parameters. A value parameter is a copy of the actual parameter. A variable parameter is a reference to the actual parameter. A constant parameter never changes in value.

- Defining new data types

  You can create your own user-defined data types in Object Pascal. The user-defined data types are

  - Enumerated types—a list of values a variable or property of this type can assume. Code can refer to these values by name, rather than by position in the list.
  - Subrange types—a range of values of any of these types: integer, *Boolean*, *Char*, or enumerated types.
  - Array types—an ordered collection of a specified data type, with each element of the collection accessible by its numeric position within the collection.
  - Set types—a collection of elements of one type, either an integer, *Boolean*, *Char*, enumerated, or subrange type.
  - Record types—collections of data that your application can refer to as a whole. Records contain fields, each with its own type, that contain data.
  - Object types—collections of typed fields that contain data, and methods, procedures and functions that act on the data in the fields.

- Understanding Object Pascal units

  Units are collections of constants, data types, variables, procedures, and functions that can be shared by several applications. Delphi comes with a large number of predefined units your code can use. Your Delphi applications are composed of a collection of units.

  You create units as you design an application and write code in Delphi. You can also write your own units that are not associated with forms.

  Units always have an **interface** part, which includes all the declarations that are accessible to other units as well as the current one.

  Units always have an **implementation** part, which contains the bodies of the procedures, functions, and methods—the coded logic of the unit.

An optional **uses** clause lists the units that the code in this unit can access. A **uses** clause can appear in either the **interface** or **implementation** part of a unit, or in both places.

Units can also have an optional **initialization** part.

Chapter

6

Programming with Delphi objects

Object-oriented programming (OOP) is a natural extension of structured programming. OOP requires that you use good programming practices and makes it very easy for you to do so. The result is clean code that is easy to extend and simple to maintain.

Once you create an object for an application, you and other programmers can then use that same object in other applications. Reusing objects can greatly cut your development time and increase productivity for yourself and others.

Together, Delphi and the Object Pascal language make programming with objects easier than ever before. This chapter explains what you need to know about objects to use Delphi effectively. If you want to create new components and put them on the Delphi Component palette, see the *Delphi Component Writer's Guide.*

These are the primary topics discussed in this chapter:

- What is an object?
- Inheriting data and code from an object
- Object scope
- Assigning values to object variables
- Creating nonvisual objects

Before reading this chapter, you should know how to design a user interface for your application using the Delphi tools, how a Delphi project is structured, and how to handle events. You should also know the fundamentals of the Object Pascal language. To review topics in any of these areas, refer to the appropriate chapters in this book, or use Delphi's online Help.

What is an object?

An object is a data type that wraps up data and code all into one bundle. Before OOP, code and data were treated as separate elements.

Think of the work involved to assemble a bicycle if you have all the bicycle parts and a list of instructions for the assembly process. This is analogous to writing a Windows program from scratch without using objects. Delphi gives you a head start on "building your bicycle" because it already gives you many of the "preassembled bicycle parts"—the Delphi forms and components.

You can begin to understand what an Object Pascal object is if you understand what an Object Pascal record is. In Chapter 5, you read that records are made of up fields that contain data, and each of these fields has its own data type. Records make it easy to refer to a related collection of varied data elements as one entity.

Objects are also collections of data elements. Like records, they also have fields, each of which has its own data type.

Unlike records, objects also contain code—procedures and functions—that act on the data contained in the object's fields. These procedures and functions are called *methods*.

Also unlike records, objects can contain properties. The properties of Delphi objects have default values. You can change these values at design time to modify an object to suit the needs of your project without writing code. If you want a property value to change at run time, you need to write only a very small amount of code.

Examining a Delphi object

When you choose to create a new project, Delphi displays a new form for you to customize. In the Code Editor, Delphi declares a new object type for the form and produces the code that creates the new form object. A later section discusses why a new object type is declared for each new form. For now, examine the following example to see what the code in the Code Editor looks like:

```
unit Unit1;

interface

uses WinTypes, WinProcs, Classes, Graphics, Forms, Controls, Apps;

type
  TForm1 = class(TForm)                { The type declaration of the form begins here }
  private
    { Private declarations }
  public
    { Public declarations }
  end;                                   { The type declaration of the form ends here }

var
  Form1: TForm1;

implementation                                     { Beginning of implementation part }

{$R *.DFM}

end.                                           { End of of implemntation part and unit}
```

The new object type is *TForm1*, and it is derived from type *TForm*, which is also an object. A later section presents more about *TForm* and objects derived from other objects.

Recall that an object is like a record in that they both contain data fields, but an object also contains methods—code that acts on the object's data. So far, type *TForm1* appears to contain no fields or methods, because you haven't added to the form any components (the fields of the new object), and you haven't created any event handlers (the methods of the new object). As discussed later, *TForm1* does contain fields and methods, even though you don't see them in the type declaration.

This variable declaration declares a variable named *Form1* of the new object type *TForm1*.

```
var
  Form1: TForm1;
```

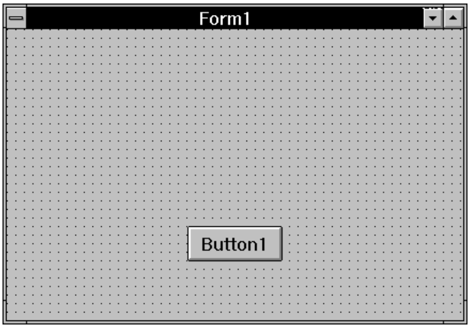
Form1 is called an instance of the type *TForm1*. The *Form1* variable refers to the form itself to which you add components to design your user interface.

You can declare more than one instance of an object type. You might want to do this to manage multiple child windows in a Multiple Document Interface (MDI) application, for example. Each instance carries its own data in its own package, and all the instances of an object use the same code.

Although you haven't added any components to the form or written any code, you already have a complete Delphi application that you can compile and run. All it does is display a blank form because the form object doesn't yet contain the data fields or methods to do more.

Suppose, though, that you add a button component to this form and an *OnClick* event handler for the button, that changes the color of the form when the user clicks the button. You then have an application that's about as simple as it can be and still actually do something. Here is the form for the application:

Figure 6.1 A simple form



When the user clicks the button, the form changes color to green. This is the event-handler code for the button *OnClick* event:

```
procedure TForm1.Button1Click(Sender: TObject);
begin
  Form1.Color := clGreen;
end;
```

If you create this application and then look at the code in the Code Editor, this is what you see:

```
unit Unit1;

interface

uses WinTypes, WinProcs, Classes, Graphics, Forms, Controls, Apps;

type
  TForm1 = class(TForm)
    Button1: TButton;                                                { New data field }
    procedure Button1Click(Sender: TObject);                 { New method declaration }
  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
  Form1: TForm1;

implementation

{$R *.DFM}

procedure TForm1.Button1Click(Sender: TObject);          { The code of the new method }
begin
  Form1.Color := clGreen;
end;

end.
```

The new *TForm1* object now has a *Button1* field—that's the button you added to the form. *TButton* is an object type, so *Button1* is also an object. Object types, such as *TForm1*, can contain other objects, such as *Button1*, as data fields. Each time you put a new component on a form, a new field with the component's name appears in the form's type declaration.

All the event handlers you write in Delphi are methods of the form object. Each time you create an event handler, a method is declared in the form object type. The *TForm1* type now contains a new method, the *Button1Click* procedure, declared within the *TForm1* type declaration.

The actual code for the *Button1Click* method appears in the **implementation** part of the unit. The method is the same as the empty event handler you created with Delphi and then filled in to respond when the user clicks the button as the application runs.

Changing the name of a component

You should always use the Object Inspector to change the name of a component. For example, when you change the default name of a form from *Form1* to something else by changing the value of the *Name* property using the Object Inspector, the name change is reflected throughout the code Delphi produces. If you wrote the previous application, but named the form *ColorBox*, this is how your code would appear:

```
unit Unit1;

interface

uses WinTypes, WinProcs, Classes, Graphics, Forms, Controls, Apps;

type
  TColorBox = class(TForm)                         { Changed from TForm1 to TColorBox }
    Button1: TButton;
    procedure Button1Click(Sender: TObject);
  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
  ColorBox: TColorBox;                               { Changed from Form1 to ColorBox }

implementation

{$R *.DFM}

procedure TColorBox.Button1Click(Sender: TObject);
begin
  Form1.Color := clGreen;                    { The reference to Form1 didn't change! }
end;

end.
```

Notice that the name of the form object type changed from *TForm1* to *TColorBox*. Also note that the form variable is now *ColorBox*, the name you gave to the form. References to the *ColorBox* variable and the *TColorBox* type also appear in the final **begin** and **end** block of code, the code that creates the form object and starts the application running. If Delphi originally generated the code, it updates it automatically when you use the Object Inspector to change the name of the form or any other component.

Note that the code you wrote in the *OnClick* event handler for the button hasn't changed. Because you wrote the code, you have to update it yourself and correct any references to the form if you change the form's name. If you don't, your code won't be compiled. In this case, change the code to this:

```
procedure TColorBox.Button1Click(Sender: TObject);
begin
  ColorBox.Color := clGreen;
end;
```

You should change the name of a component only with the Object Inspector. While nothing prevents you from altering the code Delphi produced and changing the name of component variables, you won't be able to compile your program.

Inheriting data and code from an object

The *TForm1* object described on page 217 might seem quite simple. If you create the application, *TForm1* appears to contain one field, *Button1*, one method, *Button1Click*, and no properties. Yet you can change the size of the form, add or delete minimize and maximize buttons, or set up the form to become part of a Multiple Document Interface (MDI) application. How is it possible to do all these things with a form that contains only one field and one method?

The answer lies in the notion of inheritance. Recalling the bicycle analogy, once you have put together all the objects that make up a complete "bicycle object," you can ride it because it has all the essentials to make the bicycle useful—it has pedals you push to make the wheels go around, it has a seat for you to sit on, it has handlebars so you can steer, and so on. Similarly, when you add a new form to your project, it has all the capabilities of any form. For example, all forms provide a space to put other components on them, all forms have the methods to open, show, and hide themselves, and so on.

Suppose, though, that you want to customize that bicycle, just as you would customize a form object in Delphi. You might adjust a few gear settings, add a headlight, and provide a horn with a selection of sounds—just as you might customize a form by adding or rearranging buttons, changing a few property values, and adding a new method that allows the form to appear with a plaid background.

To change the bicycle to make it exactly as you want it, you start with the basic model and then customize it. You do the same thing with Delphi forms. When you add a new form to your project, you've added the "basic model" form. By adding components to the form, changing property values, and writing event handlers, you are customizing the new form.

To customize any object, whether it be a blank form, a form with multiple controls that is used as a dialog box, or a new version of the Delphi bitmap button, you start by deriving a new object from an existing object. When you add a new form to your project, Delphi automatically derives a new form object for you from the *TForm* type.

At the moment a new form is added to a project, the new form object is identical to the *TForm* type. Once you add components to it, change properties, and write event handlers, the new form object and the *TForm* type are no longer the same.

No matter how you customize your bicycle, it can still do all the things you expect a bicycle to do. Likewise, a customized form object still exhibits all the built-in capabilities of a form, and it can still do all the things you expect a form to do, such as change color, resize, close, and so on. That's because the new form object *inherits* all the data fields, properties, methods, and events from the *TForm* type.

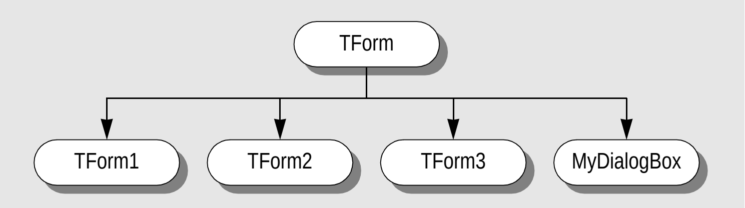
When you add a new form to an Delphi project, Delphi creates a new object type, *TForm1*, deriving it from the more generic object, *TForm.* The first line of the *TForm1* type declaration specifies that *TForm1* is derived from *TForm*:

```
TForm1 = class(TForm)
```

Because *TForm1* is derived from *TForm*, all the elements that belong to a *TForm* type automatically become part of the *TForm1* type. If you look up *TForm* in online Help (you can click the form itself and press *F1*), you see lists of all the properties, methods, and events in the *TForm* object type. You can use all the elements inherited from *TForm* in your application. Only the elements you specifically add to your *TForm1* type, such as components you place on the form or event handlers (methods) you write to respond to events, appear in the *TForm1* type declaration. These are the things that make *TForm1* different from *TForm*.

The more broad-based or generic object from which another more customized object inherits data and code is called the *ancestor* of the customized object. The customized object itself is a *descendant* of its ancestor. An object can have only one immediate ancestor, but it can have many descendants. For example, *TForm* is the ancestor type of *TForm1*, and *TForm1* is a descendant of *TForm*. All form objects are descendants of *TForm*, and you can derive many form objects from *TForm*.

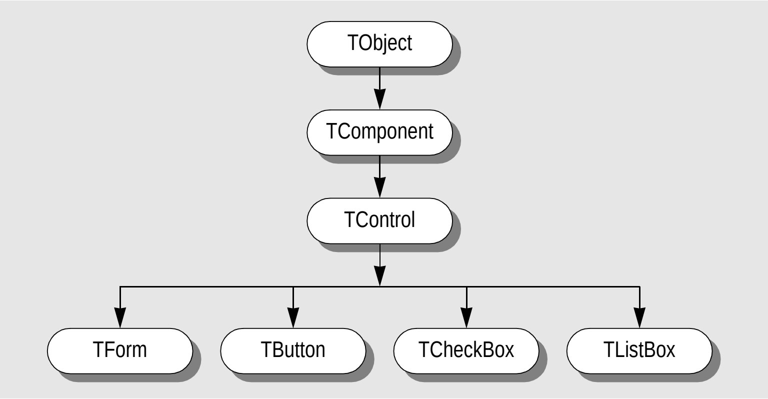
Figure 6.2 Inheriting from TForm



Objects, components, and controls

When you look up *TForm* in online Help, you'll notice that *TForm* is called a component. Don't let this confuse you. All components and controls are also objects. The terminology used in the documentation comes from the inheritance hierarchy of the Delphi Visual Component Library. Figure 6.3 is a greatly simplified diagram of the hierarchy, omitting some intermediary objects. To see a more complete diagram, refer to the *Delphi Component Writer's Guide*:

Figure 6.3 A simplified hierarchy diagram



Everything in this hierarchy is an object. Components, which inherit data and code from a *TObject* type, are objects with additional properties, methods, and events that make them suitable for specialized purposes, such as the ability to save their state to a file. Controls, which inherit data and code from a *TComponent* type (which in turn inherits elements from *TObject*) have additional specialized capabilities, such as the ability to display something. So controls are components and objects, components are objects but not necessarily controls, and objects are simply objects. This chapter refers to all components and controls as objects.

Even though *TCheckBox* isn't an immediate descendant of *TObject*, it still has all the attributes of any object because *TCheckBox* is ultimately derived from *TObject* in the VCL hierarchy. *TCheckBox* is a very specialized kind of object that inherits all the functionality of *TObject*, *TComponent*, and *TControl*, and defines some unique capabilities of its own.

Object scope

An object's scope determines the availability and accessibility of the data fields, properties, and methods within that object. Using the earlier bicycle analogy, if you were to add a headlight only to your customized "bicycle object," the headlight would belong to that bicycle and to no other. If, however, the "basic model bicycle object" included a headlight, then all bicycle objects would inherit the presence of a headlight. The headlight could lie either within the scope of the ancestor bicycle object—in which case, a headlight would be a part of all descendant bicycle objects—or within the scope only of the customized bicycle object, and available only to that bicycle.

Likewise, all data fields, properties, and methods declared within an object declaration are within the scope of the object, and are available to that object and its descendants. Even though the code that makes up the methods appears outside of the object declaration in the **implementation** part of the unit, those methods are still within the scope of the object because they were declared within the object's declaration.

When you write code in an event handler of an object that refers to properties, methods, or fields of the object itself, you don't need to preface these identifiers with the name of the object variable. For example, if you put a button and an edit box on a new form, you could write this event handler for the *OnClick* event of the button:

```
procedure TForm1.Button1Click(Sender: TObject);
begin
  Color := clFuchsia;
  Edit1.Color := clLime;
end;
```

The first statement colors the form. You could have written the statement like this:

```
Form1.Color := clFuchsia
```

It's not necessary, however, to put the *Form1* qualifier on the *Color* property because the *Button1Click* method is within the scope of the *TForm1* object. Any time you are within an object's scope, you can omit the qualifier on all properties, methods, and fields that are part of the object.

The second statement refers to the *Color* property of a *TEdit* object. Because you want to access the *Color* property of the *TEdit1* type, not of the *TForm1* type, you need to specify the scope of the Color property by including the name of the edit box, so the compiler can determine which *Color* property you are referring to. If you omit it, the second statement is like the first; the form ends up lime green, and the edit box control remains unchanged when the handler runs.

Because it's necessary to specify the name of the edit box whose *Color* property you are changing, you might wonder why it's not necessary to specify the name of the form as well. This is unnecessary because the control *Edit1* is within the scope of the *TForm1* object; it's declared to be a data field of *TForm1*.

Accessing components on another form

If *Edit1* were on some other form, you would need to preface the name of the edit box with the name of the form object variable. For example, if *Edit1* were on *Form2*, it would be a data field in the *TForm2* object declaration, and would lie with the scope of *Form2*. You would write the statement to change the color of the edit box in *Form2* from the *TForm1.ButtonClick* method like this:

```
Form2.Edit1.Color := clLime;
```

In the same way, you can also access methods of a component on another form. For example,

```
Form2.Edit1.Clear;
```

To give the code of *Form1* access to properties, methods, and events of *Form2*, you need to add *Unit2* to the **uses** clause of *Unit1* (assuming the units associated with *Form1* and *Form2* are named *Unit1* and *Unit2*, respectively). For more information about the **uses** clause, see the section, "Understanding Object Pascal units" starting on page 206 in Chapter 5.

Scope and descendants of an object

The scope of an object extends to all the object's descendants. That means all the data fields, properties, methods, and events that are part of *TForm* are within the scope of *TForm1* also, because *TForm1* is a descendant of *TForm*. Your application won't be able to declare a data field using the same name as a data field in the object's ancestor.

If Delphi displays a duplicate-identifier message, it's possible a data field with the same name already exists in the ancestor object, such as in *TForm*. If you see the duplicate identifier message and you don't understand why, try altering the name of the identifier slightly. It might be that you happened to choose the name of a data field in an ancestor object.

Overriding a method

You *can*, however, use the name of a method within an ancestor object to declare a method within a descendant object. This is how you *override* a method. You would most likely want to override an existing method if you want the method in the descendant object to do the same thing as the method in the ancestor object, but the task is accomplished in another way. In other words, the code that implements the two methods differs.

It's not often that you would want to override a method unless you are creating new components. You should be aware that you can do so, though, and that you won't receive any warning or error message from the compiler. You can read more about overriding methods in the *Delphi Component Writer's Guide.*

Public and private declarations

When you build an application using the Delphi environment, you are adding data fields and methods to a descendant of *TForm*. You can also add fields and methods to an object without putting components on a form or filling in event handlers, but by modifying the object type declaration directly.

You can add new data fields and methods to either the **public** or **private** part of an object. **Public** and **private** are standard directives in the Object Pascal language. Treat them as if they were reserved words. When you add a new form to the project, Delphi begins constructing the new form object. Each new object contains the **public** and **private** directives that mark locations for data fields and methods you want to add to the code directly. For example, note the **private** and **public** parts in this new form object declaration that so far contains no fields or methods:

```
type
  TForm1 = class(TForm)
  private
    { Private declarations }
  public
    { Public declarations }
  end;
```

Use the **public** part to

- Declare data fields you want methods in objects in other units to access
- Declare methods you want objects in other units to access

Declarations in the **private** part are restricted in their access. If you declare fields or methods to be **private**, they are unknown and inaccessible outside the unit the object is defined in. Use the **private** part to

- Declare data fields you want only methods in the current unit to access
- Declare methods you want only objects defined in the current unit to access

To add data fields or methods to a **public** or **private** section, put the fields or method declarations after the appropriate comment, or erase the comments before you add the code. Here is an example:

```
type
  TForm1 = class(TForm)
    Edit1: TEdit;
    Button1: TButton;
    procedure Button1Click(Sender: TObject);
  private
    { Private declarations }
    Number: Integer;
    function Calculate(X, Y: Integer): Integer;
  public
    { Public declarations }
    procedure ChangeColor;
  end;
```

Place the code that implements the *Calculate* and *ChangeColor* methods in the **implementation** part of the unit.

The *Number* data field and *Calculate* function are declared to be **private**. Only objects within the unit can use *Number* and *Calculate*. Usually, this restriction means that only the form object can use them, because each Delphi unit contains just one object type declaration of type *TForm*.

Because the *ChangeColor* method is declared to be **public**, code in other units can use it. Such a method call from another unit must include the object name in the call:

```
Form1.ChangeColor;
```

The unit making this method call must have *Form1* in its **uses** clause.

Note When adding fields or methods to an object, always put the fields *before* the method declarations within each **public** or **private** part.

Accessing object fields and methods

When you want to change the value of a property of an object that is a field in the form object, or you want to call a method of an object that is a field in the form object, you must include the name of that object in the property name or method call. For example, if your form has an edit box control on it and you want to change the value of its *Text* property, you should write the assignment statement something like this, making sure to specify the name of the edit box (in this example, *Edit1*):

```
Edit1.Text := 'Frank Borland was here';
```

Likewise, if you want to clear the text selected in the edit box control, you would write the call to the *ClearSelection* method like this:

```
Edit1.ClearSelection;
```

If you want to change several property values or call several methods for an object that is a field in a form object, you can use the **with** statement to simplify your code. The **with** statement is as convenient to use with objects as it is with records. For example, this is an event handler that makes several changes to a list box when a user clicks the button on the form:

```
procedure TForm1.Button1Click(Sender: TObject);
begin
  ListBox1.Clear;
  ListBox1.MultiSelect := True;
  ListBox1.Items.Add('One');
  ListBox1.Items.Add('Two');
  ListBox1.Items.Add('Three');
  ListBox1.Sorted := True;
  ListBox1.Font.Style := [fsBold];
  ListBox1.Font.Color := clPurple;
  ListBox1.Font.Name := 'Times New Roman';
  ListBox1.ScaleBy(125, 100);
end;
```

If the code uses a **with** statement, it looks like this:

```
procedure TForm1.Button1Click(Sender: TObject);
begin
  with ListBox1 do
  begin
    Clear;
    MultiSelect := True;
    Items.Add('One');
    Items.Add('Two');
    Items.Add('Three');
    Sorted := True;
    Font.Style := [fsBold];
    Font.Color := clPurple;
    Font.Name := 'Times New Roman';
    ScaleBy(125, 100);
  end;
end;
```

By using the **with** statement, you don't have to qualify each reference to a *ListBox1* property or method with the *ListBox1* identifier. Within the **with** statement, all the properties and methods called are local in scope to the *ListBox1* object variable.

Assigning values to object variables

You can assign one object variable to another object variable if the variables are of the same type or assignment compatible, just as you can assign variables of any type other than objects to variables of the same type or assignment-compatible types. For example, if objects *TForm1* and *TForm2* are derived from type *TForm*, and the variables *Form1* and *Form2* have been declared, you could assign *Form1* to *Form2*:

```
Form2 := Form1;
```

You can also assign an object variable to another object variable if the type of the variable you are assigning a value to is an ancestor of the type of the variable being assigned. For example, here is a *TDataForm* type declaration and a variable declaration section declaring two variables, *AForm* and *DataForm*:

```
type
  TDataForm = class(TForm)
    Button1: TButton;
    Edit1: TEdit;
    DataGrid1: TDataGrid;
    Database1: TDatabase;
    TableSet1: TTableSet;
    VisibleSession1: TVisibleSession;
  private
    { Private declarations }
  public
    { Public declarations }
  end;

var
```

```
  AForm: TForm;
  DataForm: TDataForm;
```

AForm is of type *TForm*, and *DataForm* is of type *TDataForm*. Because *TDataForm* is a descendant of *TForm*, this assignment statement is legal:

```
AForm := DataForm;
```

You might wonder why this is important. Taking a look at what happens behind the scenes when your application calls an event handler shows you why.

Suppose you fill in an event handler for the *OnClick* event of a button. When the button is clicked, the event handler for the *OnClick* event is called.

Each event handler has a *Sender* parameter of type *TObject*. For example, note the *Sender* parameter in this empty *Button1Click* handler:

```
procedure TForm1.Button1Click(Sender: TObject);
begin

end;
```

If you look back at Figure 6.3, "A simplified hierarchy diagram" on page 221, you'll recall that *TObject* is at the top of the Delphi Visual Component Library. That means that all Delphi objects are descendants of *TObject*. Because *Sender* is of type *TObject*, any object can be assigned to *Sender*. Although you don't see the code that makes the assignment, the component or control to which the event happened is assigned to *Sender*. This means the value of *Sender* is always the control or component that responds to the event that occurred.

How is this information useful? You can test *Sender* to find the type of component or control that called the event handler using the reserved word **is**. For example,

```
if Sender is TEdit then
  DoSomething
else
  DoSomethingElse;
```

The drag-and-drop demonstration project shipped as part of the Delphi package has a project file named DRAGDROP.DPR. If you load the project and look at the DROPFONT.PAS unit code, you'll find that the *Memo1DragOver* method checks the type of an object variable. In this case, the parameter is *Source* rather than *Sender*:

```
procedure TForm1.Memo1DragOver(Sender, Source: TObject; X, Y: Integer;
  State: TDragState; var Accept: Boolean);
begin
  Accept := Source is TLabel;
end;
```

The *Source* parameter is also of type *TObject*. *Source* is assigned the object that is being dragged. The purpose of the *Memo1DragOver* method is to ensure that only labels can be dragged. *Accept* is a *Boolean* parameter, so it can have only one of two values, *True* or *False*. If *Accept* is *True*, the control the user has selected to drag can be dragged. If *Accept* is *False*, the user can't drag the selected control.

This expression is assigned to the *Accept* variable:

```
Source is TLabel
```

The **is** reserved word checks the *Source* variable to determine if *Source* is of type *TLabel*. If it is, the expression evaluates to *True*. Because the expression becomes *True* only when the user tries to drag a label, *Accept* becomes *True* only under the same circumstances.

The next event handler in the drag-and-drop demonstration, *Memo1DragDrop*, also uses the *Source* parameter. The purpose of this method is to change the font of the text in the memo control to the font of the label dropped on the memo control. Here is the method's implementation:

```
procedure TForm1.Memo1DragDrop(Sender, Source: TObject; X, Y: Integer);
begin
  Memo1.Font := (Source as TLabel).Font;
end;
```

When writing the assignment statement in this handler, the developer didn't know which label the user would drag. By referring to the name of the label as (*Source* **as** *TLabel*), the font of the label the user dropped is assigned to *Memo1.Font* because *Source* contains the name of the control the user dragged and dropped. Only if *Source* is a label does the event handler allow the assignment to occur.

Creating nonvisual objects

Most of the objects you use in Delphi are components you can see at both design time and run time, such as edit boxes and string grids. A few, such as common dialog boxes, are components you don't see at design time, but they appear at run time. Still others, such as timers and data source components, never have any visual representation in your application at run time, but they are there for your application to use.

Occasionally you might want to create your own nonvisual objects for your application. For example, you might want to create a *TEmployee* object that contains *Name*, *Title*, and *HourlyPayRate* fields. You could then add a *CalculatePay* method that uses the data in the *HourlyPayRate* field to compute a paycheck amount for a given period.

The *TEmployee* type declaration could look like this:

```
type
  TEmployee = class(TObject)
    Name: string[25];
    Title: string[25];
    HourlyRate: Double;
    function CalculatePayAmount: Double;
   end;
```

In this case, *TEmployee* is derived from *TObject*. *TEmployee* contains three fields and one method. Because it is derived from *TObject*, *TEmployee* also contains all methods of *TObject* (*TObject* has no fields).

Place object type declarations you create without the help of Delphi in the type declaration part of your unit along with the form type declaration.

In the variable declaration part of the unit, you need to declare a variable of the new type:

```
var
  Employee: TEmployee;
```

Creating an instance of an object

TEmployee is just an object type. An actual object doesn't exist in memory until the object is *instantiated*, or created, by a *constructor* call. A constructor is a method that allocates memory for the new object and points to the new object, which is called an *instance* of the object type. Calling the *Create* method, the constructor, assigns this instance to a variable.

If you want to declare an instance of the *TEmployee* type, your code must call *Create* before you can access any of the fields of the object:

```
Employee := TEmployee.Create;
```

In the *TEmployee* type declaration, there isn't a *Create* method, but because *TEmployee* is derived from *TObject*, and *TObject* has a *Create* method, *TEmployee* can call *Create* to create a *TEmployee* instance, which is assigned to the *Employee* variable.

Now you are ready to access the fields of an *Employee* object, just as you would any other Delphi object.

Destroying your object

When you are through using your object, you should destroy it, which releases the memory the object used. You destroy an object by calling a *destructor*, a method that releases the memory allocated to the object.

Delphi has two destructors you can use, *Destroy* and *Free*. You should almost always use *Free*. In its implementation, the *Free* method calls *Destroy*, but only when the instance pointer isn't **nil**; in other words, the pointer still points to the instance. For this reason, it is safer to call *Free* than *Destroy*. Also, calling *Free* is slightly more efficient in the resulting code size.

To destroy the *Employee* object when you have finished using it, you would make this call:

```
Employee.Free;
```

Just as it inherits the *Create* method, *TEmployee* inherits *Free* from *TObject*.

To follow good programming practices, you should place your destructor call in the **finally** part of a **try..finally** block, while placing the code that uses the object in the **try** part. This assures that the memory allocated for your object is released even if an exception occurs while your code is attempting to use the object. You can read about exceptions and what a **try..finally** block is in Chapter 7.

You can find a more common example of creating a nonvisual object in Chapter 9. String list objects are commonly used in Delphi applications.

Summary

This chapter presented these topics:

- What is an object?

  An object is a data type that combines data and code. Like a record, an object contains data fields. Unlike a record, an object also contains methods, procedures and functions that act on the data, and properties.

- Inheriting data and code from an object

  An object inherits all the data fields, methods, and properties of its ancestor object. All the controls and components in the Delphi Visual Component Library are objects, as they all descend from *TObject*.

- Object scope

  All data fields, properties, and methods of an object are within the scope of the object. Any time you refer to a data field, property, or method within the scope of the object, you can omit the object qualifier.

  An object's scope extends to all descendants of the object.

  You can use the **public** part of an object to declare data fields you want to be able to access from methods in objects in other units and to declare methods you want other objects in other units to be able to use.

  You can use the **private** part of an object to restrict access to an object's data fields and methods.

  You can access the fields and methods of an object using a **with** statement.

- Assigning values to object variables

  You can assign one object variable to another object variable if the variables are of the same type or are assignment compatible. Using the reserved word **is**, you can determine which specific object is assigned to a variable. Also, instead of specifying a particular object, you can use the **as** reserved word and specify any object of a particular type in your code.

- Creating nonvisual objects

  You can create your own nonvisual objects. Write the object type declaration in the type declaration part of the unit. Before you can use the object, you need to instantiate it with a call to the *Create* method. When you have finished using the object, you must destroy it and release its allocated memory with a call to the *Free* method.

If you are interested in creating your own Delphi components, you can learn more about objects by reading the *Delphi Component Writer's Guide.*

Writing robust applications

Delphi provides you with a mechanism to ensure that your applications are *robust*, meaning that they handle errors in a consistent manner that allows the application to recover from errors if possible and to shut down if need be, without losing data or resources.

Error conditions in Delphi are indicated by *exceptions*. An exception is an object that contains information about what error occurred and where it happened.

To use exceptions to create safe applications, you need to understand the following tasks:

- Protecting blocks of code
- Protecting resource allocations
- Handling RTL exceptions
- Handling component exceptions
- Silent exceptions
- Defining your own exceptions

Protecting blocks of code

To make your applications robust, your code needs to recognize exceptions when they occur and respond to them. If you don’t specify a response, the application will present a message box describing the error. Your job, then, is to recognize places where errors might happen, and define responses, particularly in areas where errors could cause the loss of data or system resources.

When you create a response to an exception, you do so on blocks of code. When you have a series of statements that all require the same kind of response to errors, you can group them into a block and define error responses that apply to the whole block.

Blocks with specific responses to exceptions are called *protected blocks* because they can guard against errors that might otherwise either terminate the application or damage data. A protected block starts with the reserved word **try** and ends with the reserved word **end**. Between these reserved words, you put the statements you want to protect and define the kind of responses you want to make for that block.

■ To protect blocks of code you need to understand

- Responding to exceptions
- Exceptions and the flow of execution
- Nesting exception responses

Responding to exceptions

When an error condition occurs, the application *raises* an exception, meaning it creates an exception object. Once an exception is raised, your application can execute cleanup code, handle the exception, or both.

Executing cleanup code

The simplest way to respond to an exception is to guarantee that some cleanup code is executed. This kind of response doesn't correct the condition that caused the error but lets you ensure that your application doesn't leave its environment in an unstable state.

You typically use this kind of response to ensure that the application frees allocated resources, regardless of whether errors occur. For a detailed explanation, see "Protecting resource allocations" later in this chapter.

Handling the exception

Handling an exception means making a specific response to a specific kind of exception. This clears the error condition and destroys the exception object, which allows the application to continue execution.

You typically define exception handlers to allow your applications to recover from errors and continue running. Types of exceptions you might handle include attempts to open files that don't exist, writing to full disks, or calculations that exceed legal bounds. Some of these, such as "File not found," are easy to correct and retry, while others, such as running out of memory, might be more difficult for the application or the user to correct. For detailed explanations, see "Handling RTL exceptions," "Handling component exceptions," and "Defining your own exceptions" in this chapter.

Exceptions and the flow of execution

Object Pascal makes it easy to incorporate error handling into your applications because exceptions don't get in the way of the normal flow of your code. In fact, by moving error checking and error handling out of the main flow of your algorithms, exceptions can simplify the code you write.

When you declare a protected block, you define specific responses to exceptions that might occur within that block. When an exception occurs in that block, execution immediately jumps to the response you defined, then leaves the block.

Here’s some code, for example, that includes a protected block. If any exception occurs in the protected block, execution jumps to the exception-handling part, which beeps. Execution resumes outside the block.

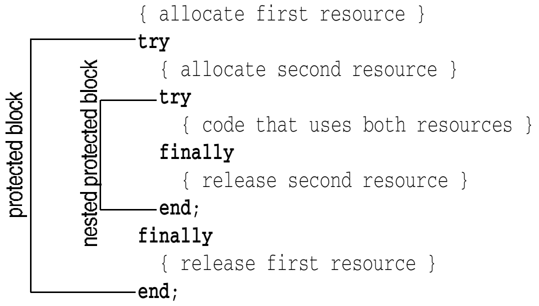
```
⋮
try                                                           { begin the protected block }
  Font.Name := 'Courier';                                    { if any exception occurs... }
  Font.Size := 24;                                       { ...in any of these statements... }
  Color := clBlue;
except                                                       { ...execution jumps to here }
  on Exception do MessageBeep(0);                   { this handles any exception by beeping }
end;
⋮                                      { execution resumes here, outside the protected block}
```

Nesting exception responses

Your code defines responses to exceptions that occur within blocks. Because Pascal allows you to nest blocks inside other blocks, you can customize responses even within blocks that already customize responses.

In the simplest case, for example, you can protect a resource allocation, and within that protected block, define blocks that allocate and protect other resources. Conceptually, that might look something like this:

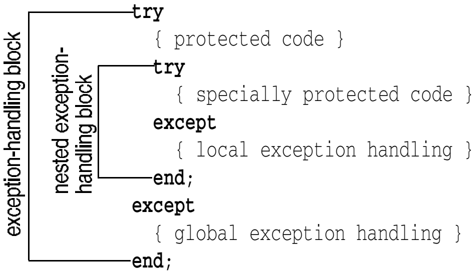
Figure 7.1 Nested resource protections



```
{ allocate first resource }
try
  { allocate second resource }
  try
    { code that uses both resources }
  finally
    { release second resource }
  end;
finally
  { release first resource }
end;
```

You can also use nested blocks to define local handling for specific exceptions that overrides the handling in the surrounding block. Conceptually, that looks something like this:

Figure 7.2 Nested exception handlers



```
try
  { protected code }
  try
    { specially protected code }
  except
    { local exception handling }
  end;
except
  { global exception handling }
end;
```

You can also mix different kinds of exception-response blocks, nesting resource protections within exception handling blocks and vice versa.

Protecting resource allocations

One key to having a robust application is ensuring that if it allocates resources, it also releases them, even if an exception occurs. For example, if your application allocates memory, you need to make sure it eventually releases the memory, too. If it opens a file, you need to make sure it closes the file later.

Keep in mind that exceptions don't come just from your code. A call to an RTL routine, for example, or another component in your application might raise an exception. Your code needs to ensure that if these conditions occur, you release allocated resources.

To protect resources effectively, you need to understand the following:

- What kind of resources need protection?
- Creating a resource-protection block

What kind of resources need protection?

Under normal circumstances, you can ensure that an application frees allocated resources by including code for both allocating and freeing. When exceptions occur, however, you need to ensure that the application still executes the resource-freeing code.

Some common resources that you should always be sure to release are

- Files
- Memory
- Windows resources
- Objects

The following event handler, for example, allocates memory, then generates an error, so it never executes the code to free the memory:

```
procedure TForm1.Button1Click(Sender: TComponent);
var
  APointer: Pointer;
  AnInteger, ADividend: Integer;
begin
  ADividend := 0;
  GetMem(APointer, 1024);                                        { allocate 1K of memory }
  AnInteger := 10 div ADividend;                               { this generates an error }
  FreeMem(APointer, 1024);                                           { it never gets here }
end;
```

Although most errors are not that obvious, the example illustrates an important point: When the division-by-zero error occurs, execution jumps out of the block, so the *FreeMem* statement never gets to free the memory.

In order to guarantee that the *FreeMem* gets to free the memory allocated by *GetMem*, you need to put the code in a resource-protection block.

Creating a resource-protection block

To ensure that you free allocated resources, even in case of an exception, you embed the resource-using code in a protected block, with the resource-freeing code in a special part of the block. Here's an outline of a typical protected resource allocation:

```
{ allocate the resource }
try
  { statements that use the resource }
finally
  { free the resource }
end;
```

The key to the **try..finally** block is that the application *always* executes any statements in the **finally** part of the block, even if an exception occurs in the protected block. When any code in the **try** part of the block (or any routine called by code in the **try** part) raises an exception, execution immediately jumps to the **finally** part, which is called the *cleanup code*. If no exception occurs, the cleanup code is executed in the normal order, after all the statements in the **try** part.

Here's an event handler, for example, that allocates memory and generates an error, but still frees the allocated memory:

```
procedure TForm1.Button1Click(Sender: TComponent);
var
  APointer: Pointer;
  AnInteger, ADividend: Integer;
begin
  ADividend := 0;
  GetMem(APointer, 1024);                                        { allocate 1K of memory }
  try
    AnInteger := 10 div ADividend;                             { this generates an error }
  finally
    FreeMem(APointer, 1024);                 { execution resumes here, despite the error }
  end;
end;
```

The statements in the termination code do not depend on an exception occurring. If no statement in the **try** part raises an exception, execution continues through the termination code.

Note A resource-protection block doesn't *handle* the exception. In fact, the termination code doesn't have information about whether an exception even occurred, so it can't determine whether it needs to handle an exception. If an exception occurs in a resource-protection block, execution first goes to the termination code, then leaves the block with the exception still raised. The block that contains the protected block can then respond to the exception.

Handling RTL exceptions

When you write code that calls routines in the run-time library (RTL), such as mathematical functions or file-handling procedures, the RTL reports errors back to your application in the form of exceptions. By default, RTL exceptions generate a message that the application displays to the user. You can define your own exception handlers to handle RTL exceptions in other ways.

There are also *silent exceptions* that do not, by default, display a message. The explanation of silent exceptions begins on page 243.

To handle RTL exceptions effectively, you need to understand the following:

- What are the RTL exceptions?
- Creating an exception handler
- Providing default exception handlers
- Handling classes of exceptions
- Reraising the exception

What are the RTL exceptions?

The run-time library's exceptions are defined in the *SysUtils* unit, and they all descend from a generic exception-object type called *Exception*. *Exception* provides the string for the message that RTL exceptions display by default.

There are seven kinds of exceptions raised by the RTL:

- Input/output exceptions
- Heap exceptions
- Integer math exceptions
- Floating-point math exceptions
- Typecast exceptions
- Conversion exceptions
- Hardware exceptions

Input/output exceptions

Input/output (I/O) exceptions can sometimes occur when the RTL tries to access files or I/O devices. Most I/O exceptions are related to error codes returned by Windows or DOS when accessing a file.

The *SysUtils* unit defines a generic input/output exception called *EInOutError* that contains an object field named *ErrorCode* that indicates what error occurred. You can access that field in the exception-object instance to determine how to handle the exception, as shown in "Using the exception instance" on page 240.

Heap exceptions

Heap exceptions can sometimes occur when you try to allocate or access dynamic memory. The *SysUtils* unit defines two heap exceptions called *EOutOfMemory* and *EInvalidPointer*. Table 7.1 shows the specific heap exceptions, each of which descends directly from *Exception*:

Table 7.1 Heap exceptions

Exception	Meaning
EOutOfMemory	There was not enough space on the heap to complete the requested operation.
EInvalidPointer	The application tried to dispose of a pointer that points outside the heap. Usually, this means the pointer was already disposed of.

Integer math exceptions

Integer math exceptions can occur when you perform operations on integer-type expressions. The *SysUtils* unit defines a generic integer math exception called *EIntError*. The RTL never raises an *EIntError*, but it provides a base from which all the specific integer math exceptions descend.

Table 7.2 shows the specific integer math exceptions, each of which descends directly from *EIntError*.

Table 7.2 Integer math exceptions

Exception	Meaning
EDivByZero	Attempt to divide by zero.
ERangeError	Number or expression out of range.
EIntOverflow	Integer operation overflowed.

Floating-point math exceptions

Floating-point math exceptions can occur when you perform operations on real-type expressions. The *SysUtils* unit defines a generic floating-point math exception called *EMathError*. The RTL never raises an *EMathError*, but it provides a base from which all the specific floating-point math exceptions descend.

Table 7.3 shows the specific floating-point math exceptions, each of which descends directly from *EMathError*:

Table 7.3 Floating-point math exceptions

Exception	Meaning
EInvalidOp	Processor encountered an undefined instruction.
EZeroDivide	Attempt to divide by zero.
EOverflow	Floating-point operation overflowed.
EUnderflow	Floating-point operation underflowed.

Typecast exceptions

Typecast exceptions can occur when you attempt to typecast an object into another type using the **as** operator. The *SysUtils* unit defines an exception called *EInvalidCast* that the RTL raises when the requested typecast is illegal.

Conversion exceptions

Conversion exceptions can occur when you convert data from one form to another using functions such as *IntToStr*, *StrToInt*, *StrToFloat*, and so on. The *SysUtils* unit defines an exception called *EConvertError* that the RTL raises when the function cannot convert the data passed to it.

Hardware exceptions

Hardware exceptions can occur in two kinds of situations: either the processor detects a *fault* it can't handle, or the application intentionally generates an interrupt to break execution. Hardware exception-handling is not compiled into DLLs, only into standalone applications.

The *SysUtils* unit defines a generic hardware exception called *EProcessorException*. The RTL never raises an *EProcessorException*, but it provides a base from which the specific hardware exceptions descend.

Table 7.4 shows the specific hardware exceptions.

Table 7.4 Hardware exceptions

Exception	Meaning
EFault	Base exception object from which all fault objects descend.
EGPFault	General protection fault, usually caused by an uninitialized pointer or object.
EStackFault	Illegal access to the processor's stack segment.
EPageFault	The Windows memory manager was unable to correctly use the swap file.
EInvalidOpCode	Processor encountered an undefined instruction. This usually means the processor was trying to execute data or uninitialized memory.
EBreakpoint	The application generated a breakpoint interrupt.
ESingleStep	The application generated a single-step interrupt.

You should rarely encounter the fault exceptions, other than the general protection fault, because they represent serious failures in the operating environment. The breakpoint and single-step exceptions are generally handled by the integrated debugger within Delphi.

Creating an exception handler

An *exception handler* is code that handles a specific exception or exceptions that occur within a protected block of code.

■ To define an exception handler, embed the code you want to protect in an exception-handling block and specify the exception handling statements in the **except** part of the block. Here is an outline of a typical exception-handling block:

```
try
  { statements you want to protect }
except
  { exception-handling statements }
end;
```

The application executes the statements in the **except** part *only* if an exception occurs during execution of the statements in the **try** part. Execution of the **try** part statements includes routines called by code in the **try** part. That is, if code in the **try** part calls a routine that doesn't define its own exception handler, execution returns to the exception-handling block, which handles the exception.

When a statement in the **try** part raises an exception, execution immediately jumps to the **except** part, where it steps through the specified exception-handling statements, or *exception handlers*, until it finds a handler that applies to the current exception.

Once the application locates an exception handler that handles the exception, it executes the statement, then automatically destroys the exception object. Execution continues at the end of the current block.

Exception-handling statements

Each statement in the **except** part of a **try..except** block defines code to execute to handle a particular kind of exception. The form of these exception-handling statements is as follows:

```
on <type of exception> do <statement>;
```

You can define, for example, an exception handler for division by zero to provide a default result:

```
function GetAverage(Sum, NumberOfItems: Integer): Integer;
begin
  try
    Result := Sum div NumberOfItems;
  except
    on EDivByZero do Result := 0;
  end;
end;
```

Note that this is clearer than having to test for zero every time you call the function. Here's an equivalent function that doesn't take advantage of exceptions:

```
function GetAverage(Sum, NumberOfItems: Integer): Integer;
begin
  if NumberOfItems <> 0 then
    Result := Sum div NumberOfItems
  else Result := 0;
end;
```

The difference between these two functions really defines the difference between programming with exceptions and programming without them. This example is quite simple, but you can imagine a more complex calculation involving hundreds of steps, any one of which could fail if one of dozens of inputs were invalid.

By using exceptions, you can spell out the "normal" expression of your algorithm, then provide for those exceptional cases when it doesn't apply. Without exceptions, you have to test every single time to make sure you're allowed to proceed with each step in the calculation.

Using the exception instance

Most of the time, an exception handler doesn't need any information about an exception other than its type, so the statements following **on**..**do** are specific only to the type of exception. In some cases, however, you might need some of the information contained in the exception instance.

To read specific information about an exception instance in an exception handler, you use a special variation of **on**..**do** that gives you access to the exception instance. The special form requires that you provide a temporary variable to hold the instance.

If you create a new project, for example, that contains a single form, you can add a scroll bar and a command button to the form. Double-click the button and add the following line to its click-event handler:

```
ScrollBar1.Max := ScrollBar1.Min - 1;
```

That line raises an exception because the maximum value of a scroll bar must always exceed the minimum value. The default exception handler for the application opens a dialog box containing the message in the exception object. You can override the exception handling in this handler and create your own message box containing the exception's message string:

```
try
  ScrollBar1.Max := ScrollBar1.Min - 1;
except
  on E: EInvalidOperation do
    MessageDlg('Ignoring exception: ' + E.Message, mtInformation, [mbOK], 0);
end;
```

The temporary variable (*E* in this example) is of the type specified after the colon (*EInvalidOperation* in this example). You can use the **as** operator to typecast the exception into a more specific type if needed.

Note *Never* destroy the temporary exception object. Handling an exception automatically destroys the exception object. If you destroy the object yourself, the application attempts to destroy the object again, generating a fatal application error.

Scope of exception handlers

You don't have to provide handlers for every kind of exception in every block. In fact, you need to provide handlers only for those exceptions you want to handle specially within that particular block.

If a block doesn't handle a particular exception, execution leaves that block and returns to the block that contains the block (or to the code that called the block), with the exception still raised. This process repeats with increasingly broad scope until either execution reaches the outermost scope of the application or a block at some level handles the exception.

Providing default exception handlers

You can provide a single default exception handler to handle any exceptions you haven't provided specific handlers for. To do that, you add an **else** part to the **except** part of the exception-handling block:

```
try
  { statements }
except
  on ESomething do { specific exception-handling code };
  else { default exception-handling code };
end;
```

Adding default exception handling to a block guarantees that the block handles every exception in some way, thereby overriding all handling from the containing block.

Warning! You should probably never use this all-encompassing default exception handler. The **else** clause handles *all* exceptions, including those you know nothing about. In general, your code should handle only exceptions you actually know how to handle. In other cases, it's better to execute cleanup code and leave the handling to code that has more information about the exception and how to handle it.

Handling classes of exceptions

Because exception objects are part of a hierarchy, you can specify handlers for entire parts of the hierarchy by providing a handler for the exception class from which that part of the hierarchy descends.

The following block outlines an example that handles all integer math exceptions specially:

```
try
  { statements that perform integer math operations }
except
  on EIntError do { special handling for integer math errors };
end;
```

You can still specify specific handlers for more specific exceptions, but you need to place those handlers above the generic handler, because the application searches the handlers in the order they appear in, and executes the first applicable handler it finds.

For example, this block provides special handling for range errors, and other handling for all other integer math errors:

```
try
  { statements performing integer math }
except
  on ERangeError do { out-of-range handling };
  on EIntError do { handling for other integer math errors };
end;
```

Note that if the handler for *EIntError* came before the handler for *ERangeError*, execution would never reach the specific handler for *ERangeError*.

Reraising the exception

Sometimes when you handle an exception locally, you actually want to augment the handling in the enclosing block, rather than replacing it. Of course, when your local handler finishes its handling, it destroys the exception instance, so the enclosing block's handler never gets to act. You can, however, prevent the handler from destroying the exception, giving the enclosing handler a chance to respond.

When an exception occurs, you might want to display some sort of message to the user, then proceed with the standard handling. To do that, you declare a local exception handler that displays the message then calls the reserved word **raise**. This is called *reraising* the exception, as shown in this example:

```
try
  { statements }
  try
    { special statements }
  except
    on ESomething do
    begin
      { handling for only the special statements }
      raise;                                                { reraise the exception }
    end;
  end;
except
  on ESomething do ...;                                 { handling you want in all cases }
end;
```

If code in the { statements } part raises an *ESomething* exception, only the handler in the outer **except** part executes. However, if code in the { special statements } part raises *ESomething*, the handling in the inner **except** part is executed, followed by the more general handling in the outer **except** part.

By reraising exceptions, you can easily provide special handling for exceptions in special cases without losing (or duplicating) the existing handlers.

Handling component exceptions

Delphi's components raise exceptions to indicate error conditions. Most component exceptions indicate programming errors that would otherwise generate a run-time error. The mechanics of handling component exceptions are no different than handling RTL exceptions.

A common source of errors in components is range errors in indexed properties. For example, if a list box has three items in its list (0..2) and your application attempts to access item number 3, the list box raises an "Index out of range" exception.

The following event handler contains an exception handler to notify the user of invalid index access in a list box:

```
procedure TForm1.Button1Click(Sender: TObject);
begin
  ListBox1.Items.Add('a string');                          { add a string to list box }
  ListBox1.Items.Add('another string');                       { add another string... }
  ListBox1.Items.Add('still another string');                 { ...and a third string }
  try
    Caption := ListBox1.Items[3];       { set form caption to fourth string in list box }
  except
    on EListError do
      MessageDlg('List box contains fewer than four strings', mtWarning, [mbOK], 0);
  end;
end;
```

If you click the button once, the list box has only three strings, so accessing the fourth string (Items[3]) raises an exception. Clicking a second time adds more strings to the list, so it no longer causes the exception.

Silent exceptions

Delphi applications handle most exceptions that your code doesn't specifically handle by displaying a message box that shows the message string from the exception object. You can also define "silent" exceptions that do not, by default, cause the application to show the error message.

Silent exceptions are useful when you don't intend to handle an exception, but you want to abort an operation. Aborting an operation is similar to using the *Break* or *Exit* procedures to break out of a block, but can break out of several nested levels of blocks.

Silent exceptions all descend from the standard exception type *EAbort*. The default exception handler for Delphi applications displays the error-message dialog box for all exceptions that reach it except those descended from *EAbort*.

■ There is a shortcut for raising silent exceptions. Instead of manually constructing the object, you can call the *Abort* procedure. *Abort* automatically raises an *EAbort* exception, which will break out of the current operation without displaying an error message.

The following code shows a simple example of aborting an operation. On a form containing an empty list box and a button, attach the following code to the button's *OnClick* event:

```
procedure TForm1.Button1Click(Sender: TObject);
var
  I: Integer;
begin
  for I := 1 to 10 do                                                 { loop ten times }
  begin
```

```
    ListBox1.Items.Add(IntToStr(I));                     { add a numeral to the list }
    if I = 7 then Abort;                               { abort after the seventh one }
  end;
end;
```

Defining your own exceptions

In addition to protecting your code from exceptions generated by the run-time library and various components, you can use the same mechanism to manage exceptional conditions in your own code.

To use exceptions in your code, you need to understand these steps:

- Declaring an exception object type
- Raising an exception

Declaring an exception object type

Because exceptions are objects, defining a new kind of exception is as simple as declaring a new object type. Although you can raise any object instance as an exception, the standard exception handlers handle only exceptions descended from *Exception*.

It's therefore a good idea to derive any new exception types from *Exception* or one of the other standard exceptions. That way, if you raise your new exception in a block of code that isn't protected by a specific exception handler for that exception, one of the standard handlers will handle it instead.

For example, consider the following declaration:

```
type
  EMyException = class(Exception);
```

If you raise *EMyException* but don't provide a specific handler for *EMyException*, a handler for *Exception* (or a default exception handler) will still handle it. Because the standard handling for *Exception* displays the name of the exception raised, you could at least see that it was your new exception raised.

Raising an exception

To indicate an error condition in an application, you can raise an exception which involves constructing an instance of that type and calling the reserved word **raise**.

■ To raise an exception, call the reserved word **raise**, followed by an instance of an exception object.

When an exception handler actually handles the exception, it finishes by destroying the exception instance, so you never need to do that yourself.

Setting the exception address

Raising an exception sets the *ErrorAddr* variable in the *System* unit to the address where the application raised the exception. You can refer to *ErrorAddr* in your exception handlers, for example, to notify the user of where the error occurred. You can also specify a value for *ErrorAddr* when you raise an exception.

- To specify an error address for an exception, add the reserved word **at** after the exception instance, followed by and address expression such as an identifier.

  For example, given the following declaration,

```
type
  EPasswordInvalid = class(Exception);
```

you can raise a “password invalid” exception at any time by calling **raise** with an instance of *EPasswordInvalid*, like this:

```
if Password <> CorrectPassword then
  raise EPasswordInvalid.Create('Incorrect password entered');
```

Summary

Exceptions provide a powerful and flexible mechanism for reporting and responding to error conditions in your applications. The Delphi run-time library and all the standard components raise and respond to exceptions.

By handling exceptions in your applications, you can ensure that you don’t lose system resources when your application must unexpectedly shut down, or you can enable the application or the user to correct the error condition and retry the operation. In either case, exceptions provide information necessary to the application and a mechanism you can use to respond to error conditions.

Chapter

8

Using the integrated debugger

No matter how careful you are when you write code, a newly completed program is likely to contain errors, or *bugs*, that prevent it from running as it was designed to. *Debugging* is the process of locating and fixing the errors in your programs.

Delphi contains an *integrated debugger,* so you can debug programs without leaving Delphi integrated development environment. The following topics are discussed in this chapter:

- Types of bugs
- Planning a debugging strategy
- Starting a debugging session
- Controlling program execution
- Restarting the program
- Using breakpoints
- Examining program data values
- Viewing function calls
- Handling hardware and language exceptions

You can access the integrated debugger through either of two menus: Debug or View.

Types of bugs

The integrated debugger can help find two basic types of programming errors: run-time errors and logic errors.

Run-time errors

If your program successfully compiles, but fails when you run it, you've encountered a *run-time error*. Your program contains valid statements, but the statements cause errors when they're executed. For example, your program might be trying to open a nonexistent file, or it might be trying to divide a number by zero. The operating system detects run-time errors and stops your program execution if such an error is encountered.

Without a debugger, run-time errors can be difficult to locate because the compiler doesn't tell you where the error is located in your source code. Often, the only clue you have to work with is where your program failed and the error message generated by the run-time error.

Although you can find run-time errors by searching through your program source code, the integrated debugger can help you quickly track down these types of errors. Using the integrated debugger, you can run to a specific program location. From there, you can begin executing your program one statement at a time, watching the behavior of your program with each step. When you execute the statement that causes your program to fail, you have pinpointed the error. From there, you can fix the source code, recompile the program, and resume testing your program.

Logic errors

Logic errors are errors in design and implementation of your program. Your program statements are valid (they do *something)*, but the actions they perform are not the actions you had in mind when you wrote the code. For instance, logic errors can occur when variables contain incorrect values, when graphic images don't look right, or when the output of your program is incorrect.

Logic errors are often the most difficult type of errors to find because they can show up in places you might not expect. To be sure your program works as designed, you need to thoroughly test all of its aspects. Only by scrutinizing each portion of the user interface and output of your program can you be sure that its behavior corresponds to its design. As with run-time errors, the integrated debugger helps you locate logic errors by letting you monitor the values of your program variables and data objects as your program executes.

Planning a debugging strategy

After program design, program development consists of a continuous cycle of program coding and debugging. Only after you thoroughly test your program should you distribute it to your end users. To ensure that you test all aspects of your program, it's best to have a thorough plan for your debugging cycles.

One good debugging method involves breaking your program down into different sections that you can systematically debug. By closely monitoring the statements in each program section, you can verify that each area is performing as designed. If you do find a programming error, you can correct the problem in your source code, recompile the program, and then resume testing.

Starting a debugging session

If you find a program run-time or logic error, you can begin a debugging session by running your program under the control of the debugger.

- To begin a debugging session,

1. Generate debug information when you compile your program.
2. Run your program from within Delphi.

When debugging, you have complete control of your program's execution. You can pause the program at any point to examine the values of program variables and data structures, to view the sequence of function calls, and to modify the values of program variables to see how different values affect the behavior of your program.

You can also use the debugger to watch each step of your program's execution. By stepping through your program's source code (as described in "Stepping through code" on page 252), you can monitor your program code as it is executed.

Generating debugging information

Before you can begin a debugging session, you need to compile your project with *symbolic debug information*. Symbolic debug information, contained in a *symbol table*, enables the debugger to make connections between your program's source code and the machine code that's generated by the compiler. This way you can view the actual source code of your program while running the program through the debugger.

- Although Delphi generates symbolic debug information by default, you can manually turn on symbolic debug information for your project with the following steps:

1. Choose Options | Project to open the Compiler Options dialog box.
2. Click the Compiler Options tab to access the debugging options.
3. Check the Debug Information and Local Symbols check boxes.

When you generate symbolic debug information for use with the internal debugger, the compiler stores a symbol table in each associated .DCU file.

If you want to use Turbo Debugger (the standalone debugger), you also need to include symbolic debug information in your final .EXE file.

- To include symbolic debug information in your project's compiled .EXE file,

1. Choose Options | Project to open the Compiler Options dialog box.
2. Click the Linker tab to access the linker options.
3. Check the Debug Info In EXE check box.

Note Be aware that including symbolic debug information in your executable file significantly increases the size of the final .EXE file. Because of this, you want to include debug information in your files only during the development stage of your project. Once your program is fully debugged, compile your program without debug information to reduce the final .EXE file size.

Before you begin

In order to access the integrated debugger commands, you need to make sure the integrated debugger is enabled.

■ To enable the integrated debugger,

1. Choose Options | Environment and click the Preferences page tab.
2. Check the Integrated Debugging check box, if necessary (this box is checked by default).
3. If you want, check the Minimize On Run check box to specify that the Delphi environment be minimized when you run your program.

Running your program

Once you've compiled your program with debug information, you can begin a debugging session by running your program from Delphi. The debugger takes control whenever you run, trace, or step through your program code.

When you run your program under the control of the debugger, it behaves as it normally would; your program creates windows, accepts user input, calculates values, and displays output. In the time that your program is not running, the debugger has control, and you can use its features to examine the current state of the program. By viewing the values of variables, the functions on the call stack, and the program output, you can ensure that the area of code you're examining is performing as it was designed to.

As you run your program through the debugger, you can watch the behavior of your application in the windows it creates. For best results during your debugging sessions, arrange your screen so you can see both the Code Editor and your application window as you debug. To keep windows from flickering as the focus alternates between the debugger windows and those of your application, arrange the windows so they don't overlap (tile the windows). With this setup, your program's execution will be quicker and smoother during the debugging session.

Specifying program arguments

If the program you want to debug uses command-line arguments, you can specify those arguments from within Delphi.

■ To specify command-line arguments for your application,

1. Choose Run | Parameters.
2. In the Run Parameters dialog box, type the arguments you want to pass to your program when you run it under the control of the integrated debugger.
3. Choose OK.

Controlling program execution

The most important property of a debugger is that it lets you control the execution of your program; you can control whether your program executes a single line of code, an entire function, or an entire program block. By dictating when the program should run and when it should pause, you can quickly move over the sections that you know work correctly and concentrate on the sections that are causing problems. The integrated debugger lets you control the execution of your program in the following ways:

- Running to the cursor location
- Stepping and tracing
- Running to a breakpoint
- Pausing your program

When running code through the debugger, all program execution is based on lines of source code. The integrated debugger lets you control the rate of debugging to the level of a single line of code. However, the debugger considers multiple program statements on one line of text to be a single line of code; you cannot individually debug multiple statements contained on a single line of text. In addition, the debugger regards a single statement that's spread over several lines of text as a single line of code.

Running to the cursor location

When beginning a debugging session, you often run your program to a spot just before the suspected location of the problem. At that point, you want to ensure that all data values are as they should be. If everything appears to be correct, you can run your program to another location, and again check to ensure things are functioning correctly.

■ To run to a specific program location,

1. In the Code Editor, position the cursor on the line of code where you want to begin (or resume) debugging.
2. Run to the cursor location using one of the following methods:
   - Choose Run To Cursor from the Code Editor SpeedMenu.
   - Choose Run | Run To Cursor.
   - Press *F4* (default key mapping).

When you run to the cursor, your program executes at full speed until the execution reaches the location marked by the text cursor in the Code Editor. When the execution encounters the code marked by the cursor, the debugger regains control and places the execution point on that line of code.

The execution point

The *execution point* marks the next line of source code to be executed by the debugger. Whenever you pause the program execution within the debugger (for example, whenever you run to the cursor or step to a program location), the debugger highlights a line of code, marking the location of the execution point. The execution point always shows the next line of code to be executed, whether you are going to trace, step, or run your program at full speed.

Stepping through code

The Trace Into and Step Over commands offer the simplest way of moving through your program code. While the two commands are very similar, they each offer a different way to *step* through code. When you step, you watch your program execute statements one at a time. After stepping, the program execution is paused, and you can use the debugger to investigate the different aspects of your program.

Trace Into

The Trace Into command executes a single program statement at a time. If the execution point is located on a call to a function that was compiled with debugging information, choosing Trace Into causes the debugger to step into that function by placing the execution point on the function's first statement. However, if the execution point is located on a function call that doesn't contain debugging information (a library function, for example), then choosing Trace Into runs that function at full speed, after which the execution point is positioned on the statement following the function call.

If the execution point is located on the last statement of a function, choosing Trace Into causes the debugger to return from the function, placing the execution point on the line of code that follows the call to the function you are returning from.

The term *single stepping* refers to using Trace Into to successively run though the statements in your program code.

■ To issue the Trace Into command, choose one of the following methods:

- Choose Run | Trace Into.
- Press *F7* (default key mapping).
- Click the Trace Into SpeedButton.

Step Over

The Step Over command, like Trace Into, enables you to execute program statements one at a time. However, if you issue the Step Over command when the execution point is located on a function call, the debugger runs that function at full speed (instead of tracing into it), then positions the execution point on the statement that follows the function call.

■ To issue the Step Over command, choose from one of the following methods:

- Choose Run | Step Over.
- Press *F8* (default key mapping).
- Click the Step Over SpeedButton.

As you debug, you can choose to trace into some functions and step over others. If you know a function performs as it was designed to, you can step over calls to that function with confidence that the function call will not cause an error. If, on the other hand, you aren't sure that a function is well behaved, you can choose to Trace Into the function to verify that it works as designed.

Debugging your application startup code

By default, when you initiate a debugging session by choosing Trace Into or Step Over, Delphi moves the execution point to the first line of code that contains debugging information (this is normally a location that contains user-written code). However, you can override this behavior and have Delphi step to the first executable statement in the program when you begin a debugging session. This feature provides the ability to debug the startup routines of your project.

- To have Delphi step to the first executable statement in the program,

1 Choose Options | Environment, then click the Preferences page tab.
2 Check the Step Program Block check box.
3 Run your program by choosing Trace Into or Step Over.

Running to a breakpoint

You set *breakpoints* on lines of source code where you want the program execution to pause during a run. Running to a breakpoint is similar to running to a cursor position in that the program runs at full speed until it reaches a certain source code location. However, unlike Run To Cursor, you can have multiple breakpoints in your code, and you can customize each one so it pauses the program execution only when a specified condition is met. For more information on breakpoints, see "Using breakpoints" on page 254.

Pausing the program

In addition to stepping over or tracing into code, you can also pause your program while it's running. Choosing Run | Program Pause causes the debugger to pause your program the next time the execution point enters your code. You can then use the debugger to examine the state of your program with respect to this program location. When you've finished examining the program, continue debugging by running as usual.

If your program assumes control and won't allow you to return to the debugger (for example, if it runs into an infinite loop), you can press *Ctrl+Alt+Sys Req* to stop your program. However, be aware that you might need to press this command several times before your program actually stops—the command doesn't work if Windows kernel code is executing.

Restarting the program

Sometimes while debugging, you will find it necessary to restart the program from the beginning. For example, you might need to restart the program if you step past the location of a bug, or if variables or data structures become corrupted with unwanted values.

- To end the current program run and reset the program, choose Run | Program Reset (or press *Ctrl+F2*).

Resetting a program closes all open program files, releases resources allocated by calls to the VCL, and clears all variable settings. However, resetting a program does not delete any breakpoints or watches that you have set, which makes it easy to resume a debugging session.

Note Resetting a program might not release all Windows resources allocated by your program. In most cases, all resources allocated by VCL routines are released. However, Windows resources allocated by the code you have written might not be properly released. If your system becomes unstable (through either multiple hardware or language exceptions or through a loss of system resources as a result of resetting your program), it is best to exit Delphi before restarting your debugging session.

Using breakpoints

You use *breakpoints* to pause the program execution at designated source code locations during a debugging session. By setting breakpoints in potential problem areas of your source code, you can run your program at full speed, knowing that its execution will pause at a location you want to debug. When your program execution encounters a breakpoint, the program pauses, and the debugger displays the line containing the breakpoint in the Code Editor. You can then use the debugger to view the state of your program.

Setting breakpoints

Breakpoints are flexible in that they can be set before you begin a program run or at any time that the integrated debugger has control. For a breakpoint to be valid, it must be set on an executable line of code. Breakpoints set on comment lines, blank lines, declarations, or other non-executable lines of code are invalid and become disabled when you run your program.

■ To set a breakpoint, select the line of code in the Code Editor where you want the breakpoint set, then do one of the following:

- Click the left margin of the line in the Code Editor where you want the breakpoint set.
- Press *F5* (default key mapping).
- Choose Toggle Breakpoint from the Code Editor SpeedMenu.
- Choose Run | Add Breakpoint, then choose New (in the Edit Breakpoint dialog box) to confirm a new breakpoint setting, or choose Modify to implement changes to an existing breakpoint.
- Choose Add Breakpoint from the Breakpoint List SpeedMenu.

Alternately, if you know the line of code where you want the breakpoint set, choose Run | Add Breakpoint and type the source-code line number in the Line Number box. When the settings in the Edit Breakpoint dialog box are correct, choose New to complete the breakpoint entry.

When you set a breakpoint, the line on which the breakpoint is set becomes highlighted, and a stop-sign glyph appears in the left margin of the breakpoint line.

Invalid breakpoints

If a breakpoint is not placed on an executable line of code, the debugger considers it invalid. For example, a breakpoint set on a comment, a blank line, or declaration is invalid. If you set an invalid breakpoint, the debugger displays the Invalid Breakpoint error box when you attempt to run the program. To correct this situation, close the error box and delete the invalid breakpoint from the Breakpoint List window. You can then reset the breakpoint in the intended location. However, you can also ignore invalid breakpoints; the IDE disables any invalid breakpoints when you run your program.

Note During the linking phase of compilation, lines of code that do not get called in your program are marked as *dead code* by the linker. In turn, the integrated debugger marks any breakpoints set on dead code as invalid.

Setting breakpoints after starting a program

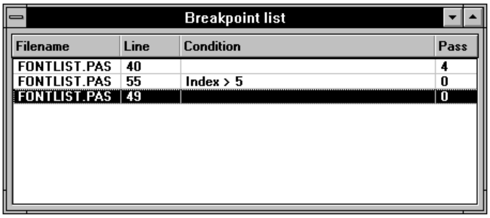
While your program is running, you can switch to the debugger (by accessing the Code Editor) and set a breakpoint. When you return to your application, the new breakpoint is set, and your application halts when it reaches the breakpoint.

Working with breakpoints

The Breakpoint List window lists all breakpoints by their file name and line number. In addition, each breakpoint listing shows any condition and pass count associated with the breakpoint. If a breakpoint is either disabled or invalid, then the breakpoint listing is dimmed in the Breakpoint List window.

- To open the Breakpoint List window, choose View | Breakpoint.

Figure 8.1 The Breakpoint List window



Filename	Line	Condition	Pass
FONTLIST.PAS	40		4
FONTLIST.PAS	55	Index > 5	0
FONTLIST.PAS	49		0

Use the Breakpoint List window to view and maintain all your breakpoints; you don't need to search through your source files to find the breakpoints you've set. Also, using the commands on the Breakpoint List SpeedMenu, you can view or edit the code at any breakpoint location.

Viewing and editing code at a breakpoint

If a breakpoint isn't displayed in the Code Editor window, you can use the Breakpoint List window to quickly find the breakpoint's location in your source code.

■ To use the Breakpoint List window to locate a breakpoint,

1 Select the breakpoint in the Breakpoint List window.
2 Choose View Source or Edit Source from the SpeedMenu.

The Code Editor is updated to show the breakpoint's location. If you choose View Breakpoint, the Breakpoint List window remains active so you can modify the breakpoint or go on to view another. If you choose Edit Breakpoint, the Code Editor gains focus on the line containing the breakpoint, enabling you to modify the source code at that location.

Disabling and enabling breakpoints

Disabling a breakpoint hides the breakpoint from the current program run. When you disable a breakpoint, all the breakpoint settings remain defined, but the breakpoint is hidden from the execution of your program; your program will not stop on a disabled breakpoint. Disabling a breakpoint is useful if you have defined a conditional breakpoint that you don't need to use now, but might need to use at a later time.

■ To disable a breakpoint,

1 Open the Breakpoint List window and highlight the breakpoint you want to disable.
2 Choose Disable Breakpoint from the Breakpoint List SpeedMenu.

You can also disable all current breakpoints by selecting the Disable All Breakpoints command on the Breakpoint List SpeedMenu.

■ To reenable a breakpoint, highlight the breakpoint in the Breakpoint List window, then choose Enable Breakpoint from the SpeedMenu. You can also choose Enable All Breakpoints from the SpeedMenu to enable breakpoints.

Deleting breakpoints

When you no longer need to examine the code at a breakpoint location, you can delete the breakpoint from the debugging session. You can delete breakpoints using either the Code Editor or the Breakpoint List window:

■ Use the following methods to delete breakpoints:

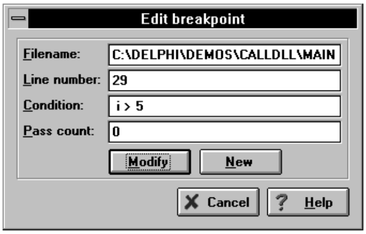
- From the Code Editor, place the text cursor in the line containing the breakpoint and press *F5* (or choose Toggle Breakpoint from the Speed Menu).
- Click the stop-sign glyph in the Code Editor window to delete the associated breakpoint.
- From the Breakpoint List window, highlight the breakpoint you want removed, then choose Delete Breakpoint from the SpeedMenu.
- To delete all currently set breakpoints, choose Delete All Breakpoints from the Breakpoint List SpeedMenu.

Caution The breakpoint delete commands are not reversible.

Modifying breakpoint properties

To view and modify the properties of a breakpoint, double-click the breakpoint in the Breakpoint List window or select it and choose Edit Breakpoint from the SpeedMenu. The Edit Breakpoint dialog box appears.

Figure 8.2 The Edit Breakpoint dialog box



Filename: C:\DELPHI\DEMOS\CALLDLL\MAIN
Line number: 29
Condition: i > 5
Pass count: 0

In addition to examining a breakpoint's properties, you can use the Edit Breakpoint dialog box to change the location of a breakpoint, set a conditional breakpoint, and set a pass count for the breakpoint.

Creating conditional breakpoints

When a breakpoint is first set, by default it pauses the program execution each time the breakpoint is encountered. However, using the Edit Breakpoint dialog box, you can customize your breakpoints so that they are activated only when a specified set of conditions is met.

Use the integrated debugger to add two types of conditions to your breakpoints:

- Boolean expressions
- Pass counts

Setting Boolean conditions

The Condition edit box in the Edit Breakpoint dialog box lets you enter an expression that is evaluated each time the breakpoint is encountered during the program execution. If the expression evaluates to *True* (or not zero), then the breakpoint pauses the program run. If the condition evaluates to *False* (or zero), then the debugger does not stop at the breakpoint location.

Conditional breakpoints are useful when you want to see how your program behaves when a variable falls into a certain range or what happens when a particular flag is set.

➤ For example, suppose you want a breakpoint to pause on a line of code only when the variable *mediumCount* is greater than 10. To do so,

1 Set a breakpoint on the line of code you want by moving the text cursor to that line of code in the Code Editor and pressing F5.

2 Open the Breakpoint List window by choosing View | Breakpoints.

3 Highlight the breakpoint just set and choose Edit Breakpoint from the SpeedMenu. The Edit Breakpoint dialog box opens.

4 Enter the following expression into the Condition edit box:

```
mediumCount > 10
```

5 Choose Modify to confirm your settings.

Note You can input any valid language expression into the Condition edit box, but all symbols in the expression must be accessible from the breakpoint's location, and the expression cannot contain any function calls.

Using pass counts

The Pass Count edit box enables you to specify a particular number of times that a breakpoint must be passed for the breakpoint to be activated; *pass counts* tell the debugger to pause the program execution the *n*th time that the breakpoint is encountered during the program run (the number *n* is user-specified and is set to 1 by default).

The pass count number is decremented each time the line containing the breakpoint is encountered during the program execution. If the pass count equals 1 when the breakpoint line is encountered, the breakpoint activates and pauses the program execution on that line of code.

Pass counts are useful, for example, when you think that a loop is failing on the *n*th iteration. Or, if you can't tell on which iteration the loop fails, you can set the pass count to the maximum loop count and run your program. When the program fails, calculate the number of times that the program went through the loop by examining the number in the pass count field.

When pass counts are used in conjunction with Boolean conditions, the breakpoint pauses the program execution the *n*th time that the condition is true; the condition must be true for the pass count to be decremented.

Customizing the breakpoint and execution point colors

You can customize the colors used to indicate the execution point and the enabled, disabled, and invalid breakpoint lines.

- To set execution point and breakpoint colors,

1 Choose Options | Environment to access the Environment Options dialog box.
2 Select the Editor Colors page tab.
3 From the Element list, select Execution Point, Active Break, Disabled Break, or Invalid Break, then set the background and foreground colors as you want.

Examining program data values

Even though you can discover many interesting things about your program by running and stepping through it, you usually need to examine the values of program variables to uncover bugs. For example, it's helpful to know the value of the index variable as you step though a **for** loop, or the values of the parameters passed to a function call.

The integrated debugger has the following tools to help you examine the data values in your program:

- The Watch List window
- The Evaluate/Modify dialog box
- The Call Stack window

Data evaluation operates at the level of *expressions*. An expression consists of constants, variables, and values contained in data structures, combined with language operators. In fact, almost anything you can use as the right side of an assignment operator can be used as a debugging expression, with the exception of function calls.

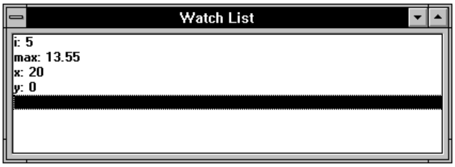
Watching expressions

You use *watches* to monitor the changing values of variables or expressions during your program run. After you enter a watch expression, the Watch List window displays the current value of the expression. As your program runs, the value of the watch changes as your program updates the values of the variables contained in the watch expression.

If the execution point moves to a location where any of the variables in the watch expression are undefined, then the entire watch expression becomes undefined. If the execution point returns to a location where the watch expression can be evaluated, then the Watch List window again displays the current value of the watch expression.

- To open the Watch List window, choose View | Watches.

Figure 8.3 The Watch List window



```
i: 5
max: 13.55
x: 20
y: 0
```

- The easiest way to set a watch is from the Code Editor:

1. Select the expression you want to monitor.
2. Choose Set Watch from the Code Editor SpeedMenu to add the expression to the Watch List window.

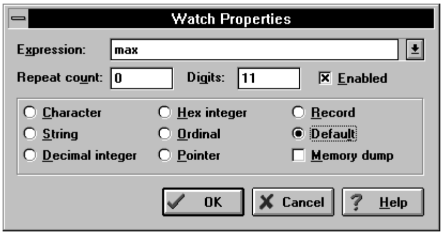
- You can also create a watch by doing the following:

1. Open the Watch Properties dialog box using any of the following techniques:
   - From the Main menu, choose Run | Add Watch.
   - Choose Add Watch At Cursor from the Code Editor SpeedMenu.
   - Press *Ctrl+F5* (default key mapping).
   - Double-click a watch in the Watch List window.
   - Select a watch in the Watch List window, then choose Edit from the SpeedMenu.
2. In the Expression edit box, enter the expression you want to watch (or choose a previously entered expression from the drop-down list).

Formatting watch expressions

You can format the display of a watch expression using the Watch Properties dialog box. By default, the debugger displays integer values in decimal form. However, by checking the Hex Integer button in the Watch Properties dialog box, you can specify that an integer watch be displayed as hexadecimal.

Figure 8.4 The Watch Properties dialog box



Watch Properties

Expression: max

Repeat count: 0   Digits: 11   ☒ Enabled

○ Character   ○ Hex integer   ○ Record
○ String   ○ Ordinal   ● Default
○ Decimal integer   ○ Pointer   □ Memory dump

If you're setting up a watch on an element in a data structure (such as an array), you can display the values of consecutive data elements. For example, suppose you have an array of five integers named *xarray.* Type the number `5` in the Repeat Count box of the Watch Properties dialog box to see all five values of the array. However, to use a repeat count, the watch expression must represent a single data element.

To format a floating-point expression, indicate the number of significant digits you want displayed in the Watch List window by typing this number in the Digits edit box.

Disabling a watch

If you prefer not to watch an expression that you've entered in the Watch List window, but you don't want to delete it because you might need to use it later, you can disable the watch. Disabling watches speeds up the response of the debugger because it won't have to monitor the watch as you step or run through your program.

In the Watch List window, the Enable check box lies to the left of each watch listing. When you set a watch, the debugger enables the watch by checking this box.

■ To disable a watch, do one of the following:

- Double-click a watch in the Watch List window to open the Watch Properties dialog box, then uncheck the Enabled check box.
- Select the watch in the Watch window and choose Disable Watch from the SpeedMenu.

You can also disable all current watches by choosing Disable All Watches from the SpeedMenu. To reenable a watch, recheck the Enabled check box, or select it in the Watches window, then choose Enable Watch (or Enable All Watches) from the SpeedMenu.

Deleting a watch

To delete a watch expression, select the expression in the Watch window, then choose Delete Watch from the SpeedMenu. You can also delete all the watches by choosing Delete All Watches from the SpeedMenu.

Caution The delete watch commands cannot be reversed.

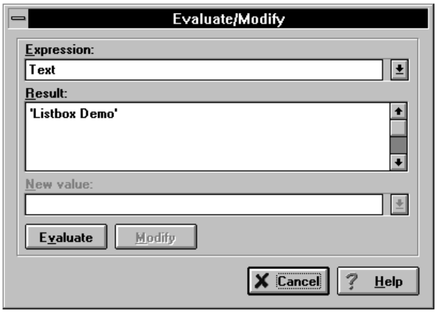
Evaluating and modifying expressions

You can evaluate expressions and change the values of data items using the Evaluate/Modify dialog box. The Evaluate/Modify dialog box has the advantage over watches in that it enables you to change the values of variables and items in data structures during the course of your debugging session. This can be useful if you think you've found the solution to a bug, and you want to try the correction before exiting the debugger, changing the source code, and recompiling the program.

Evaluating expressions

Choose Run | Evaluate/Modify to open the Evaluate/Modify dialog box.

Figure 8.5 The Evaluate/Modify dialog box



Expression: Text

Result: 'Listbox Demo'

New value:

By default, the word at the cursor position in the current Code Editor is placed in the Expression edit box. You can accept this expression, enter another one, or choose an expression from the history list of expressions you've previously evaluated.

- To evaluate the expression, click the Evaluate button at the bottom of the Evaluate/Modify dialog box. Using this dialog box, you can evaluate any valid language expression, except those that contain
  - Local or static variables that are not accessible from the current execution point
  - Function and procedure calls

Note The Evaluate/Modify dialog box lets you view and modify the values of object properties while running the program. However, to view a property, you need to explicitly specify the property name. For example, you can enter the following expression to evaluate the Caption property of *Button1*:

```
Button1.Caption
```

When you evaluate an expression, the current value of the expression is displayed in the Result field of the dialog box. If necessary, you can format the result by adding a comma and one or more format following specifiers to the end of the expression entered in the Expression edit box. Table 8.1 details the legal format specifiers.

Table 8.1 Expression format specifiers

Character	Types affected	Function
H or X	Integers	**Hexadecimal**. Shows integer values in hexadecimal with the **0x** prefix, including those in data structures.
C	*Char*, strings	**Character**. Shows special display characters for ASCII 0..31. By default, such characters shown using the appropriate C escape sequences (**/n**, **/t**, and so on).
D	Integers	**Decimal**. Shows integer values in decimal form, including those in data structures.
F*n*	Floating point	**Floating point**. Shows *n* significant digits (where *n* is in the range 2..18, and 7 is the default).
*n*M	All	**Memory dump**. Shows *n* bytes starting at the address of the indicated expression. If *n* is not specified, it defaults to the size in bytes of the type of the variable. By default, each byte shows as two hex digits. The C, D, H, S, and X specifiers can be used with M to change the byte formatting.
P	Pointers	**Pointer**. Shows pointers as *seg:ofs* instead of the default *Ptr(seg:ofs)*. It tells you the region of memory in which the segment is located, and the name of the variable at the offset address, if appropriate.
R	Records, classes, and objects	**Records/Classes/Objects**. Shows both field names and values such as (*X*:1;*Y*:10;*Z*:5) instead of (1,10,5).
S	*Char*, strings	**String**. Shows any non-displayable ASCII characters as #*nn*, where *nn* represents the ordinal value of the ASCII character. Use only to modify memory dumps (see *n*M).

For example, to display a result in hexadecimal, type `,H` after the expression. To see a floating point number to 3 decimal places, type `,F3` after the expression.

Modifying the values of variables

Once you've evaluated a variable or data structure item, you can modify its value. Modifying the value of data items during a debugging session enables you to test different bug hypotheses and see how a section of code behaves under different circumstances.

■ To modify the value of a data item,

1 Open the Evaluate/Modify dialog box, then enter the name of the variable or data item you want to modify in the Expression edit box.

2 Click Evaluate to evaluate the data item.

3 Type a value into the New Value edit box (or choose a value from the drop down box), then click Modify to update the data item.

Note When you modify the value of a data item through the debugger, the modification is effective for that specific program run only; the changes you make through the Evaluate/Modify dialog box do not effect your program source code or the compiled program. To make your change permanent, you must modify your program source code in the Code Editor, then recompile your program.

Keep these points in mind when you modify program data values:

- You can change individual variables or elements of arrays and data structures, but you cannot change the contents of an entire array or data structure.
- The expression in the New Value box need to evaluate to a result that is assignment-compatible with the variable you want to assign it to. A good rule of thumb is that if the assignment would cause a compile-time or run-time error, it's not a legal modification value.
- You can't directly modify untyped parameters passed into a function, but you can typecast them and then assign new values.

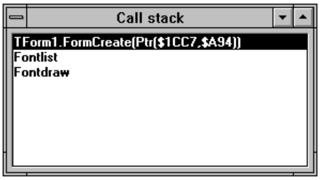
Warning! Modifying values (especially pointer values and array indexes), can have undesirable effects because you can overwrite other variables and data structures. Use caution whenever you modify program values from the debugger.

Viewing function calls

While debugging, it can be useful to know the order of function calls that brought you to your current program location. Using the Call Stack window, you can view the current sequence of function calls. The Call Stack window is also helpful when you want to view the arguments passed to a function call; each function listing in the window is followed by a listing that details the parameters with which the call was made.

■ To display the Call Stack window, choose View | Call Stack.

Figure 8.6 Call Stack window



```
TForm1.FormCreate(Ptr($1CC7,$A94))
Fontlist
Fontdraw
```

The top of the Call Stack window lists the last function called by your program. Below this is the listing for the previously called function. The listing continues, with the first function called in your program located at the bottom of the list. Note that only functions in the currently loaded symbol table are listed in this window. To view functions located in a different module, change symbol tables, as described later in this chapter.

The Call Stack window is particularly useful if you accidentally trace into code you wanted to step over. Using the Call Stack window, you can return to the point from which the current function was called, then resume debugging from there.

■ To use the Call Stack window,

1 In the Call Stack window, double-click the function that called the function you accidently traced into (it is the second function listed in the Call Stack window). The Code Editor becomes active with the cursor positioned at the location of the function call.

2 In the Code Editor, move the cursor to the statement following the function call.

3 Choose Run To Cursor on the Code Editor SpeedMenu (or press *F4*).

Navigating to function calls

Using the Call Stack window, you can view or edit the source code located at a particular function call.

- To view or edit the source code of a function call, choose either View Source or Edit Source (as appropriate) from the Call Stack SpeedMenu.

The View Source and Edit Source commands each cause the Code Editor to navigate to the selected function. However, Edit Source gives focus to the Code Editor so you can modify the source code at that function location, while View Source does not move the focus from the Call Stack window.

If you select the top function in the Call Stack window, View Source and Edit Source cause the Code Editor to display the location of the execution point in the current function. Selecting any other function call causes the debugger to display the actual function call in the Code Editor.

Handling hardware and language exceptions

Delphi provides a mechanism to control the way exceptions are handled while you are debugging. In addition, Delphi makes the debugging session easier by treating most hardware exceptions as Object Pascal language exceptions. This means Delphi traps the hardware exceptions generated by your Delphi application, and you can gracefully recover before your program run ends with a system crash.

If a hardware or language exception occurs during a debugging session, the VCL displays a dialog box that notes the exception (note that the VCL displays this dialog box regardless of whether you are debugging the program). When you choose OK to close the dialog box, your program run continues and you can continue to debug your application.

- To have Delphi pause the program run when an exception occurs,

1 Choose Options | Environment, then click the Preferences page tab.
2 Check the Break On Exceptions check box (checked by default).
3 Begin your debugging session.

If you check Break On Exception, the IDE displays an Error dialog box whenever an exception occurs. When you choose OK to close this dialog box, Delphi opens the Code Editor with the execution point positioned on the code that caused the exception. At this point, you can examine the program code to determine why the exception occurred. If you continue the program run from this point, the VCL displays an exception dialog box.

Note Because certain hardware exceptions can place your system in an unstable condition, it is usually best to terminate your program run after an exception occurs. Resolve the program error, then resume the debugging session.

Summary

You can use the integrated debugger to debug your Delphi applications without leaving the IDE. You can control the execution of your program by pausing the execution at any code location. Once you pause the program, you can examine the program state by reviewing the current values of program data values and the routines that are currently on the program call stack.

Controlling program execution means that you control when the program should be executed and when (or where) the program should pause. You can use the integrated debugger to control the program execution by

- Running to the cursor location
- Stepping and tracing
- Running to a breakpoint
- Pausing your program

While you're debugging a program, either the program is running or it is paused at a program code location. When the program is paused, you are free to examine the current values of the program data items. Program data items include program variables, items in data structures, class fields, and object properties. The integrated debugger enables you to examine the values of these data items with the following:

- The Watch List window
- The Call Stack window
- The Evaluate/Modify dialog box

In addition to examining program data values, you can also change the values of single data items using the Evaluate/Modify dialog box. Modifying program data values during a debugging session provides a way to test hypothetical bug fixes during a program run. If you find that a modification fixes a program error, you can exit the debugging session, fix your program code accordingly, and recompile the program to make the fix permanent.

Part IV

Sample applications

The chapters in this part show several complete examples of building applications with Delphi. Although each of the sample applications is a complete and useful application, the primary purpose of these chapters is to explain how to perform typical application-building tasks in Delphi within a realistic context.

For example, the text editor example describes how to manipulate menu items, and the graphics example shows how to create and use tool bars. You will most likely use these techniques in other kinds of applications, but by seeing these items in the context of complete applications, you can better see how to integrate them into your own.

You can use the chapters in this part in several ways: to learn to build complete applications, to see how to use particular components, or to see how to perform a specific task with a component.

The sample applications in this part describe the following skills:

- **“Using string lists”**
  This chapter presents various skills for using string-list objects, which appear in the text editor example and the file manager example.
- **“Text editor example”**
  This chapter demonstrates the creation and seamless integration of Multiple-Document Interface (MDI) applications, fundamental concepts and techniques for displaying and manipulating text.
- **“Using graphics at run time”**
  This chapter discusses concepts and techniques for creating graphics applications in Delphi. Encapsulation of Windows GDI functions in the Delphi Canvas.

- **“Graphics example”**
  This chapter features an extension and practical application of the techniques presented in Chapter 11, including dynamic creation of tool bars and use of the pen and brush.
- **“File manager example”**
  This chapter demonstrates such concepts as building a drive list, creating owner-draw controls, manipulating files, using drag-and-drop techniques, using file controls, and using the tab-set control.
- **“Exchanging data with DDE or OLE”**
  This chapter offers background and conceptual material for understanding Dynamic Data Exchange (DDE), Object Linking and Embedding (OLE) versions 1.0 and 2.0, and their implementation within the Delphi programming environment.
- **“OLE example”**
  This chapter expands on the concepts introduced in Chapter 14 by showing you how to create an MDI application that can use either OLE 1.0 or OLE 2.0.

Chapter

9

Working with string lists

There are numerous occasions when Delphi applications need to deal with lists of character strings. Among these lists are the items in a list box or combo box, the lines of text in a memo field, the list of fonts supported by the screen, the names of the tabs on a notepad, the items in an outline, and a row or column of entries in a string grid.

Although applications use these lists in various ways, Delphi provides a common interface to all of them through an object called a *string list*, and goes even farther by making them interchangeable—meaning you can, for example, edit a string list in a memo field and then use it as the list of items in a list box.

You have probably already used string lists through the Object Inspector. A string-list property appears in the Object Inspector with `(TStrings)` in the Value column. When you double-click `(TStrings)`, the String List editor appears, where you can edit, add, or delete lines.

You can also work with string lists at run time. These are the most common types of string-list tasks:

- Manipulating the strings in a list
- Loading and saving string lists
- Creating a new string list
- Adding objects to a string list

Manipulating the strings in a list

Quite often in an Delphi application, you need to write code to work with strings in an existing string list. The most common case is that some component in the application has a string-list property, and you need to change it or get strings from it.

These are the common operations you might need to perform:

- Counting the strings in a list
- Accessing a particular string

- Finding the position of a string
- Adding a string to a list
- Moving a string within a list
- Deleting a string from a list
- Copying a complete string list
- Iterating the strings in a list

Counting the strings in a list

■ To find out how many strings are in a string list, use the *Count* property. *Count* is a read-only property that indicates the number of strings in the list. Since the indexes used in string lists are zero-based, *Count* is one more than the index of the last string in the list.

For example, an application can find out how many different fonts the current screen supports by reading the *Count* property on the screen object's font list, which is a string list containing the names of all the supported fonts:

```
FontCount := Screen.Fonts.Count;
```

Accessing a particular string

The string list has an indexed property called *Strings*, which you can treat like an array of strings for most purposes. For example, the first string in the list is *Strings*[0]. However, since the *Strings* property is the most common part of a string list to access, *Strings* is the default property of the list, meaning that you can omit the *Strings* identifier and just treat the string list itself as an indexed array of strings.

■ To access a particular string in a string list, you refer to it by its ordinal position, or index, in the list. The string numbers are zero-based, so if a list has three strings in it, the indexes cover the range 0..2.

■ To determine the maximum index, check the *Count* property. If you try to access a string outside the range of valid indexes, the string list raises an exception.

For example, the following two lines do exactly the same thing, setting the first line of text in a memo field:

```
Memo1.Lines.Strings[0] := 'This is the first line.';
Memo1.Lines[0] := 'This is the first line.';
```

Finding the position of a string

Given a string, you often want to find out its position in a string list (or whether it's in the list at all).

■ To locate a string in a string list, you use the string list's *IndexOf* method. *IndexOf* takes a string as its parameter, and returns the index of the matching string in the list, or –1 if the string is not in the list.

Note that *IndexOf* works only with complete strings. That is, it must find an exact match for the whole string passed to it, and it must match a complete string in the list. If you want to match partial strings (for instance, to see if any of the strings in the list contains a given series of characters), you must iterate the list yourself and compare the strings.

Here's an example of using *IndexOf* to determine whether a given file name is in the list of files in a file list box:

```
if FileListBox1.Items.IndexOf('AUTOEXEC.BAT') > -1 then { you're in the root directory };
```

Adding a string to a list

There are two ways to add a string to a string list. You can either add it to the end of the list or insert it in the middle of the list.

- To add a string to the end of the list, call the *Add* method, passing the new string as the parameter. The added string becomes the last string in the list.
- To insert a string into the list, call the *Insert* method, passing two parameters: the index where you want the inserted string to appear and the string.

To make the string 'Three' become the third string in a list, you would call `Insert(2, 'Three')`. If the list doesn't already have at least two strings, Delphi raises an index-out-of-range exception.

Moving a string within a list

You can move a string to a different position in a string list, such as when you want to sort the list. If the string has an associated object, the object moves with the string.

- To move a string in the list, call the *Move* method, passing two parameters: the current index of the item and the index where you want to move the item to. For example, to move the third string in a list to the fifth position, you would call `Move(2, 4)`.

Deleting a string from a list

- To delete a string from a string list, you call the string list's *Delete* method, passing the index of the string you want to delete. If you don't know the index of the string you want to delete, use the *IndexOf* method to locate it.
- To delete *all* the strings in a string list, use the *Clear* method.

This example uses *IndexOf* to determine the location of a string in a list, and deletes that string if present:

```
with ListBox1.Items do
begin
  if IndexOf('bureaucracy') > -1 then
    Delete(IndexOf('bureaucracy'));
end;
```

Copying a complete string list

- To copy a list of strings from one string list to another, just assign the source list to the destination list. Even if the lists are associated with different kinds of components (or no components at all), Delphi handles the copying of the list for you.

  Copying the strings from one list to another overwrites the strings that were originally in the destination list. If you want to add a list of strings to the end of another list, you call the *AddStrings* method, passing as a parameter the list of strings you want to add.

  This example copies the items from a combo box into an outline:

```
Outline1.Lines := ComboBox1.Items;
```

  This example adds all the items from the combo box to the end of the outline:

```
Outline1.AddStrings(ComboBox1.Items);
```

Iterating the strings in a list

Many times you need to perform an operation on each string in a list, such as searching for a particular substring or changing the case of each string.

- To iterate through each string in a list, you use a **for** loop with an Integer-type index. The loop should run from zero up to one less than the number of strings in the list (*Count* – 1). Inside the loop you can access each string and perform the operation you want.

  For example, here's a loop that iterates the strings in a list box and converts each one to all uppercase characters in response to a button click:

```
procedure TForm1.Button1Click(Sender: TObject);
var
  Index: Integer;
begin
  for Index := 0 to ListBox1.Items.Count - 1 do
    ListBox1.Items[Index] := UpperCase(ListBox1.Items[Index]);
end;
```

Loading and saving string lists

You can easily store any Delphi string list in a text file and load it back again (or load it into a different list). String list objects have methods to handle both operations. Using these methods, you can quickly create a simple text editor by loading a file into a memo component (as shown in Chapter 10). But you can also use the same mechanism to save lists of items for list boxes or complete outlines.

- To load a string list from a file, call the *LoadFromFile* method and pass the name of the text file to load from. *LoadFromFile* reads each line from the text file into a string in the list.

- To store a string list in a text file, call the *SaveToFile* method and pass it the name of the text file to save to. If the file doesn't already exist, *SaveToFile* creates it. Otherwise, it overwrites the current contents of the file with the strings from the string list.

  This example loads a copy of the AUTOEXEC.BAT file from the root directory of the C drive into a memo field and makes a backup copy called AUTOEXEC.BAK:

```
procedure TForm1.FormCreate(Sender: TObject);
var
  FileName: string;                                              { storage for file name }
begin
  FileName := 'C:\AUTOEXEC.BAT';                                     { set the file name }
  with Memo1 do
  begin
    LoadFromFile(FileName);                                             { load from file }
    SaveToFile(ChangeFileExt(FileName, 'BAK'));                    { save into backup file }
  end;
end;
```

Creating a new string list

Most of the time when you use a string list, you use one that is part of a component, so you don't have to construct the list yourself. However, you can also create standalone string lists that have no associated component. For instance, your application might need to keep a list of strings for a lookup table.

The most important thing to remember when you create your own string list is to free the list when you finish with it. There are two distinct cases you might need to handle: a list that the application creates, uses, and destroys all in a single routine, and a list that the application creates, uses throughout run time, and destroys before it shuts down.

The way you create and manage a string list depends on whether it's going to be a long-term list or a short-term list.

Short-term string lists

If you need to use a string list only for the duration of a single routine, you can create it, use it, and destroy it all in one place. This is the safest way to use string list objects.

Because the string list object allocates memory for itself and its strings, it is important that you protect the allocation by using a **try..finally** block to ensure that the object frees its memory even if an exception occurs.

- The basic outline of the use of a short-term string list, then, is to

1. Construct the string-list object.
2. In the **try** part of a **try..finally** block, use the string list.
3. In the **finally** part, free the string-list object.

The following event handler responds to a button click by constructing a string list, using it, and then destroying it again.

```
procedure TForm1.Button1Click(Sender: TObject);
var
  TempList: TStrings;                                             { declare the list }
begin
  TempList := TStringList.Create;                         { construct the list object }
  try
    { use the string list }
  finally
    TempList.Free;                                          { destroy the list object }
  end;
end;
```

Long-term string lists

If you need a string list that's available at any time while your application runs, you need to construct the list when the application is first executed, then destroy it before the application is terminated.

- To create a string list that's available throughout run time,

1. Add a field of type *TStrings* to the application's main form object, giving it the name you want to use.
2. Create a handler for the main form's *OnCreate* event. The create-event handler executes before the form appears onscreen at run time.
3. In the create-event handler, construct the string-list object.
4. Create a handler for the main form's *OnDestroy* event. The destroy-event handler executes just after the main form disappears from the screen before the application stops running.

Any other event handlers can then access the string list by the name you declared in the first step.

This example features an added string list named *ClickList*. The click-event handler for the main form adds a string to the list every time the user clicks a mouse button, and the application writes the list out to a file before destroying the list.

```
unit Unit1;
interface
uses SysUtils, WinTypes, WinProcs, Messages, Classes, Graphics, Controls, Forms, Dialogs;

type
  TForm1 = class(TForm)
    procedure FormCreate(Sender: TObject);
    procedure FormDestroy(Sender: TObject);
    procedure FormMouseDown(Sender: TObject; Button: TMouseButton;
      Shift: TShiftState; X, Y: Integer);
  private
    { Private declarations }
  public
    { Public declarations }
    ClickList: TStrings;                                         { declare the field }
  end;

var
  Form1: TForm1;

implementation

{$R *.DFM}

procedure TForm1.FormCreate(Sender: TObject);
begin
  ClickList := TStringList.Create;                                 { construct the list }
end;

procedure TForm1.FormDestroy(Sender: TObject);
begin
  ClickList.SaveToFile(ChangeFileExt(Application.ExeName, '.LOG'));      { save the list }
  ClickList.Free;                                               { destroy the list object }
end;

procedure TForm1.FormMouseDown(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  ClickList.Add(Format('Click at (%d, %d)', [X, Y]));          { add a string to the list }
end;

end.
```

Adding objects to a string list

In addition to its list of strings, stored in the *Strings* property, a string list can also have a list of *objects*, which it stores in its *Objects* property. Like *Strings*, *Objects* is an indexed property, but instead of an indexed list of strings, it is an indexed list of objects.

If you're just using the strings in the list, it doesn't matter whether you have objects; the list does nothing with the objects unless you specifically access them. Also, it doesn't matter what kind of object you assign to the *Objects* property. Delphi just holds the information; you manipulate it as you need to.

Note Some string lists ignore added objects, because it doesn't make sense to have them. For example, the string lists representing the lines in a memo do not store objects added to them. Other string lists, such as the pages in a notebook, already use their associated objects as part of their standard operation. The Notebook component uses its *Pages* string list to store both the names of the pages and the objects that represent those pages.

Although you can assign any type of objects you want to *Objects*, the most common use is to associate bitmaps with strings for owner-draw controls. The important thing to remember is that strings and objects in a string list work in pairs. For every string, there is an associated object, although by default, that object is **nil**. Chapter 13 includes an example of how to associate objects with strings and use them in an owner-draw control.

It's important to understand that the string list doesn't own the objects associated with it. That is, destroying the string-list object does *not* destroy the objects associated with the strings.

Operating on objects in a string list

For each of the operations you can perform on a string list with a string, you can perform the corresponding operation with a string and its associated object. For example, you can access a particular object by indexing into the *Objects* property, just as you would the *Strings* property. The biggest difference is that you cannot omit the name *Objects*, since *Strings* is the default property of the string list.

The following table summarizes the properties and methods you use to perform corresponding operations on strings and objects in a string list.

Table 9.1 Corresponding string and object methods in string lists

Operation	For strings	For objects
Access an item	*Strings* property	*Objects* property
Add an item	*Add* method	*AddObject* method
Insert an item	*Insert* method	*InsertObject* method
Locate an item	*IndexOf* method	*IndexOfObject* method

Methods such as *Delete*, *Clear*, and *Move* operate on items as a whole. That is, deleting an item deletes both the string and the corresponding object. Also note that the *LoadFromFile* and *SaveToFile* methods operate on only the strings, since they work with text files.

Accessing associated objects

You access objects associated with a string list just as you access the strings. For example, to get the first string in a string list, you access the string list's *Strings* property at index 0: Strings[0]. The object corresponding to that string is Objects[0].

Adding associated objects

To associate an object with an existing string, you assign the object to the *Objects* property at the same index. For example, if a string list named *Fruits* contains the string 'apple' and you want to associate a bitmap called *AppleBitmap* to it, you would use the following assignment:

```
with Fruits do Objects[IndexOf('apple')] := AppleBitmap;
```

You can also add objects at the same time you add the strings by calling the string list's *AddObject* method instead of *Add*, which just adds a string. *AddObject* takes two parameters, the string and the object. For example,

```
Fruits.AddObject('apple', AppleBitmap);
```

Summary

Delphi components use string-list objects for a number of purposes. Because all string lists share some common properties and methods, your applications can easily move entire lists of strings from one component to another.

In addition, you can create your own string lists to store data outside of components, either on a short-term, temporary basis, or for the duration of the application's execution.

Chapter

10

Text editor example

This chapter presents the steps involved in building a simple Multiple Document Interface (MDI) text editor that uses the Windows common dialog boxes to open, save, and print manipulable text files.

It assumes you are familiar with the material covered in Part II, “Fundamental skills.” For instance, you need to know how to set component properties and build a menu. You should also be familiar with Object Pascal language constructs, as discussed in Part III, “Programming topics.” Finally, Chapter 9 discusses concepts that you’ll encounter as you build the text editor.

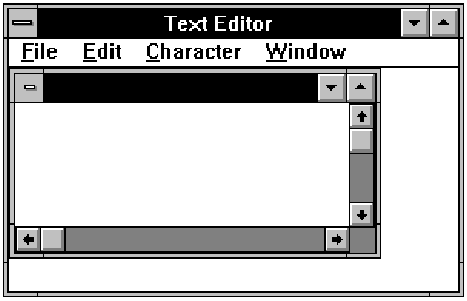
The topics discussed in the context of creating this application are

- Multiple Document Interface (MDI) applications
- Working with open child windows
- Manipulating text in a Memo component
- Using common dialog boxes
- Printing the text file
- Exiting the application

Each section of this chapter builds upon preceding sections, but the steps themselves are modular and can be used in a different context to achieve the same result. If you want to learn how to load a text file, for example, you don’t need to read the section on creating an MDI editor window first.

To see the completed application, open the project file TEXTEDIT.DPR, found in the DELPHI\DEMOS\DOCS\TEXTEDIT directory if you installed Delphi using default directories. Figure 10.1 shows the application as it appears the first time a new window is opened.

Figure 10.1 The finished text editor program, TEXTEDIT.EXE



Multiple Document Interface (MDI) applications

Multiple Document Interface is a means for applications to simultaneously open and display two or more files, within the same application. For example, you might use MDI to allow a word-processing application to open and display several documents simultaneously and provide the user with a way to quickly switch among those open documents. Likewise, you might use MDI to create a spreadsheet application that enables users to have several spreadsheets open at once, for example to compare sales figures or interest charges.

MDI applications provide a convenient way to view and exchange data among multiple documents that share a common workspace. The common workspace is often referred to as the “parent” or “frame.” In a Delphi MDI application, the frame is always the application’s main form.

Within the frame window other windows, often called “child” windows, can be opened. Each child window appears and behaves the same way. The application documents, or other data, are opened inside the child windows. These documents can all be of the same format, or they can be a mix of file formats supported by the MDI application.

At design time, you create the MDI frame form as the main application form, and you create the child form as a template for the application’s child windows. You can create more than one type of child form, but MDI applications support only one frame form.

This section describes the following steps involved in creating a basic MDI application for text manipulation:

- Creating the MDI frame form
- Creating the MDI child form
- Creating the application menus
- Merging the application menus
- Creating child windows at run time

You’ll want to save your work periodically as you follow the steps this chapter outlines.

Creating the MDI frame form

In an MDI application, the frame window provides a workspace for the application documents, which open inside one or more child windows. Creating a frame form is the first step in building the text editor application.

➤ If necessary, start Delphi. Then, choose File | New Project, and select the Blank project.

The FormStyle property

The *FormStyle* property determines whether the form is a frame or child form (or a non-MDI application form). You set the *FormStyle* property only at design time.

■ To create an MDI frame form, select the main form and use the Object Inspector to set its *FormStyle* property to *fsMDIForm*.

There can be only one MDI frame form per application.

Caution You can set any form's *FormStyle* property to *fsMDIForm*, but your application will not be compiled correctly if you do so for a form that is not specified as the application's main form. To verify or change the application's main form, choose Options | Project and select the Forms page.

➤ For the purposes of the text editor application, set the values of the *FormStyle*, *Caption*, and *Name* properties as indicated in Table 10.1.

Table 10.1 Text editor property values

Property	Value
Name	FrameForm
Caption	*Text Editor*
FormStyle	fsMDIForm

Creating the MDI child form

You create child forms at design time as templates for the appearance of each instance of the child window that the user opens at run time. Since child windows are visible by default, your code needs to explicitly create them at run time, rather than allowing Delphi to automatically create them when the application first runs. The section "Creating child windows at run time" on page 285 discusses how to do so.

The text editor application, for example, creates an instance of the text editor (child) form every time the user chooses File | New. This instance reads its initial state from the image in the form's .DFM file. (For more information about the .DFM file, refer to Chapter 1.)

The following procedure sets the form property for an MDI child window, and removes the MDI child form from the form Auto-Create list.

Caution You can set any form's *FormStyle* property to *fsMDIChild*, however your program won't be compiled correctly if you do so for the application's main form. To verify or change the application's main form, choose Options | Project and select the Forms page.

- To create an MDI child form,

1. Choose File | New Form, and choose the Blank form option.
2. Use the Object Inspector to set the new form's *FormStyle* property to *fsMDIChild*.
3. Choose Options | Project to access the Forms Auto-Create list.
4. In the Auto-Create forms list, select the MDI child form.
5. Click the > key to move the MDI child form into the Available forms list, and choose OK to exit the dialog box.

Note The text editor application uses just one type of child form, but you can have any number of different types of child windows in an MDI application. If your application uses multiple types of child windows, you'll generally want to remove them from the Auto-create forms list, as just described, and write code that specifically creates them at runtime. If, however, your application will use only one instance of each type of child form, it's probably better to let Delphi create them for you.

➤ For the purposes of the text editor application, create a new form and set the values of its *FormStyle*, *Caption*, and *Name* properties as indicated in Table 10.2. Then remove *EditForm* from the project's Auto-Create forms list, as described in the previous procedure.

Table 10.2 Child form property settings for the text editor example

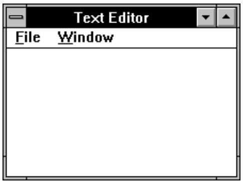
Property	Setting
Name	EditForm
Caption	< blank>
FormStyle	fsMDIChild

Creating the application menus

The frame form menu bar serves as the main application menu. If the child form contains a menu bar, any menu items on it merge into the frame form's menu when a child window has focus at run time.

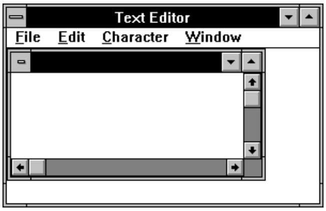
For example, Figure 10.2 shows the text editor menu as it appears when the application first runs, with no child windows open:

Figure 10.2 Text editor application menu with no child windows open



The File and Window menu items exist in the frame form, because they control functions of the frame, rather than functions specific to a particular child window. When the user opens a child window by choosing File | New or File | Open, the application menu changes to include two new menu options, as shown in Figure 10.3:

Figure 10.3 Text editor application menu with child window open



The Edit and Character menu items exist in the child form, because they control functions specific to the child window and its contents. These menu items merge with the frame form's menu items to present one application menu, with options appropriate to the current condition of the application.

Note While most MDI applications merge frame and child menus, you can also choose to replace menus, rather than merging them.

You'll use the Delphi Menu Designer to create the text editor application menus. If you do not know how to use the Menu Designer, see Chapter 3.

Creating the frame form menu

The menu items in the text editor frame form provide users with various ways to manipulate child windows in the running application.

➤ Create the File and Window menus for the text editor frame form, as shown in Table 10.3. For each menu item, specify a value for the *Caption* property, and accept the values Delphi then creates for the *Name* property.

Table 10.3 Frame form menu items

&File	&Window
&New	&Tile
&Open ...	&Cascade
– <hyphen>	&Arrange Icons
E&xit	

Note that specifying a hyphen for the caption (below the *Open1* menu item on the file menu) creates a separator bar. In later sections you'll set additional properties for the frame form menu.

Creating the child form menu

The menu items in the text editor child form provide users with ways to manipulate text in the running application. At run time, the File menu in *EditForm* completely replaces the File menu in *FrameForm*. Instead of creating a new File menu, however, you'll use the File menu template provided with Delphi.

➤ To create the *EditForm* menu, add the Delphi File menu template, and then create the remaining menu items shown in Table 10.4. For each menu item, specify values for the

Caption property, and accept the default value that Delphi then generates for the *Name* property. For the Edit menu, specify values for the *ShortCut* property.

Table 10.4 Child form menu items

&Edit	(Edit menu Shortcut keys)	&Character
Cu&t	Ctrl+X	&Left
&Copy	Ctrl+C	&Right
&Paste	Ctrl+V	&Center
De&lete	Ctrl+D	– <hyphen>
– <hyphen>		&Word Wrap
Select &All		– <hyphen>
		&Font ...

In later sections you'll set additional properties for this menu.

You should now have a frame form and a child form for the MDI application, each with its respective menu bar. The following section discusses how these two menus interact at run time.

➤ Save the project now. Use the following names:

Table 10.5 Naming the project files

Default name	Save as
UNIT1.PAS	MDIFRAME.PAS
UNIT2.PAS	MDIEDIT.PAS
PROJECT1.DPR	TEXTEDIT.DPR

Merging the application menus

MDI child windows do not always have their own menus, but when they do (as in this example) these menus often interact during run time with the application's main menu bar. This is known as merging menus. Merging menus is discussed in detail in Chapter 3.

When the text editor first opens, and no child window is open, only the *FrameForm* menu items are available. Once the user opens a child window by choosing File | New, the *EditForm* menu items merge into the frame form's menu bar. This happens automatically in a Delphi MDI application.

The way that menu items merge is determined by the *GroupIndex* property.

➤ Set the *GroupIndex* property for each form's menu titles as noted in Table 10.6. To do so, either open the Menu Designer or select each menu item from the Object selector in the Object Inspector.

Table 10.6 GroupIndex property settings

Form	Menu title	GroupIndex setting
FrameForm	File	0
FrameForm	Window	9
EditForm	File	0
EditForm	Edit	1
EditForm	Character	1

Assigning both File menu titles a *GroupIndex* value of 0 causes the *EditForm* File menu to replace the *FrameForm* File menu at merge time and ensures that the File menu always appears first, whether or not the menus are merged. Assigning the Window menu title a GroupIndex a value of 9 ensures that the Window menu always appears last (because the number 9 exceeds the total number of merged menu items).

Assigning the Edit and Character menu items identical *GroupIndex* values maintains their order in the merge, and the value of 1 in this case inserts them after the File menu. If the frame form had a menu item with a value of 1, the Edit and Character menu items would, as a unit, replace it.

The following section describes how to create your application's child windows at run time.

Creating child windows at run time

Now that you have created the child form and its menus, you're ready to write the code that generates an instance of *EditForm* at run time. You do this by calling the *Create* method of *EditForm*.

In the text editor application, when the new child window is created to contain a new document or to display an existing one, the *EditForm* File menu replaces the *FrameForm* File menu. This is part of the menu merging mentioned previously. Because of this, you need to handle the File | New and File | Open events separately for each menu.

➤ Write the following event handler for the *OnClick* event of the File | New item on the *FrameForm* menu bar (be sure to name the handler *NewChild*, rather than accepting the default name Delphi generates):

```
procedure TFrameForm.NewChild(Sender: TObject);
var
  EditForm: TEditForm;                           {declare the child form as a variable}
begin
EditForm := TEditForm.Create(Self);                     {create the new child window}
end;
```

Opening a new document won't vary much—you can simply point back to the original event handler in *FrameForm*. Opening an existing file involves a bit more, and is discussed under "Using the OpenDialog component" on page 297.

➤ Write the following event handler for the *EditForm* File | New click:

```
procedure TEditForm.New1Click(Sender: TObject);
begin
  FrameForm.NewChild(Sender);
end;
```

Referencing other units

If you try to compile the application now, Delphi generates an "Unknown identifier" error message. If you want to reference anything declared in another form's unit, you need to add the form to the referencing form's **uses** clause. In this case it's actually *EditForm* itself that *FrameForm* doesn't recognize.

➤ Add *MDIEdit* to the **uses** clause in the **interface** section of the *MDIFrame* unit:

```
uses Sysutils, ... Menus, MDIEdit;
```

By the same token, if you run the application now, you get the same error message for the *FrameForm* reference in *EditForm*'s *New1Click* method.

➤ Create the following **uses** clause in the **implementation** part of the *MDIEdit* unit:

```
uses MDIFrame;
```

Note When two units reference each other, placing both unit references in the **uses** clause of the **interface** part causes a circular reference. That is why you wrote a **uses** clause in the **implementation** part of *MDIEdit*, instead of editing the existing **uses** clause in the **interface** part. For more information, refer to Chapter 5.

➤ Try the following:

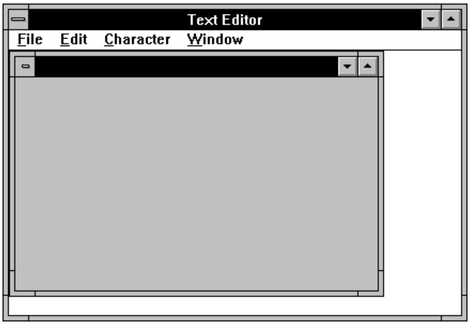
1 Run the application.

Even though you've created the child form, it doesn't appear initially because you removed it from the Auto-create forms list.

2 Choose File | New Form.

You've just called the event handler that instantiates the child form at run time, and the child window appears.

Figure 10.4 Open child window



3 Close the running application.

The application as it's written doesn't provide any way to easily navigate among multiple open child windows. The following section discusses how to accomplish this.

Working with open child windows

Now that your application can respond to the File | New menu command by creating a new child window, you can begin writing code that works with open child windows.

In the text editor application, when a child window is opened, the *EditForm* menu bar merges into the *FrameForm* menu. Commands from the *EditForm* File menu, such as printing, saving, and closing files, become available. Commands on the *FrameForm* Window menu provide a way to arrange and navigate among the open child windows.

This section describes the following topics:

- Arranging and accessing open child windows
- Providing an area for text manipulation

Arranging and accessing open child windows

MDI applications provide the ability to open several child windows within one common workspace (the frame window). Because of this, MDI applications should always include a Window (or other) menu item that contains

- Tile, Cascade, and Arrange Icons commands to offer users an easy way to arrange their open documents in the client area of the frame window.
- A list of the open document windows, which enables users to quickly switch among them. (The window that currently has focus appears in the list with a check mark next to it.)

You've already created the Window menu for the text editor application. Enabling the Tile, Cascade, and Arrange Icons commands requires just a few lines of code. Similarly, providing a list of open documents as part of the Window menu requires only that you set a property. Both of these procedures are described in the next section.

Coding the Window menu commands

➤ To handle the clicks for the Tile, Cascade, and Arrange Icons menus commands, generate the following *OnClick* event handlers, assigning each handler to the appropriate command. For each event handler, you need write only one line of code—a method call—and Delphi does the rest for you.

```
procedure TFrameForm.Tile1Click(Sender: TObject);
begin
  Tile;                                                   {this is the only code you write}
end;

procedure TFrameForm.Cascade1Click(Sender: TObject);
begin
  Cascade;                                                {this is the only code you write}
end;
```

```
procedure TFrameForm.ArrangeIcons1Click(Sender: TObject);
begin
  ArrangeIcons;                                          {this is the only code you write}
end;
```

Including a list of open documents in a menu

You can add a list of open documents to any menu item that appears on a menu bar in the MDI form. However, there can be only one such list per menu bar. The list of open documents appears underneath the last item in the menu.

To include a list of open documents as part of a menu, set the frame form's *WindowMenu* property to the name (not the caption) of the menu under which you want the list to appear. The following procedure describes this process.

■ To include an open document list in a menu,

1 Select the frame form, and then select the Properties page of the Object Inspector.
2 From the drop-down list next to the *WindowMenu* property, select the name of the menu item under which you want the open document list to appear (for example, a Window or View menu).

Note This name must represent an item that appears on the menu bar, not a submenu item, because document lists cannot be used in nested menus.

➤ For the text editor application, assign *Window1* to *FrameForm*'s *WindowMenu* property.

Providing an area for text manipulation

Once you've created a child form for text editors, and a frame form to contain the child forms and provide a means of navigating them, you need to provide an area where the user can manipulate text. You do this by adding a Memo component to the child form.

Adding the Memo component

The Memo component can be used in an application to read and display multiple lines of text, whether that text is loaded in from an existing file, pasted from the Clipboard, or entered by the user. You can set properties of the Memo component to enable word wrapping, provide scroll bars, and control the border style and alignment of the memo within the form.

➤ Add a Memo component to *EditForm*, and set its properties as noted in Table 10.7.

Table 10.7 Memo component settings

Property	Value
Align	alClient
BorderStyle	bsNone
ScrollBars	ssBoth
WordWrap	False

You now have a form with an area that can receive text. By setting several properties, you've ensured that the Memo component remains indistinguishable from the form at run time.

Setting the memo's *Align* property to a value of *alClient* ensures that the memo always fills the client area, or working space, of the form. The *bsNone* value of the *BorderStyle* property removes any border from within the Memo component.

Note Because the Memo component has been aligned to fill the client area, when you edit the form itself later in this chapter, you will access it by using the Object selector in the Object Inspector.

Manipulating text in a Memo component

Once the user can open a new text file, you want to provide some basic text manipulation operations, such as alignment, word wrapping, and cutting, copying, and pasting. This application uses event handlers for the *EditForm* menu items to provide these options. Depending on the current condition of the text, these menu items might change during run time—for example, a check mark might appear next to a menu item to indicate whether an option is selected, or a menu item might appear dimmed when it's not available. The text editor application also provides a local, or pop-up, menu that contains text manipulation commands such as Cut, Copy, and Paste.

This section discusses the following topics:

- Setting text alignment and word wrapping
- Selecting text
- Using the Clipboard with text
- Providing a pop-up menu

Setting text alignment and word wrapping

In the text editor application, users set text alignment and word wrapping options by means of commands on the Character menu. A check mark appears next to the menu command to indicate which options are in effect.

Alignment and *WordWrap* are properties of the Memo component. As with all properties, you can set their values during run time with a simple assignment statement. *Checked* is a *Boolean* property for menu items: If *Checked* is *True*, then a check mark appears next to that menu item.

Setting text alignment

An example of using the *Sender* parameter is discussed in Chapter 3. The text alignment commands on the *EditForm* Character menu have a single event handler that uses the *Sender* parameter to check which alignment option was selected. Depending on the value of *Sender*, the event handler sets the appropriate alignment, and either checks or unchecks the menu items as called for.

Here is the event handler:

```
procedure TEditForm.AlignClick(Sender: TObject);
begin
  Left1.Checked := False;
  Right1.Checked := False;
  Center1.Checked := False;
with Sender as TMenuItem do Checked := True;
  with Memo1 do
    if Left1.Checked then
      Alignment := taLeftJustify
    else if Right1.Checked then
      Alignment := taRightJustify
    else if Center1.Checked then
      Alignment := taCenter;
end;
```

➤ Write the *OnClick* event handler for the Character | Left menu item, as shown. Then associate the same event handler with both the Right and Center menu items on the Character menu. (For more information see Chapter 3.)

➤ You can test the application at this point if you like. Run the application and experiment with opening and arranging new child windows, and entering and aligning text.

Adding scroll bars dynamically

Recall that you set the initial value of the *ScrollBars* property for the Memo component at design time. When the application first runs, the memo contains both vertical and horizontal scroll bars, and word wrap is not selected. If the user selects word wrap, then only the vertical scroll bar remains, as there is no need to scroll to the right because text wraps within the current size of the Memo component.

The *OnClick* event handler for the Character | WordWrap command sets the value of the Memo component's *WordWrap* property as a toggle. In other words, whenever the user selects the WordWrap command, the value of the *WordWrap* property changes to its inverse. If WordWrap was *True*, it becomes *False*; if *False*, it becomes *True*. The event handler adds either vertical scroll bars, or both vertical and horizontal scroll bars to the Memo component based on the value of the *WordWrap* property. Finally, it sets the *Checked* property to the value of the *WordWrap* property: if WordWrap is *True*, then the *Checked* property is also set to *True*.

➤ Write the following *OnClick* event handler for the Character | WordWrap menu item:

```
procedure TEditForm.SetWordWrap(Sender: TObject);
begin
  with Memo1 do
  begin
    WordWrap := not WordWrap;
    if WordWrap then
      ScrollBars := ssVertical else
      ScrollBars := ssBoth;
    WordWrap1.Checked := WordWrap;
  end;
end;
```

Using the Clipboard with text

Most text-handling applications provide users with a way to move selected text between documents, including documents in different applications. The *Clipboard object* in Delphi encapsulates the Windows Clipboard and includes methods that provide the basis for operations such as cutting, copying, and pasting text (and other formats).

The Clipboard object is declared in the CLIPBRD.PAS unit file. Before you can access methods declared in the Clipboard object, you need to add CLIPBRD.PAS to any units that will use those methods. In the text editor application, only the *MDIEdit* unit calls methods of the Clipboard object.

➤ Add *Clipbrd* to the **uses** clause in the *MDIEdit* unit's **interface** part.

Selecting text

Before you can send any text to the Clipboard, the text must be selected. The function of reading and displaying selected text is native to the Memo and Edit components. In other words, you don't need to write code so that the Memo component can display selected text; it comes with this behavior.

The *Stdctrls* unit in Delphi provides several methods to work with selected text. (Recall that Delphi automatically adds the *Stdctrls* unit to the **uses** clause of any unit whose form contains a component declared within *Stdctrls*.) *SelText*, a run-time only property, contains a string based on any text selected in the component. The *SelectAll* method selects all the text in the memo or other component. The *SelLength* and *SelStart* methods return values for a selected string's length and starting position, respectively.

The text editor application uses *SelLength* to determine whether the Memo component contains any selected text, and then sets the condition of the Edit menu items accordingly. This is discussed in the section "Dimming menu items" on page 292. *SelStart* is discussed in the section "Loading the file" on page 300.

➤ Write the following handler for the Edit|Select All *OnClick* event:

```
procedure TEditForm.SelectAll(Sender: TObject);
begin
  Memo1.SelectAll;
end;
```

Cutting, copying, and pasting text

In Delphi, the *CopyToClipboard* method copies all selected text in a memo or edit component to the Clipboard; the *CutToClipboard* method cuts selected text from the memo or edit component and also places it on the Clipboard; and the *PasteFromClipboard* method copies all text currently on the Clipboard back to the location of the insertion point.

In the text editor application, these methods are called with *OnClick* event handlers for the Edit menu commands.

➤ Write the following *OnClick* event handlers for the Edit|Cut, Edit|Copy, and Edit|Paste commands, respectively:

```
procedure TEditForm.CutToClipboard(Sender: TObject);
begin
  Memo1.CutToClipboard;
end;

procedure TEditForm.CopyToClipboard(Sender: TObject);
begin
  Memo1.CopyToClipboard;
end;

procedure TEditForm.PasteFromClipboard(Sender: TObject);
begin
  Memo1.PasteFromClipboard;
end;
```

Deleting text without changing the contents of the Clipboard

The Edit menu also includes a Delete command that simply clears any selected text from the memo, without copying the text to the Clipboard. The event handler for the Edit | Delete command calls the *ClearSelection* method for *Memo1*.

➤ Write the following event handler for the Edit | Delete *OnClick* event:

```
procedure TEditForm.Delete(Sender: TObject);
begin
  Memo1.ClearSelection;
end;
```

➤ Save and run the application, then try cutting, copying, and pasting selected text. To demonstrate that the text you delete doesn't get copied to the Clipboard, delete some text and choose Edit | Paste again. The text that gets pasted into the memo corresponds to the last text copied or cut to the Clipboard, not the text you deleted.

Dimming menu items

Often in an application you want to prevent users from accessing certain menu commands based on current program conditions, but you don't want to remove the command from the menu altogether. In the text editor application, for example, if there is no text currently selected in the document, the Cut, Copy, and Delete items on the Edit menu appear dimmed.

You specify whether a particular menu command is available to the user by setting the *Boolean* value for its *Enabled* property. (In contrast to the *Visible* property, the *Enabled* property leaves the item visible: a value of *False* simply dims the menu item.)

As with most properties, you can specify the *Enabled* property's initial value by using the Object Inspector. The default value for this property is *True*.

In the text editor application, the *UpdateMenus* method sets the *Enabled* property for the Cut, Copy, and Delete menu items based on whether any text is selected in the memo. By contrast, it sets the *Enabled* property for the Paste command based on whether any text exists on the Clipboard.

UpdateMenus uses a Boolean variable, *HasSelection*, to reflect the value of the memo's *SelLength* property. If *SelLength* is not equal to zero (in other words, if the memo contains selected text), *HasSelection* stores *True*; otherwise, it stores *False*. The rest of the procedure assigns a value to the menu items' *Enabled* property based on the value of *HasSelection*.

➤ Open the Code Editor, and write the following method in the *MDIEdit* unit. This method will be called by another event handler (which you will write shortly), so you won't use the Object Inspector to generate it.

```
procedure TEditForm.UpdateMenus;
var
  HasSelection: Boolean;       {declare a variable that stores the results of the Boolean}
begin
  Paste1.Enabled := Clipboard.HasFormat(CF_TEXT);  {enable or disable the Paste menu item}
  HasSelection := Memo1.SelLength <> 0; {assign the value of the Boolean variable based on
                                                whether any text is selected in the Memo}
  Cut1.Enabled := HasSelection;  {enable the menu items if HasSelection evaluates to True}
  Copy1.Enabled := HasSelection;
  Delete1.Enabled := HasSelection;
end;
```

The *HasFormat* method of the Clipboard returns a Boolean value based on whether the Clipboard contains objects, text, or images of a particular format. By checking the value of the Boolean expression for *HasFormat* of type text (*CF_TEXT*), the *UpdateMenus* procedure enables the Paste menu item if the Clipboard contains any text, and disables the Paste item if the Clipboard does not contain text.

For more information about the *HasFormat* method, refer to online Help. For information about using the Clipboard object with graphics, refer to Chapter 12.

Declaring a method

If you compile the program now, Delphi generates a "Method identifier expected" error message. Because *UpdateMenus* wasn't generated by using the Object Inspector, Delphi didn't create the method declaration. In order for the program to recognize *UpdateMenus* as a valid method of the *TEditForm* class, you need to declare it yourself.

➤ Add the following line to the **private** part of the *TEditForm* type declaration in the **interface** part of the *MDIEdit* unit:

```
procedure UpdateMenus;
```

Declaring the method in the **private** part keeps other units from accessing this method. Because the MDIFrame unit has no reason to use this method (since it contains no such menus) it's good programming practice to keep it separate from the *MDIEdit* unit's sharable methods.

Calling a procedure from an event handler

The handler for the Edit menu item *OnClick* event consists of one line of code—a call to the *UpdateMenus* method you've just written. The *OnClick* event handler for the pop-up menu component, which you'll add later, calls this same method.

➤ Write the following handler for the Edit menu item's *OnClick* event:

```
procedure TEditForm.SetEditItems(Sender: TObject);
begin
```

```
    UpdateMenus;
  end;
```

Providing a pop-up menu

Pop-up, or local, menus are a common “ease of use” feature for any application. They enable users to minimize mouse movement by simply right-clicking anywhere in the application workspace to access a list of frequently used commands.

In the text editor application, for example, a pop-up menu repeats the Cut, Copy, and Paste commands. These pop-up menu items use the same event handlers as the items on the application’s main Edit menu.

➤ Add a PopupMenu component to *EditForm*, and use the Menu Designer to create the Cut, Copy, and Paste menu items. You don’t need to create any accelerator or shortcut keys for pop-up menus. Then attach the pop-up menu items to the event handlers for the corresponding menu items from the Edit menu.

Adding a pop-up menu and associating a menu item’s *OnClick* event with an existing handler are explained in Chapter 3.

Handling the OnPopup event

To complete the pop-up menu, you need to handle the menu component’s *OnPopup* event. This event handler calls the *UpdateMenus* procedure, as does the handler for the Edit menu title’s *OnClick* event, *SetEditItems*. In both cases, you need to call the event handler code when the user activates the menu. With a pop-up menu, however, there is no top-level menu bar, so to prepare the pop-up menu commands, you code the menu component itself.

First you need to add a few lines of code to *UpdateMenus*, one for each menu item in the pop-up menu. You simply duplicate the code you wrote for the equivalent items on the main menu—Cut, Copy, and Paste.

➤ Locate the *UpdateMenus* procedure in the Code Editor, and add the three lines of code as shown:

```
procedure TEditForm.UpdateMenus;
var
  HasSelection: Boolean;
begin
  Paste1.Enabled := Clipboard.HasFormat(CF_TEXT);
  Paste2.Enabled := Clipboard.HasFormat(CF_TEXT);                          {Add this line}
  HasSelection := Memo1.SelLength <> 0;
  Cut1.Enabled := HasSelection;
  Cut2.Enabled := HasSelection;                                            {Add this line}
  Copy1.Enabled := HasSelection;
  Copy2.Enabled := HasSelection;                                           {Add this line}
  Delete1.Enabled := HasSelection;
end;
```

Now you could simply associate the pop-up menu component’s *OnPopup* event with the *SetEditItems* event handler. The text editor, however, keeps each event handler separate, for the purpose of clarity. When the code is simple enough that duplicating it isn't a serious obstacle, sometimes it makes more sense to give distinct procedures their own names. This is one such example.

➤ Generate a new event handler called *SetPopupItems* for the PopUpMenu component's *OnPopup* event, that calls the *UpdateMenus* procedure.

```
procedure TEditForm.SetPopUpItems(Sender: TObject);
begin
  UpdateMenus;
end;
```

Specifying the pop-up menu for the form

If you ran the application now and tried to access the pop-up menu by right-clicking in the memo, nothing would happen. That's because you haven't told the form which pop-up menu to call in response to the right-click. The form has a *PopupMenu* property which you can use to specify which pop-up menu the form should call.

➤ From the Object selector, select *EditForm* and set its *PopupMenu* property to *PopupMenu1*. Try running the application again—choose File | New and right-click in the new child window.

The pop-up menu appears, and is fully functional. Note that because no text is selected, the Cut and Copy items appear dimmed. The condition of the Paste item indicates whether any text exists on the Windows Clipboard.

Using common dialog boxes

The dialog box components on the Dialogs page of the Component palette make the Windows "common" dialog boxes available to your Delphi applications. These dialog boxes provide all Windows-based applications with a familiar, consistent interface that enables the user to perform common file operations such as opening, saving, and printing files.

Each dialog box opens when its *Execute* method is called. *Execute* returns a Boolean value: if the user chooses OK to accept any changes made in the dialog box, *Execute* returns *True*; if the user chooses Cancel to escape from the dialog box without making or saving any changes, *Execute* returns *False*.

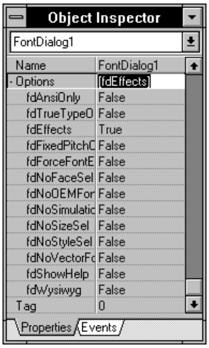
This section discusses the following topics:

- Common dialog box options in the Object Inspector
- Using the OpenDialog component
- Using the Save dialog box
- Saving the text file
- Using the Font dialog box
- Changing the font in the Memo component

Common dialog box options in the Object Inspector

In Delphi's implementation of the common dialog boxes, each dialog box (with the exception of the Printer Setup dialog box) includes an *Options* property. The available settings are presented as nested properties under the *Options* property. For example, the following figure shows the nested *Options* settings for the Font dialog box:

Figure 10.5 Font dialog box component options



Name	FontDialog1
- Options	[fdEffects]
fdAnsiOnly	False
fdTrueTypeO	False
fdEffects	True
fdFixedPitchC	False
fdForceFontE	False
fdNoFaceSel	False
fdNoOEMFor	False
fdNoSimulatic	False
fdNoSizeSel	False
fdNoStyleSel	False
fdNoVectorFc	False
fdShowHelp	False
fdWysiwyg	False
Tag	0

The following sections discuss several of the options for the dialog box components you'll use as you build the text editor application. Most of these options are unique to each dialog box. All the common dialog boxes share at least one option in common, however, which deserves special mention. For each dialog box, you can specify whether to display a Help button. If you choose to display a Help button, you need to enable it, so that when the user chooses the Help button at run time, the application's Help file is opened to a relevant topic.

The following section describes how to do this.

Enabling the Help button from a common dialog box

There are three steps to enabling a Help button from a common dialog box:

1. Display the button in the dialog box.
2. Specify a Help context for the dialog box component.
3. Specify the application Help file.

- To display a Help button in a common dialog box, set the *Options* | *ShowHelp* property to *True*.

The *ShowHelp* setting is a nested property under the *Options* property for most common dialog box components. For each dialog box component, the *ShowHelp* property is prefaced with initials particular to the component. For example, in the Font dialog box component, the *ShowHelp* property is called *fdShowHelp*—for Font Dialog.

- To specify a Help context for the dialog box component, enter a number in the *HelpContext* property.

This number must correspond to a Help topic in the application's Help file. For more information on developing Help files, see the online Help topic Creating Windows Help.

- To specify the application Help file,

1. Choose Options | Project.

   The Project Options multi-page dialog box appears.
2. Choose the Applications page tab.
3. In the Auxiliary files section, specify a Help file. Use the Browse button if necessary to locate the Help file.

For more information, see “Help file” and “Icon” on page 128 of Chapter 4.

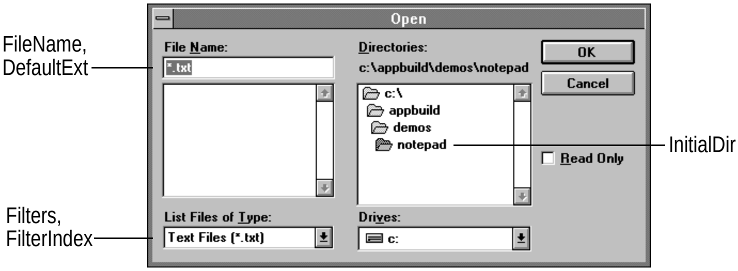
Using the OpenDialog component

In the text editor application, the handler for the *FrameForm* File | Open menu item *OnClick* event interacts with the Open dialog box to load a file. By setting initial values for several properties of the OpenDialog component, and writing a few lines of code, you can provide users with an interface consistent with other Windows-based applications, so they can easily view a list of available files and select a file to open.

OpenDialog component properties

The properties for the OpenDialog component correspond to areas of the dialog box, as shown in Figure 10.6.

Figure 10.6 OpenDialog component properties



File Name: *.txt

Directories: c:\appbuild\demos\notepad

List Files of Type: Text Files (*.txt)

Drives: c:

For the purposes of the text editor application, you’ll specify values only for the *Filter* property. For information about the other properties of the OpenDialog component, refer to online Help.

➤ Add an OpenDialog component to *FrameForm*. Name it *OpenFileDialog*.

Specifying file filters

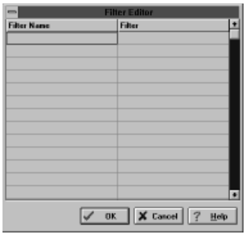
The List Files Of Type list box displays file types from which the user can select when specifying a file to open. Only those files with the specified extension and in the current directory are displayed in the list box. These file extensions are also known as *filters*.

To create such a list of filters, or valid file extensions, you set the *Filters* property for the Open dialog box. (For more information about creating file filters, see the online Help topic “Filter Editor.”)

The Filter property

The Open dialog box includes a property named *Filters*, which provides a quick way to specify both the types and the listed order of file filters. In the Filter editor, shown in the following figure, you specify a description and the file extension that you want to be associated with each file type.

Figure 10.7 The Filter editor



■ To specify file filters,

1 In the Object Inspector, double-click the Value column next to the *Filter* property, or click the ellipsis (...) button in the Value column.

2 Specify a filter name (for example, “Text”) and an associated file-name extension (for example, “*.TXT”) for each filter you want to use.

➤ Specify filters for the Open dialog box of the text editor, as shown in the following table:

Table 10.8 File filter settings for the text editor

Filter name	Filter
Text files (*.TXT)	*.TXT
All files	*.*

Note The order in which you enter filters is the order in which they then appear in the List File Of Type list box.

Opening an existing text file

Your application can already present a new window where the user can enter and manipulate text. Now you can continue by providing the ability to open existing files in a child window.

In the text editor application, you’ll write event handlers for both the *FrameForm* File | Open click and the *EditForm* File | Open click. As mentioned earlier, the event handler for the *EditForm* File | New click simply pointed to the event handler for the *FrameForm* File | New click. In a similar way, the *EditForm* File | Open click points back to the *FrameForm* File | Open click. Then, the *FrameForm* File | Open event handler calls an *Open* method that exists in the new child form.

By writing a generic handler at the application (*FrameForm*) level, you can reuse the event handler. For example, if you wanted to load other types of files, you could simply write a different *Open* method in the child form. You wouldn’t have to modify the *FrameForm* event handler.

➤ Write the following event handlers for the *EditForm* and *FrameForm* File|Open click events, respectively:

```
procedure TEditForm.Open1Click(Sender: TObject);
begin
  FrameForm.OpenChild(Sender);
end;

procedure TFrameForm.OpenChild(Sender: TObject);
var
  EditForm: TEditForm;
begin
  if OpenFileDialog.Execute then
  begin
    EditForm := TEditForm.Create(Self);
    EditForm.Open(OpenFileDialog.Filename);          {Calls the Open method of EditForm}
    EditForm.Visible := True;
  end;
end;
```

The event handler code for the File|Open click executes the Open File dialog box. If the user then selects a file to open, the *Execute* function returns a value of *True*, and the remaining code runs. The value of the file name specified by the user in the Open File dialog box is then passed as a parameter to the *Open* method.

The *Open* method exists in *EditForm*, which is why you need to qualify the method call.

If you try to compile the application now, Delphi generates an error message because the *OpenChild* event handler calls the *Open* method of *EditForm*, which you haven't written yet. In the following section, you'll write the *Open* method that loads the file the user selected in the Open File dialog box. First you need to declare a new field in the *MDIEdit* unit.

Declaring a form-level variable

The text editor application source code uses a form-level variable called *Filename* that you'll declare in the *MDIEdit* unit. *Filename* stores the value of the name for the text file that each child window can contain. The *Filename* variable is used in the *Open* method, and several other methods of *EditForm*—for example, those you write to save files and create backup files.

Previously, you added the *UpdateMenus* procedure to the **private** part of the *TEditForm* declaration in the *MDIEdit* unit's type declaration. Now you'll add the *Filename* field to that same part.

➤ In the **private** part of the *MDIEdit* unit's type declaration, add the following line:

```
Filename: string;
```

Caution As with all such field declarations, this line must precede any method declarations in the **private** part. Thus, the *Filename* declaration should immediately follow the reserved word **private** in the *MDIEdit* unit's type declaration.

When *EditForm* is instantiated (for example, through the *FrameForm.NewChild* procedure), *Filename* acts as a form-level variable of *EditForm*. Therefore, to access it from *FrameForm*, you'd need to qualify it (*EditForm.Filename*).

Compiling the application at this point still generates an error message because the*Open* method of *EditForm* does not yet exist. The following section discusses the writing and declaration of this method.

Loading the file

The *EditForm.Open* method uses the *LoadFromFile* method discussed in Chapter 9. In this case, the file being loaded corresponds to the value passed from the *FrameForm.OpenChild* method, which was the file the user selected from the Open File dialog box.

The *Open* method also uses a function, *ExtractFileName*, which takes a full file name, including the file-name extension and a path if specified, and returns only the file name and extension. For example, if the user used the Open File dialog box to specify a file such as: C:\WINDOWS\DELPHI\MYFILE.TXT, *ExtractFileName*, when passed that file as a parameter, returns only MYFILE.TXT.

Once the file is loaded into the memo, the *Open* method resets the value of the memo's *SelStart* property to zero. The *SelStart* property returns the starting position of the selected text, or the current cursor position if there is no text selected. By default, when lines are loaded into either an edit or a Memo component, *SelStart* gets the value of the last position of the lines, rather than the first. By setting *SelStart* to zero, the cursor appears where the user expects it— that is, at the beginning rather than the end of the file.

➤ First declare the *Open* method. Add the following line to the *TEditForm* type declaration section in the **interface** part of the MDIEdit unit:

```
procedure Open(const AFilename: string);
```

You declare the file name as a constant because its value won't be modified inside the method.

➤ Now write the *Open* method in the **implementation** part:

```
procedure TEditForm.Open(const AFilename: string);
begin
  Filename := AFilename;     {assigns the parameter passed from FrameForm.OpenChild to the
                                                                            form variable}
  Memo1.Lines.LoadFromFile(FileName);      {loads the file specified in the form variable}
  Memo1.SelStart := 0;
  Caption := ExtractFileName(FileName);        {displays the filename in the form caption}
  Memo1.Modified := False;
end;
```

Setting the memo's *Modified* property to *False* enables you to track any changes the user makes to the text file. This in turn gives you the opportunity to provide messages that prompt the user to save the file before closing.

Using the Save dialog box

Once users have created a new file, or modified an existing one, your code must enable them to save their work. You'll do this by means of a handler for the File|Save event.

In the text editor application, the event handler for the *FrameForm* File|Save menu command interacts with the Save As dialog box to save the file. If the file has never been saved, choosing File|Save opens the Save As dialog box, prompting the user to enter a file name. If the file has been saved (and therefore named), no dialog box appears when the user chooses File|Save, but the file is saved and a backup version of the file is created.

SaveDialog component properties

You use the Open dialog box to read from files, and the Save As dialog box to write to files. The properties for both dialog box components are identical. It follows that the properties for the SaveDialog component correspond to the areas of the dialog box in the same way as do those for the OpenDialog component. Refer to Figure 10.6.

For the purposes of the text editor application, you'll set the *Filter* property, which you also set for the OpenDialog component. You'll also set the *Options* property so that the Read Only check box isn't displayed in the dialog box—since setting read-only attributes would prevent users from saving the file—and so that read-only files cannot be overwritten.

➤ Add a SaveDialog component to *EditForm*, and set the properties as noted in Table 10.9.

Table 10.9 SaveDialog component properties

Property	Value
Filter	Text Files (*.TXT) | *.TXT | All Files (*.*) | *.*
Name	*SaveFileDialog*
Options	[*ofHideReadOnly,ofNoReadOnlyReturn*]

■ To set the *Options* property,

1. Double-click *Options* to view the members of the set.
2. Double-click in the Values column to change the Boolean value, or choose the value you want from the drop-down list.

➤ For the purpose of the text editor application, change the value for *ofHideReadOnly* and *ofNoReadOnlyReturn* to *True*.

Saving the text file

In the text editor application, saving a file is handled with three procedures:

- *Save1Click*, which is called when the user selects File|Save, whether for a new or existing file,
- *SaveAs1Click*, which is called when the user selects File|Save As, and
- *CreateBackup*, which is nested and called within *Save1Click*.

The outer block of the nested procedure, *Save1Click*, determines whether the file has been previously saved by checking for an existing value of *Filename*. (Recall that the code written so far assigns a value to *Filename* if the user opens an existing file. Otherwise, *Filename* remains empty.) If the user selects Save for an existing file, *Save1Click* calls the nested procedure, *CreateBackup*, which creates a backup version of the file. This is described in the next section. The remaining code in *Save1Click* then saves the file by calling the *SaveToFile* method.

If *Filename* is empty (or null), *Save1Click* calls the event handler for the Save As menu item click, *SaveAs1Click*. *SaveAs1Click* saves the file, using the file name that the user specifies in the Save As dialog box.

Note The user must enter a file name or the Save As dialog box does not close when the user chooses OK. This is a function of the dialog box, not of the event handler code.

➤ First write the method for the *EditForm* File|Save As click event:

```
procedure TEditForm.SaveAs1Click(Sender: TObject);
begin
  SaveFileDialog.Filename := Filename;         {display current value of Filename, if any}
  if SaveFileDialog.Execute then
  begin
    Filename := SaveFileDialog.Filename;
    Caption := ExtractFileName(Filename);
    Save1Click(Sender);
  end;
end;
```

If the file has already been named when the user selects Save As, *SaveAs1Click* displays the existing name in the File Name field of the Save As dialog box. Otherwise, what's displayed there corresponds to the *Filters* property of the dialog box, discussed earlier.

Next you'll write the *Save1Click* method called by *SaveAs1Click*.

Creating a backup file

The *EditForm* method for creating a backup file is part of the nested event handler for the File|Save click event, and is actually called by the outer program block. This kind of procedure is often called a "helper" or subroutine because it performs a subtask as part of a larger task.

CreateBackup calls three Visual Class Library methods: *ChangeFileExt*, *DeleteFile*, and *RenameFile*. *ChangeFileExt* has two formal parameters, *FileName* and *Extension*. In the text editor application, the *Extension* string parameter is replaced with a *BackupExt* constant.

➤ Write the following constant declaration in the **implementation** part of the *MDIEdit* unit:

```
const
BackupExt = '.BAK';
```

The *ChangeFileExt* method combines the name of the file and the backup extension (.BAK) into one string. *CreateBackup* assigns this string to a local variable, *BackupFilename*, which is then used to delete the existing file and rename it with the parameters specified in the *RenameFile* method.

➤ Write the following handler for the *EditForm* File | Save *OnClick* event:

```
procedure TEditForm.Save1Click(Sender: TObject);
  procedure CreateBackup(const Filename: string);
  var
    BackupFilename: string;
  begin
    BackupFilename := ChangeFileExt(Filename, BackupExt);
    DeleteFile(BackupFilename);
    RenameFile(Filename, BackupFilename);
  end;
begin
  if Filename = '' then
    SaveAs1Click(Sender)
  else
  begin
    CreateBackup(Filename);
    Memo1.Lines.SaveToFile(Filename);
    Memo1.Modified := False;
  end;
end;
```

The *SaveToFile* file-name parameter takes the value of the *Filename* variable whenever the user saves the file.

➤ Run the application and choose File | Open.

The Open File dialog box appears, displaying the file filters you specified at design time.

➤ Select a text file and choose OK.

The text file you specified opens inside the child window.

Using the Font dialog box

At design time, you can use the *Font* property of the Memo component or of the Font dialog box component, to set an initial font for text in the memo. Primarily, however, you need to provide a way for the user to select a font at run time. You might, for example, provide a menu list that interacts with the Font dialog box to provide a list of available fonts.

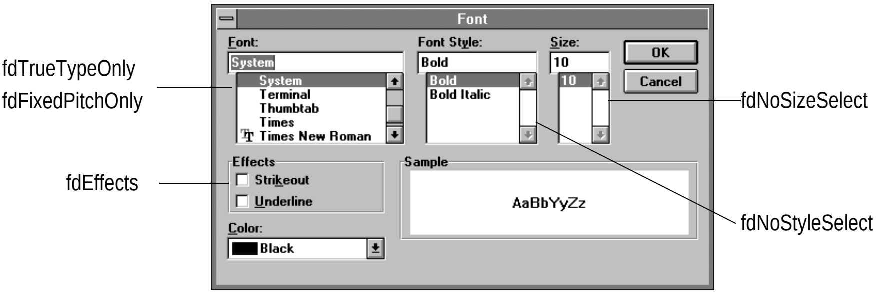
In the text editor application, the Character | Font command opens the Font dialog box, where the user can then select a font.

➤ Add a Font dialog box component to *EditForm*.

Font dialog box component properties

The properties available in the Object Inspector for the Font dialog box consist mainly of the settings in the Options drop-down list. These settings correspond to several areas of the Font dialog box in the running application, as shown in the following illustration.

Figure 10.8 Font dialog box component properties



Font:
System

Font Style:
Bold

Size:
10

Color:
Black

You can also edit the initial settings for the dialog box by selecting the *Font* property in the Object Inspector and clicking the ellipsis (...) button next to (TFont). This opens the dialog box in a design-time state.

For the purposes of the text editor application, you won't set any properties for the Font dialog box component at design time. For more information about the properties of the Font dialog box component not discussed here, refer to online Help.

Changing the font in the Memo component

The event handler for the Character | Font click creates a reflexive relationship between the Memo component and the Font dialog box: it ensures that the value of the memo's *Font* property is reflected in the dialog box, and that settings made from within the dialog box are reflected back into the memo.

The first time the user opens the Font dialog box in the text editor application, the default settings are displayed. To change this, change the *Font* property for the Memo component—not for the Font dialog box.

Note Any settings you make at design time to the Font dialog box are overridden by the Character | Font event handler. This is by design, because you generally don't want the dialog box to display anything other than default settings unless the user makes modifications from within the dialog box at run time.

➤ Write the following handler for the Character | Font *OnClick* event:

```
procedure TEditForm.SetFont(Sender: TObject);
begin
  FontDialog1.Font := Memo1.Font;
  if FontDialog1.Execute then
  Memo1.Font := FontDialog1.Font;
end;
```

➤ Test the event handler by running the application, opening a new file, and then choosing Character | Font to change the font.

Printing the text file

The Delphi *Printers* unit contains routines that provide your application with all the printing capabilities users expect. The printing functionality written into the text editor represents only a subset of what you can provide in your Delphi applications. In the text editor application, you'll enable users to print the contents of the text file, or to print selected text. When printing a selection, the first line of selected text will be printed left-aligned, even if, for example, the selected text starts mid-line. Subsequent lines will be printed left-aligned, as expected.

The following printing features are beyond the scope of the text editor application:

- WYSIWYG printing
- Printing multiple copies
- Collating multiple copies
- Printing page ranges
- Printing multiple fonts
- Printing word-wrapped text

The *Printers* unit declares an object, *TPrinter*, that acts as an interface between a print job and the output printer. The *AssignPrn* procedure, also declared in the *Printers* unit, directs your text file to the printer currently selected in the Print Setup dialog box.

Using the printer object

You call methods and set properties declared in the Printer object to control the way your application prints documents. These methods and properties interact with the Print and Printer Setup common dialog boxes.

The code for the File | Print *OnClick* event handler in the text editor application refers to only some of the printer object properties, as noted here. For information about the other methods refer to online Help.

Canvas

Canvas represents the surface of the currently printing document. You assign the contents of your text file to the *Canvas* property of the printer object. The printer object then directs the contents of the *Canvas* property (your text file) to the printer.

Fonts

Fonts represents the list of fonts supported by the current printer. These fonts appear in the Font list of the Font dialog box.

As described previously, any font selected from the Font dialog box is reflected back into the *Font* property for *Memo1*. However, the printer object has no such relationship to the Font dialog box or to the *Font* property for *Memo1*. Unless your program specifies otherwise, the printer uses the default (System) font that is returned by the Windows device driver to print your text file.

To change the printer's font, simply assign the *Font* property for *Memo1* to the *Font* property for the printer object's Canvas. This effectively downloads the selected font to the printer.

For example,

```
Printer.Canvas.Font := Memo1.Font;
```

Using the printer dialog box(es)

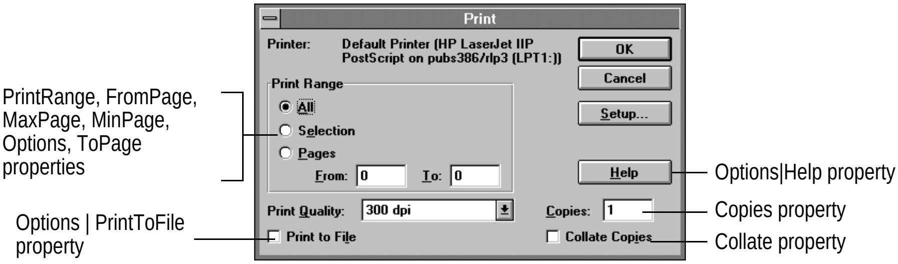
In the text editor application, the File | Print command opens the Print dialog box, where the user can then select printing options, or open the Printer Setup dialog box to change printers. The File Print Setup command also opens the Printer Setup dialog box.

➤ Add a Print dialog box component and a Printer Setup dialog box component to *EditForm*.

Print dialog box component properties

The properties available in the Object Inspector for the Print dialog box component correspond to several areas of the Print dialog box in the running application, as shown in the following illustration.

Figure 10.9 Print dialog box component properties



Printer: Default Printer (HP LaserJet IIP PostScript on pubs386/rlp3 (LPT1:))

Print Range: ● All ○ Selection ○ Pages From: 0 To: 0

Print Quality: 300 dpi

Copies: 1

□ Print to File

□ Collate Copies

Print
OK
Cancel
Setup...
Help
PrintRange, FromPage, MaxPage, MinPage, Options, ToPage properties
Options | PrintToFile property
Options|Help property
Copies property
Collate property

Although Delphi makes it easy to do so, you don't usually need to reset the default options for this dialog box at design time. There are, however, a few print options worth mentioning here.

MinPage / MaxPage

Use these settings to place an upper or lower limit on the number of pages the user can specify in the Pages From: and To: edit boxes. Note that any setting you make does not change what's displayed in the dialog box. If the user enters a number outside the range you specify and then presses *Enter*, the application displays an error message that says "From (or To) value is below (or above) the minimum (or maximum) range."

Options | poPageNums

A value of *True* enables the Pages From: and To: radio buttons, so the user can specify a page range. For example, you might set this to *True* at run time once you've determined that more than one page exists in the current document.

Options | poPrintToFile

A value of *True* adds the Print To File check box to the dialog box. (Your application code must provide the actual capability of printing to a file.)

Options | poSelection

A value of *True* enables the Selection radio button, so the user can print selected text. For example, you might set this to *True* at run time once you've determined that selected text exists in the current document.

PrintRange

The Print Range settings specify what appears as the Print Range default when the dialog box first opens. For example, a setting of PrintRange = *prPageNums* specifies that the Pages radio button is selected, instead of the All radio button. AllPages is the default setting.

Note that in order for either of the two non-default settings to take effect in the dialog box, the corresponding *Options* setting must be *True*. For example, if you set *PrintRange* to *prSelection* without also setting Options | Selection to *True*, the dialog box still opens with the default Print Range setting of AllPages.

Using the Printer Setup dialog box component

ChangeDefault is the only property displayed in the Object Inspector for the Printer Setup dialog box component that interacts with the dialog box in the running application. The run-time value of this property changes to *True* when the user selects a different printer setup.

The remaining settings in this dialog box and in the Options and Advanced Options dialog boxes write to and read from settings in the user's WIN.INI file. Therefore you won't write much code that interacts directly with this component, other than launching it. All the functions it provides after that are handled by Windows.

Handling the File | Print Setup *OnClick* event

The File | Print Setup *OnClick* event handler simply calls the Print Setup dialog box.

➤ Write the following handler for the *EditForm* File | Print Setup *OnClick* event:

```
procedure TEditForm.PrintSetUp1Click(Sender: TObject);
begin
  PrinterSetupDialog1.Execute;
end;
```

Directing your text file to the printer

The next few sections describe the parts of code that make up the File | Print *OnClick* event handler. You'll see how to write the complete event handler in "Printing the contents of the memo" on page 308.

Before you begin printing, you need to assign a text-file variable to the printer by calling the *AssignPrn* procedure. The File | Print *OnClick* event handler, *Print1Click*, declares a local variable, *PrintText*, for a file of type Text, as defined by the *System* unit. *Print1Click* then passes this variable as a parameter to the *AssignPrn* method.

Once you use *AssignPrn* to assign *PrintText* to the printer, any Write or Writeln statements sent to the file variable are then written on the printer object's canvas, using the *Canvas* property's font and pen position.

Here is the *AssignPrn* procedure call from the text editor application:

```
begin
  AssignPrn(PrintText);
  Rewrite(PrintText);
```

The call to *Rewrite* (a procedure in the *System* unit) actually creates and opens the output file.

The *AssignPrn* method is declared in the Delphi *Printers* unit, so you need to add *Printers* to *MDIEdit*'s **uses** clause.

➤ Add *Printers* to the uses clause in *MDIEdit*'s **interface** part. Here's what the **uses** clause should include at this point:

```
uses SysUtils, WinTypes, WinProcs, Classes, Messages, Graphics, Forms, Controls,
Printers, Dialogs, Menus, StdCtrls, Clipbrd;
```

You'll add two additional Delphi units before you complete the text editor application.

Downloading the text

When the printer is ready for input, you use a **for** loop to write the text from the memo to the printer. First, you declare a counter variable:

```
var
  Line: Integer;
```

Then you need to write a **for** loop to write the contents (*Lines* property) of *Memo1* to the printer. Here is the code that follows the call to *Rewrite* in the text editor application:

```
for Line := 0 to Memo1.Lines.Count-1 do
  Writeln(Printer1, Memo1.Lines[Line]);
```

The last line to be printed equals the number of lines in the memo, minus one, because the counting begins with zero as the first line.

The following section shows how all of these methods fit together into a single event handler for the *EditForm* File | Print *OnClick* event.

Printing the contents of the memo

All the code discussed in the preceding sections is used in the text editor application to handle the File | Print click event. This section shows the event handler in its entirety.

➤ Write the following handler for the *EditForm* File | Print *OnClick* event:

```
procedure TEditForm.Print1Click(Sender: TObject);
var
  Line: Integer;{declare an integer variable for the number of lines of text}
  PrintText: System.Text; {declare PrintText as text file defined in System unit}
begin
  if PrintDialog1.Execute then
```

```
    begin
      AssignPrn(PrintText);           {assign the global variable PrintText to the printer}
      Rewrite(PrintText);                                      {create and open the output file}
      Printer.Canvas.Font := Memo1.Font;{assign the current Font setting for Memo1 to the
                                                                    Printer object's canvas}
      for Line := 0 to Memo1.Lines.Count - 1 do
        Writeln(PrintText, Memo1.Lines[Line]);        {write the contents of the Memo to the
                                                                            printer object}
      CloseFile(PrintText);
    end;
  end;
```

Your application now has the ability to print a text file.

➤ Save and run the application, and test its printing capability.

Exiting gracefully

Applications that enable users to modify and save data into files should include safeguards so that users do not lose their work. The text editor application, for example, creates a backup file every time the user saves an existing file. Other important safety measures involve responding to a file or application close event—making sure that modified files are not closed without giving the user the option to save changes.

So far you've given users the ability to open, save, and print their text files—but not the ability to close them. In Delphi, closing a child window involves the same process as closing the main MDI application window. In both cases you use the *Close* method of *TForm*.

The *Close* method executes your form's *OnCloseQuery* event handler code, which returns a Boolean value for the *CanClose* parameter. If *CanClose* returns *True*, then the *Close* method executes your form's *OnClose* event handler code. You should ensure that the code you write for the *OnCloseQuery* event handles any changes made to the text file before the window closes.

This section discusses

- Closing a window
- Determining whether the file has been modified
- Exiting the application

Closing a window

In the text editor application, there are two menu items that call the *Close* method: File | Close, and File | Exit. File | Close closes the child window, and File | Exit closes *FrameForm*, which terminates the application (and indirectly closes all child windows).

Note that users can also close an application window in any of the following ways:

- Pressing *Alt+F4* from an MDI frame window (terminates the application)
- Pressing *Ctrl+F4* from an MDI child window (closes the child window)

- Double-clicking the Control-menu box (also known as the System menu)
- Choosing Close from the Control menu

All of these occurrences invoke *Form.Close* as well. In the text editor application, to handle any of these user actions, you'll write a handler for the edit form's *OnClose* event.

Closing the child window

The handler for the File | Close *OnClick* event exists in *EditForm*, so there is no need to specify which form should close.

➤ Write the following handler for the *EditForm* File | Close *OnClick* event:

```
procedure TEditForm.Close1Click(Sender: TObject);
begin
  Close;
end;
```

Now you'll write the handler that gets called when the user closes the form without using the File | Close command.

➤ Write the following handler for the *EditForm OnClose* event:

```
procedure TEditForm.FormClose(Sender: TObject; var Action: TCloseAction);
begin
  Action := caFree;
end;
```

This method closes the form and frees all memory allocated to it.

Determining whether the file has been modified

The *Close* method of *TForm* calls the *CloseQuery* method of *TForm*, as mentioned previously. *CloseQuery* returns a Boolean value for the variable *CanClose*, which determines whether to close the form.

The text editor application uses *CloseQuery* in conjunction with the *Modified* property of the memo to provide users with a message that asks them whether they want to save their changes. If the user cancels the message box, *CanClose* returns *False* and the form doesn't close.

The *MessageDlg* function, which is declared in the *Dialogs* unit, produces the message dialog box. (For more information about *MessageDlg*, refer to online Help.) *MessageDlg* calls the *Format* function, which exists in the *SysUtils* unit (automatically declared in the **uses** clause of *EditForm*'s **interface** part).

The text editor application uses a global constant to present the user's file name in the message dialog box, or "Untitled" if the file name has not already been saved.

➤ Declare the following global constant in the **implementation** part of the *MDIEdit* unit:

```
const
  SWarningText = 'Save Changes to "%s"?';
```

The *EditForm CloseQuery* method substitutes the "%s" wildcard with the value of the *Caption* property for the text file. Thus, if the user has previously saved the file, the file name is displayed.

➤ Write the following handler for the *EditForm OnCloseQuery* event:

```
procedure TEditForm.FormCloseQuery(Sender: TObject; var CanClose: Boolean);
var
  DialogValue: Integer;          {declare an integer variable to store the user's response
                                                                  to the message dialog}
  FName: string;                           {declare a string variable to store the value of
                                                              the file name when saving}
begin
  if Memo1.Modified then
  begin
    FName := Caption;       {save the value of the Caption property to the FName variable}
    if Length(FName) = 0 then
     FName := 'Untitled';                        {if there is no filename, use 'Untitled'}
    DialogValue := MessageDlg(Format(SWarningText, [FName]), mtConfirmation,
      [mbYes, mbNo, mbCancel], 0);                          {produce the message dialog box}
    case DialogValue of
      id_Yes: Save1Click(Self);     {Self parameter saves the instance of EditForm open at
                                         the time the user chooses Yes in the dialog}}
      id_Cancel: CanClose := False;       {if the user chooses Cancel, exit the dialog and
                                                  don’t close the form}
    end;
  end;
end;
```

Note that there is no need to provide a response if the user chooses No from the message dialog box, because the default value for *CanClose* is *True*— which means that the dialog box will close without saving the user’s changes.

Exiting the application

The File | Exit event handler calls the *Close* method of *TForm*, as does the File | Close event handler. In an MDI application, the *Close* method closes the window that has focus; if the focused window is the application’s main form, then the *CloseQuery* method of that form first iterates through all open MDI child windows to determine whether they can close. If any MDI child form’s *CanClose* value is *False*, then the MDI frame form won’t close. If every child form closes successfully (*CanClose* returns *True*), then the MDI frame form closes, and therefore the application terminates.

Since both the *EditForm* and *FrameForm* File menus have an Exit item, you need to write an event handler for each menu’s File | Exit *OnClick* event. Similar to the handlers for the File | New and File | Open clicks, the handler for *EditForm*’s File | Exit click simply calls *FrameForm*’s File | Exit click event handler.

➤ Write the following handler for the *EditForm* File | Exit *OnClick* event:

```
procedure TEditForm.Exit1Click(Sender: TObject);
begin
```

```
    FrameForm.Exit1Click(Sender);
  end;
```

➤ Writ e the following handler for the *FrameForm* File | Exit *OnClick* event:

```
procedure TFrameForm.Exit1Click(Sender: TObject);
begin
  Close;
end;
```

Summary

Delphi provides tools to help you quickly and easily create Multiple Document Interface applications, as well as several text-manipulation tools. This chapter discussed such text manipulation techniques as cutting, copying, and pasting text, using the Clipboard with text, and specifying a text font. In addition, the chapter presented such application-development techniques as creation of MDI frame and child windows and merging frame and child menus.

Chapter

11

Drawing graphics at run time

There are three ways to get graphic images into your Delphi applications: you can insert pre-drawn pictures at design time, create them using graphical controls at design time, or draw them dynamically at run time. This chapter describes how to draw graphics at run time, either on a window or on a custom control or owner-draw control. Design-time graphics, using image controls, are explained in Chapter 13.

When you draw graphics in a Delphi application, you draw on an object's*canvas*, rather than directly on the object. The canvas is a property of the object, and is itself an object with its own properties. The canvas object has four important properties: a pen for drawing lines, a brush for filling shapes, a font for writing text, and an array of pixels to represent the image.

The *Font* property is described in detail in Chapter 10. This chapter discusses how to use the pixel array, the pen, and the brush.

Canvases are available only at run time, so you do all your work with canvases by writing code.

To use graphics effectively at run time, you need to understand

- Drawing versus painting
- Using the pixel array
- Drawing lines and polylines
- Drawing shapes
- Drawing special parts

If you're already familiar with the graphics capabilities of Windows, you can probably go straight to the sample application in Chapter 12. You'll find that the canvas is easier to use than direct calls to the Windows Graphics Device Interface (GDI), while maintaining a high degree of compatibility.

While working through the sample application in Chapter 12, you might find it convenient to refer back to this chapter for specific techniques.

Drawing versus painting

When working with graphics, you often encounter the terms *drawing* and *painting*. It's important that you understand the difference between the two.

- Drawing is the creation of a single, specific graphic element, such as a line or a shape, with code. In your code, you tell an object to draw a specific graphic in a specific place on its canvas by calling a drawing method of the canvas.
- Painting is the creation of the entire appearance of an object. At certain times, Windows determines that objects onscreen need to refresh their appearance, so it generates *OnPaint* events. *OnPaint* events happen when, for example, a window that was hidden is brought to the front.

The thing to remember is this: *painting usually involves drawing*. That is, in response to *OnPaint* events, an object generally draws some graphics. An edit box, for instance, paints itself by drawing a rectangle and then drawing some text inside. A shape control, on the other hand, paints itself by drawing a single graphic.

The examples in this chapter demonstrate how to draw various graphics, but they do so in response to *OnPaint* events. The sample application in Chapter 12 shows how to do the same kind of drawing in response to other events.

Using the pixel array

Every canvas has an indexed property called *Pixels* that represents the individual colored points that make up the image on the canvas. You rarely need to access *Pixels* directly, unless you need to find out what color a particular pixel is or to set that pixel's color. It's more important to understand that *Pixels* is the drawing surface of the canvas, and that the pen and brush are just convenient ways to manipulate groups of pixels.

This section describes

- Manipulating pixels
- Using pens
- Using brushes

Manipulating pixels

You can treat the pixels of a canvas like a two-dimensional array, with each element in the array having a particular color. You can either read or set individual pixels.

Reading a pixel's color

■ To retrieve the color of a particular pixel, you access the *Pixels* property of the canvas, using as indexes the *x*- and *y*-coordinates of the pixel you want to read. The upper left corner of the canvas is the origin of the coordinate system.

For example, the following event handler responds to a click on a check box by changing the color of the text in the check box to the color of the pixel at the point (10, 10) in the form:

```
procedure TForm1.CheckBox1Click(Sender: TObject);
begin
  CheckBox1.Font.Color := Canvas.Pixels[10, 10];
end;
```

Setting a pixel's color

- To set a pixel's color, you assign a color value to the *Pixels* property, using as indexes the *x*- and *y*-coordinates of the pixel.

For example, the following event handler responds to a click on a button by changing a random pixel on the form to red. (For detailed information on the *Random* function, see online Help.)

```
procedure TForm1.Button1Click(Sender: TObject);
begin
  Canvas.Pixels[Random(ClientWidth), Random(ClientHeight)] := clRed;
end;
```

Using pens

The *Pen* property of a canvas controls the way lines appear, including lines drawn as the outlines of shapes. Drawing a straight line is really just changing a group of pixels that lie between two points.

The pen itself has four properties you can change: *Color*, *Width*, *Style*, and *Mode*.

The values of these properties determine how the pen changes the pixels in the line. By default, every pen starts out black, with a width of 1 pixel, a solid style, and a mode called copy that overwrites anything already on the canvas.

You can set the color of a pen as you would any other *Color* property at run time. *Width* is an integer number of pixels. *Style* gives you solid lines, dashed lines, dotted lines, and so on. *Mode* lets you specify various ways to combine the pen's color with the colors already in the pixel array.

The sample program in Chapter 12 demonstrates the effects of each pen property.

Moving the pen

The current drawing position—the position from which the pen will draw its next line—is called the pen position. The canvas stores its pen position in a property called *PenPos*. Pen position affects the drawing of lines only; for shapes and text, you specify all the coordinates you need.

- To set the pen position, call the *MoveTo* method of the canvas. For example, to move the pen position to the upper left corner of the canvas, you use the following code:

```
Canvas.MoveTo(0, 0);
```

Note Drawing a line with the *LineTo* method also moves the current position to the endpoint of the line.

Using brushes

The *Brush* property of a canvas controls the way you fill areas, including the interior of shapes. Filling an area with a brush is a way of changing a large number of adjacent pixels in a specified way.

The brush has three properties you can manipulate: *Color*, *Style*, and *Bitmap*.

The values of these properties determine the way the canvas fills shapes or other areas. By default, every brush starts out white, with a solid style and no pattern bitmap.

You can set the color of a brush as you would any other *Color* property at run time. *Style* lets you specify various ways to combine the brush's color with any colors already on the canvas. *Bitmap* lets you specify a bitmap image for the brush to use as a pattern for filling shapes and other areas.

The sample program in Chapter 12 demonstrates the effects of each brush property.

Drawing lines and polylines

A canvas can draw two kinds of lines: straight lines and polylines. A straight line is just a line of pixels connecting two points. A polyline is a string of straight lines, connected end-to-end. The canvas draws all lines using its pen.

Drawing straight lines

- To draw a straight line on a canvas, use the *LineTo* method of the canvas. *LineTo* draws a line from the current pen position to the point you specify and makes the endpoint of the line the current position. The canvas draws the line using its pen.

For example, the following method draws crossed diagonal lines across a form whenever the form is painted:

```
procedure TForm1.FormPaint(Sender: TObject);
begin
  with Canvas do
  begin
    MoveTo(0, 0);
    LineTo(ClientWidth, ClientHeight);
    MoveTo(0, ClientHeight);
    LineTo(ClientWidth, 0);
  end;
end;
```

An *OnPaint* event occurs whenever Windows determines that a form needs to be redrawn, such as when another window covers it and then goes away again. *FormPaint* is the default name Delphi generates for a handler for a form's *OnPaint* event. Handle

OnPaint events when you want to paint a background on a form or when you want to regenerate an image.

The rest of the examples in this chapter also do their drawing in *OnPaint* event handlers. As you construct the sample application in Chapter 12, you'll see how to draw on a canvas interactively.

Drawing polylines

In addition to individual lines, the canvas can also draw polylines, which are groups of any number of connected line segments.

■ To draw a polyline on a canvas, call the *PolyLine* method of the canvas. The parameter passed to the *PolyLine* method is an array of points. You can think of a polyline as performing a *MoveTo* on the first point and *LineTo* on each successive point.

The following method, for example, draws a rhombus in a form:

```
procedure TForm1.FormPaint(Sender: TObject);
begin
  with Canvas do
    PolyLine([Point(0, 0), Point(50, 0), Point(75, 50), Point(25, 50), Point(0, 0)]);
end;
```

This example takes advantage of Delphi's ability to create an open-array parameter "on the fly." You can pass any array of points, but an easy way to construct an array quickly is to put its elements in brackets and pass the whole thing as a parameter. For more information, see online Help.

Drawing shapes

Canvases have methods for drawing four kinds of shapes. The canvas draws the outline of a shape with its pen, then fills the interior with its brush.

There are three distinct kinds of shape drawing:

- Drawing rectangles and ellipses
- Drawing rounded rectangles
- Drawing polygons

Drawing rectangles, ellipses, and rounded rectangles are quite similar, but polygons are a little different.

Drawing rectangles and ellipses

■ To draw a rectangle or ellipse on a canvas, you call the canvas's *Rectangle* or *Ellipse* method, passing the coordinates of a bounding rectangle. The *Rectangle* method draws the bounding rectangle; *Ellipse* draws an ellipse that touches all sides of the rectangle.

The following method, for example, draws a rectangle filling a form's upper left quadrant, then draws an ellipse in the same area:

```
procedure TForm1.FormPaint(Sender: TObject);
begin
  Canvas.Rectangle(0, 0, ClientWidth div 2, ClientHeight div 2);
  Canvas.Ellipse(0, 0, ClientWidth div 2, ClientHeight div 2);
end;
```

Drawing rounded rectangles

To draw a rounded rectangle on a canvas, you call the canvas's *RoundRect* method. The first four parameters passed to *RoundRect* are a bounding rectangle, just as for *Rectangle* or *Ellipse*. *RoundRect* also takes two more parameters that indicate how to draw the rounded corners.

The following method, for example, draws a rounded rectangle in a form's upper left quadrant, rounding the corners as sections of a circle with a diameter of 10 pixels:

```
procedure TForm1.FormPaint(Sender: TObject);
begin
  Canvas.RoundRect(0, 0, ClientWidth div 2, ClientHeight div 2, 10, 10);
end;
```

Drawing polygons

■ To draw a polygon with any number of sides on a canvas, call the *Polygon* method of the canvas. Polygon takes an array of points as its only parameter and connects the points with the pen, then connects the last point to the first to close the polygon. After drawing the lines, *Polygon* uses the brush to fill the area inside the polygon.

To draw a right triangle in the lower left half of a form, for example, do the following:

```
procedure TForm1.FormPaint(Sender: TObject);
begin
  Canvas.Polygon([Point(0, 0), Point(0, ClientHeight),
    Point(ClientWidth, ClientHeight)]);
end;
```

Drawing special parts

In addition to all the lines and shapes described in this chapter, a canvas also provides some more specialized graphics capabilities, such as pie slices, arcs, and chords. You can also flood-fill regions and rectangles and copy images from other canvases. To see details on all the graphics you can draw on a canvas, see *TCanvas* component in online Help.

Summary

Delphi's canvas objects enable you to draw quickly and easily on a form at run time. You can use the same techniques to create images in owner-draw controls and other custom controls. Normally, you use the pen and brush properties of the canvas to create lines and shapes, but you can also manipulate individual pixels.

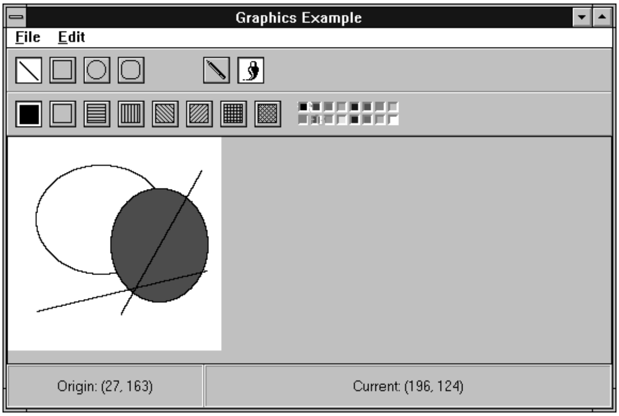
Chapter 12

Graphics example

This chapter presents all the steps to create a simple graphics application that draws lines and shapes on a window's canvas in response to mouse clicks and drags. Each section in the chapter builds on the previous sections, but the individual sections also explain discrete tasks.

To see the finished application, open the project GRAPHEX.DPR in the DEMOS\ GRAPHEX directory. Figure 12.1 shows the completed application.

Figure 12.1 The finished graphics program, GRAPHEX.EXE



The main steps involved in creating the program are

- Responding to the mouse
- Adding a field to a form object
- Refining line drawing
- Adding a tool bar to a form
- Adding speed buttons to a tool bar
- Responding to clicks

- Drawing with different tools
- Customizing pens and brushes
- Adding a status bar
- Drawing on a bitmap
- Adding a menu
- Printing graphics
- Working with graphics files
- Using the Clipboard with graphics

The basic graphics skills used in this chapter are explained in Chapter 11.

Responding to the mouse

There are four kinds of mouse actions you can respond to in your applications. Three of these are uniquely mouse actions: mouse-button down, mouse moved, and mouse-button up. The fourth kind of action, a click (a complete press-and-release, all in one place) is a bit different, as it can also be generated by some kinds of keystrokes (such as pressing *Enter* in a modal dialog box).

In this example, you'll respond to the unique mouse actions. You'll also see how clicks work when responding to tool-bar commands.

In this example, your application will draw shapes in response to clicks and drags: pressing a mouse button starts drawing and releasing the button ends the drawing. You'll also have the application draw a temporary "rubber-band" image of the drawing while the user moves the mouse with the button pressed.

Initially, you'll just draw lines. Later you'll use other drawing tools to draw shapes.

There are four important topics to understand about mouse events:

- What's in a mouse event?
- Responding to a mouse-down action
- Responding to a mouse-up action
- Responding to a mouse move

What's in a mouse event?

There are three mouse events defined in Delphi: *OnMouseDown*, *OnMouseMove*, and *OnMouseUp*.

When a Delphi application detects a mouse action, it calls whatever event handler you've defined for the corresponding event, passing five parameters. You use the information in those parameters to customize your responses to the events. The five parameters are as follows:

Table 12.1 Mouse-event parameters

Parameter	Meaning
Sender	The object that detected the mouse action
Button	Indicates which mouse button was involved: *mbLeft*, *mbMiddle*, or *mbRight*
Shift	Indicates the state of the *Alt*, *Ctrl*, and *Shift* keys at the time of the mouse action
X, *Y*	The coordinates where the event occurred

Most of the time, the most important information in a mouse-event handler is the coordinates, but sometimes you also need to check *Button* to determine which mouse button caused the event.

Note Delphi uses the same criteria as Microsoft Windows in determining which mouse button has been pressed. Thus, if you have switched the default "primary" and "secondary" mouse buttons (so that the right mouse button is now the primary button), clicking the primary (right) button will record *mbLeft* as the value of the *Button* parameter.

Responding to a mouse-down action

Whenever the user presses a button on the mouse, an *OnMouseDown* event goes to the object the pointer is over. The object can then respond to the event.

In this example, the user will press the mouse button with the pointer over the form itself, at which time the application starts drawing. So you need to define the form's response to *OnMouseDown* events.

■ To respond to a mouse-down action, you attach an event handler to the *OnMouseDown* event. If you're not sure how to create an event handler, see Chapter 2.

Delphi generates an empty handler for a mouse-down event on the form:

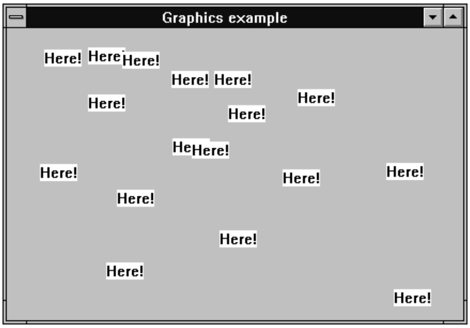
```
procedure TForm1.FormMouseDown(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin

end;
```

➤ Just to get a feel for writing a mouse-event handler, try displaying some text at the point where you press the mouse button. To do that, you use the *X* and *Y* parameters sent to the method, and call the *TextOut* method of the canvas to display text there:

```
procedure TForm1.FormMouseDown(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  Canvas.TextOut(X, Y, 'Here!');                              { write text at (X, Y) }
end;
```

If you run the application, you can press the mouse button down on with the mouse cursor on the form and have the string appear at the point clicked, as shown in Figure 12.2.

Figure 12.2 Drawing text at the point clicked



The application wouldn't be able to draw a line yet, because the user would only have pressed the mouse button. Pressing the button only tells the application where the drawing will start, and for a line you need both a starting point and an ending point.

➤ For now, you can change the mouse-down event handler to set the current drawing position to the coordinates where the user presses the button:

```
procedure TForm1.FormMouseDown(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  Canvas.MoveTo(X, Y);                                      { set pen position }
end;
```

Pressing the mouse button now sets the pen position, setting the line's starting point. You just need to draw a line to the point where the user releases the button. To do that, you'll need to respond to a mouse-up event.

Responding to a mouse-up action

An *OnMouseUp* event occurs whenever the user releases a mouse button. The event usually goes to the object the mouse cursor is over when the user presses the button, which is not necessarily the same object the cursor is over when the button is released. This enables you, for example, to draw a line as if it extended beyond the border of the form.

■ To respond to mouse-up actions, you define a handler for the*OnMouseUp* event. If you're not sure how to create an event handler, see Chapter 2.

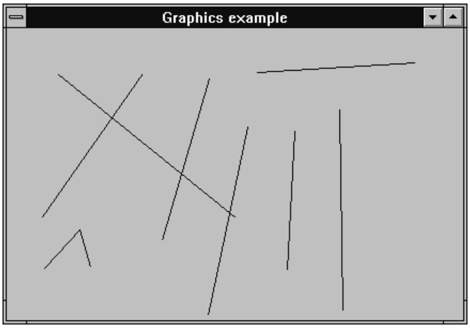
➤ In this example, you can draw a line to the point on the form where the user releases the mouse button.

Here's a simple *OnMouseUp* event handler that draws a line to the point of the mouse-button release:

```
procedure TForm1.FormMouseUp(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  Canvas.LineTo(X, Y);                                 { draw line from PenPos to (X, Y) }
end;
```

If you run the application, you can draw lines by clicking, dragging, and releasing, as shown in Figure 12.3.

Figure 12.3 Graphics application with lines drawn



Unfortunately, you can't see the line until you release the mouse button. In the next section you'll give the user some intermediate feedback by drawing temporary lines while the mouse moves.

Responding to a mouse move

An *OnMouseMove* event occurs periodically when the user moves the mouse. The event goes to the object that was under the mouse pointer when the user pressed the button.

■ To respond to mouse movements, you need to define the form's handler for the *OnMouseMove* event. If you're not sure how to define an event handler, see Chapter 2.

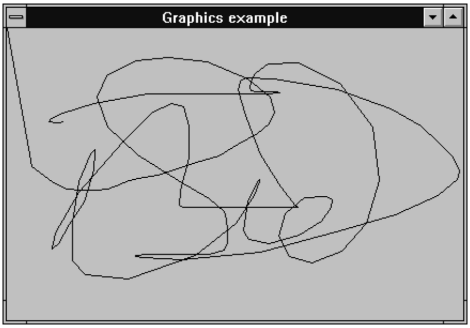
➤ In this example, you'll use mouse-move events to draw intermediate shapes while the user holds down the mouse button, thus providing some feedback to the user.

Here's a simple *OnMouseMove* event handler that draws a line on a form to the location of the *OnMouseMove* event:

```
procedure TForm1.FormMouseMove(Sender: TObject;Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  Canvas.LineTo(X, Y);                                   { draw line to current position }
end;
```

Note that if you run the application, moving the mouse over the form causes drawing to follow the mouse, even before you press a mouse button, as shown in Figure 12.4.

Figure 12.4 Graphics application following the mouse



Mouse-move events occur even when you haven't pressed the mouse button. You need to add code so the application acts on mouse-move events only when the mouse button is down.

To track whether there is a mouse button pressed, you need to add an object field to the form object.

Adding a field to a form object

When you add a component to a form, Delphi also adds a field that represents that component to the form object, and you can refer to the component by the name of its field. Component fields are explained in Chapter 6. You can also add your own fields to forms by editing the type declaration at the top of the form's unit.

In this example, the form needs to track whether the user has pressed a mouse button. To do that, you can add a Boolean field and set its value when the user presses the mouse button.

■ To add a field to an object, edit the object's type definition, specifying the field identifier and type after the **public** directive at the bottom of the declaration. Delphi "owns" any declarations before the **public** directive: that's where it puts the fields that represent controls and the methods that respond to events.

To give a form a field called *Drawing* of type *Boolean*, you edit the form object's declaration as follows:

```
type
  TForm1 = class(TForm)
    procedure FormMouseDown(Sender: TObject; Button: TMouseButton;
      Shift: TShiftState; X, Y: Integer);
    procedure FormMouseUp(Sender: TObject; Button: TMouseButton;
      Shift: TShiftState; X, Y: Integer);
    procedure FormMouseMove(Sender: TObject; Button: TMouseButton;
      Shift: TShiftState; X, Y: Integer);
  public
    Drawing: Boolean;                        { field to track whether button was pressed }
  end;
```

- ➤ You'll add several more fields to the graphics form as you work on this example. In fact, you're going to need two fields of type *TPoint*, so go ahead and add one called *Origin* and one called *MovePt* in addition to *Drawing*:

```
type
  TForm1 = class(TForm)
    procedure FormMouseDown(Sender: TObject; Button: TMouseButton;
      Shift: TShiftState; X, Y: Integer);
    procedure FormMouseUp(Sender: TObject; Button: TMouseButton;
      Shift: TShiftState; X, Y: Integer);
    procedure FormMouseMove(Sender: TObject; Button: TMouseButton;
      Shift: TShiftState; X, Y: Integer);
  public
    Drawing: Boolean;
    Origin, MovePt: TPoint;                                    { fields to store points }
  end;
```

- ➤ Now that you have the *Drawing* field to track whether to draw, you should set it to *True* when the user presses the mouse button, and *False* when the user releases it:

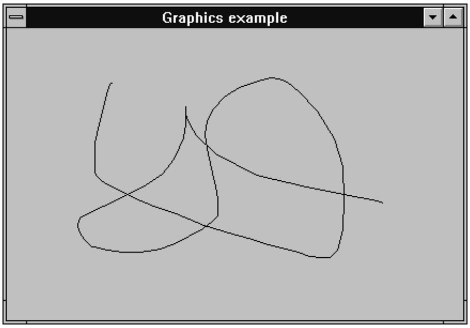
```
procedure TForm1.FormMouseDown(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  Drawing := True;                                             { set the Drawing flag }
  Canvas.MoveTo(X, Y);
end;

procedure TForm1.FormMouseUp(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  Canvas.LineTo(X, Y);
  Drawing := False;                                          { clear the Drawing flag }
end;
```

- ➤ Then you can modify the *OnMouseMove* event handler to draw only when *Drawing* is *True*:

```
procedure TForm1.FormMouseMove(Sender: TObject;Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  if Drawing then                                  { only draw if Drawing flag is set }
    Canvas.LineTo(X, Y);
end;
```

Now you get drawing only between the mouse-down and mouse-up events, but it's still not very useful. You still get a scribbled line that tracks the mouse movements instead of a nice, straight line, and no final line from the original point when you release the mouse button, as shown in Figure 12.5.

Figure 12.5 Line with lost origin



The problem is that each time you move the mouse, the mouse-move event handler calls *LineTo*, which moves the pen position, so by the time you release the button, you've lost the point where the straight line was supposed to start.

In the next section, you'll use the *Origin* and *MovePt* fields you added to track the starting and intermediate points.

Refining line drawing

Now that you have fields in place that can track various points, you can correct some of the problems introduced in the application. The first step is to track the line origin so you can draw the final line.

Tracking the origin point

The most important thing to track when drawing lines is the point where the line starts. As you saw earlier, you know where the line ends, because that's where the mouse-up event occurs. The *OnMouseUp* event handler needs to know where the line started, too. That's where the *Origin* field comes in.

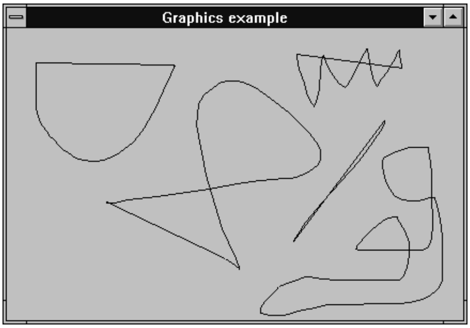
➤ Set *Origin* to the point where the mouse-down event occurs, so the mouse-up event handler can use *Origin* to place the beginning of the line:

```
procedure TForm1.FormMouseDown(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  Drawing := True;
  Canvas.MoveTo(X, Y);
  Origin := Point(X, Y);                                  { record where the line starts }
end;

procedure TForm1.FormMouseUp(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  Canvas.MoveTo(Origin.X, Origin.Y);                        { move pen to starting point }
  Canvas.LineTo(X, Y);
```

```
    Drawing := False;
  end;
```

Those changes get the application to draw the final line again, but what about the intermediate drawing?

Figure 12.6 Straight line with intermediate drawing



Tracking movement

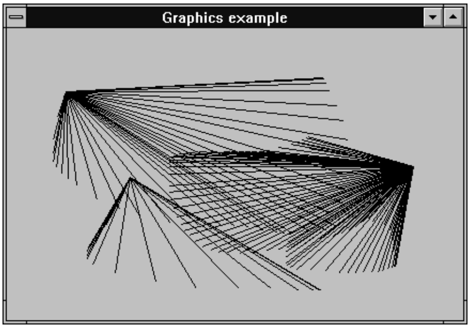
The problem with the *OnMouseMove* event handler as currently written is that while it draws a line to the current position of the mouse, it draws that line from the last mouse position, not from the original position.

➤ Now that the application tracks the origin, however, that's easy to correct. Move the drawing position to the origin point, then draw to the current point:

```
  procedure TForm1.FormMouseMove(Sender: TObject;Button: TMouseButton;
    Shift: TShiftState; X, Y: Integer);
  begin
    if Drawing then
    begin
      Canvas.MoveTo(Origin.X, Origin.Y);                      { move pen to starting point }
      Canvas.LineTo(X, Y);
    end;
  end;
```

That's better, in that you now get lines to the current mouse position. Unfortunately, the lines don't go away, so you can hardly find the final line.

Figure 12.7 Persistent intermediate lines



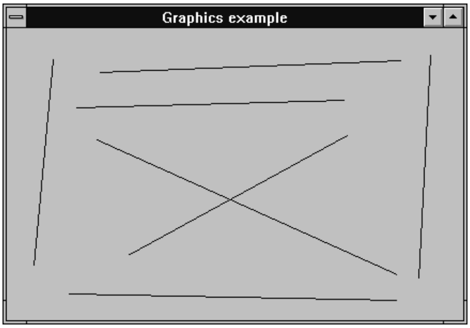
The trick is to erase each line before you draw the next one, and that means you need to keep track of where the previous one was. That's the purpose of the*MovePt* field you added earlier.

➤ Set *MovePt* to the endpoint of each intermediate line, so you can use*MovePt* and *Origin* to erase that line the next time a line is drawn:

```
procedure TForm1.FormMouseDown(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  Drawing := True;
  Canvas.MoveTo(X, Y);
  Origin := Point(X, Y);
  MovePt := Point(X, Y);                              { keep track of where this move was }
end;

procedure TForm1.FormMouseMove(Sender: TObject;Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  if Drawing then
  begin
    Canvas.Pen.Mode := pmNotXor;                             { use XOR mode to draw/erase }
    Canvas.MoveTo(Origin.X, Origin.Y);                          { move pen back to origin }
    Canvas.LineTo(MovePt.X, MovePt.Y);                              { erase the old line }
    Canvas.MoveTo(Origin.X, Origin.Y);                            { start at origin again }
    Canvas.LineTo(X, Y);                                              { draw the new line }
  end;
  MovePt := Point(X, Y);                                     { record point for next move }
  Canvas.Pen.Mode := pmCopy;
end;
```

Now you get a nice "rubber-band" effect when you draw the line. By changing the pen's mode to *pmNotXor*, you have it combine your line with the background pixels. When you go to erase the line, you're actually setting the pixels back to the way they were. By changing the pen mode back to *pmCopy* (its default value) after drawing the lines, you ensure that the pen is ready to do its final drawing when you release the mouse button.

Figure 12.8 Line after rubber banding



You've come a long way with your line drawing, and as you'll see shortly, it will all pay off when you want to draw different shapes, such as rectangles and ellipses. Before you can draw those shapes, however, you need to add a way for the user to choose which shape to draw. In the next section, you'll define a tool bar that provides those choices, then see how to respond to the tool bar's controls.

Adding a tool bar to a form

A tool bar is a panel, usually across the top of a form, below the menu bar, that holds a number of controls, especially buttons. Tool bars provide an easy, visible way to present options to users of your applications, and Delphi makes it easy to add tool bars to your forms.

■ To add a tool bar to a form,

1. Add a Panel component to the form.
2. Set the panel's *Align* property to *alTop*. When aligned to the top of the form, the panel maintains its height, but matches its width to the full width of the form's client area, even if the window changes size.
3. Add speed buttons or other controls to the bar.

You can add as many tool bars to a form as you want. If you have multiple panels aligned to the top of the form, they "stack" vertically in the order added.

➤ Add a tool bar to the graphics-example form and delete its caption. In the next section, you'll add buttons to the tool bar. Later in this example, you'll add more tool bars to the form, and see how to show and hide them at run time.

Adding speed buttons to a tool bar

Delphi provides buttons, called speed buttons, specially designed to work on tool bars. A speed button usually has no caption, only a small graphic called a glyph, which represents the button's function.

Speed buttons have three possible modes of operation. They can

- Act like regular pushbuttons
- Toggle on and off when clicked
- Act like a set of radio buttons

The graphics example uses some of each kind of speed button.

There are four tasks related to speed buttons on tool bars:

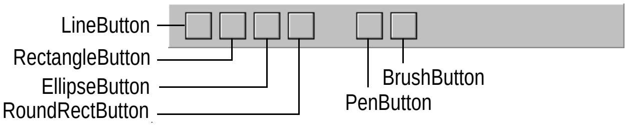
- Adding a speed button to a tool bar
- Assigning a speed button's glyph
- Setting the initial condition of a speed button
- Creating a group of speed buttons

Adding a speed button to a tool bar

■ To add a speed button to a tool bar, just place the speed button component on the panel that represents the tool bar. The panel, rather than the form, "owns" the speed button, so moving or hiding the panel also moves or hides the speed button.

➤ For the graphics program, add six speed buttons to the tool bar, arranged as shown in Figure 12.9, and change the *Name* property of each to the indicated text.

Figure 12.9 The tool bar with 6 buttons:



The default height of the tool bar is 41, and the default height of speed buttons is 25. If you set the *Top* property of each button to 8, they'll be vertically centered. The default grid setting snaps the speed button to that vertical position for you.

Assigning a speed button's glyph

Each speed button needs a graphic image called a *glyph* to indicate to the user what the button does. If you supply the speed button only one image, the button manipulates that image to indicate whether the button is pressed, unpressed, selected, or disabled. You can also supply separate, specific images for each state if you prefer.

You normally assign glyphs to speed buttons at design time, although you can assign different glyphs at run time.

■ To assign a glyph to a speed button at design time,

1 Select the speed button.

2 In the Object Inspector, select the *Glyph* property.

3 Double-click the Value column beside *Glyph*.

Delphi opens the Picture editor.

4 Choose Load in the Picture editor.

Delphi opens a file-open dialog box.

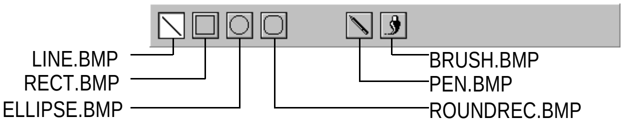
5 Select the .BMP file that contains the image you want on the button and choose OK.

The file-open dialog box closes, and the Picture editor displays the selected bitmap image.

6 Choose OK to close the Picture editor.

➤ Assign the appropriate glyphs to each speed button. Figure 12.10 shows the graphics example's tool bar with the file names for the glyphs for all the speed buttons. These files are all located in the same directory as the project files.

Figure 12.10 The tool bar buttons with glyphs assigned



Setting the initial condition of a speed button

Speed buttons use their appearance to give the user clues as to their state and purpose. Because they have no caption, it's important that you use the right visual cues to assist users.

■ • To make a speed button appear pressed, set its *Down* property to *True*.

■ • To make a speed button appear disabled, set its *Enabled* property to *False*.

Since the default drawing tool for this application is the line, you need to ensure that the line button on the tool bar is pressed when the application starts.

➤ Set *LineButton*'s *Down* property to *True*.

Creating a group of speed buttons

A series of speed buttons often represents a set of mutually exclusive choices. In that case, you need to associate the buttons into a group, so that clicking any button in the group causes the others in the group to pop up.

■ To associate any number of speed buttons into a group, assign the same number to each speed button's *GroupIndex* property. The easiest way to do that is to select all the buttons you want in the group, and with the whole group selected, set *GroupIndex* to a unique value.

Since the shape-drawing-tool buttons are mutually exclusive, you assign them to a group.

➤ Select the four shape-drawing tools (the four leftmost buttons), and set their *GroupIndex* to 1. Now when you run the application, you can click any tool's button, and all others pop up.

Allowing toggle buttons

Sometimes you want to be able to click a button in a group that's already pressed and have it pop up, leaving no button in the group pressed. Such a button is called a *toggle*. Use *AllowAllUp* to create a grouped button that acts as a toggle: click it once, it's down; click it again, it pops up.

- To make a grouped speed button a toggle, set its *AllowAllUp* property to *True*. Setting *AllowAllUp* to *True* for any speed button in a group automatically sets the same property value for all buttons in the group. This enables the group to act as a normal group, with only one button pressed at a time, but also allows the case with no button pressed.

➤ Both the pen and brush buttons in this example are single-button groups that act as toggles. Make sure each has its *AllowAllUp* property set to *True*, then set the *GroupIndex* properties of *PenButton* and *BrushButton* to 2 and 3, respectively.

Responding to clicks

When the user clicks a control, such as a button on a tool bar, the application generates an *OnClick* event. You handle those *OnClick* events by writing *OnClick* event handlers for your forms. In this section, you'll see how to respond to one such click event, and do something useful in response.

Responding to a button click

Speed-button components have only two events built into them: *OnClick* and *OnDblClick*.

- To respond to the user's click on a speed button, you define a handler for the button's *OnClick* event. If you're not sure how to generate an event handler, see Chapter 2.

By default, Delphi generates an *OnClick* event handler named after the control clicked. For example, the default *OnClick* event handler for a speed button named *LineButton* would be

```
procedure TForm1.LineButtonClick(Sender: TObject);
begin

end;
```

You then fill in the action you want to occur when the user clicks that button.

In this example, you'll write several kinds of responses to speed-button clicks. For the drawing-tool buttons, you'll select the appropriate drawing tool. For the pen and brush buttons, you'll display other tool bars.

Drawing with different tools

Now it's time to put some of the skills explained earlier to good use. Earlier sections have described adding fields to keep track of a state and how to respond to speedbutton clicks. In this section, you'll respond to clicks on speed buttons by setting the drawing tool for the form.

The next few sections demonstrate

- Declaring an enumerated type
- Changing the tool with speed buttons
- Using the drawing tools

Declaring an enumerated type

The graphics program needs a way to keep track of what kind of drawing tool you want it to use at any given time. You could assign numbers to each kind of tool, but then you would have to remember what each number stands for. You can do that more easily by assigning mnemonic constant names to each number, but your code won't be able to distinguish which numbers are in the proper range and of the right type. Fortunately, Object Pascal provides a means to handle both of these shortcomings. You can declare an *enumerated type*.

An enumerated type is really just a shorthand way of assigning sequential values to constants. Since it's also a type declaration, you can use Object Pascal's type-checking to ensure that you assign *only* those specific values.

■ To declare an enumerated type, you use the reserved work **type**, followed by an identifier for the type, then an equal sign, and the identifiers for the values in the type in parentheses, separated by commas.

For example, the following code declares an enumerated type for each of the drawing tools in a graphics application:

```
type
  TDrawingTool = (dtLine, dtRectangle, dtEllipse, dtRoundRect);
```

➤ Add the declaration of the *TDrawingTool* type above the declaration of the form class:

```
type                                                          { this is already there }
  TDrawingTool = (dtLine, dtRectangle, dtEllipse, dtRoundRect);        { you type this }
  TForm1 = class(TForm)                                       { this is already there }
  ⋮
```

By convention, type identifiers begin with the letter *T*, and groups of similar constants (such as those making up an enumerated type) begin with a 2-letter prefix (such as *dt* for "drawing tool").

The declaration of the *TDrawingTool* type is equivalent to declaring a group of constants:

```
const
  dtLine = 0;
  dtRectangle = 1;
  dtEllipse = 2;
  dtRoundRect = 3;
```

The main difference is that by declaring the enumerated type, you give the constants not just a value, but also a type, which enables you to use Object Pascal's type-checking to prevent many errors. A variable of type *TDrawingTool* can be assigned only one of the constants *dtLine..dtRoundRect*. Attempting to assign some other number (even one in the range 0..3) generates a compile-time error.

➤ You can now add a field to the form to keep track of its drawing tool:

```
type
  TDrawingTool = (dtLine, dtRectangle, dtEllipse, dtRoundRect);
  TForm1 = class(TForm)
    ⋮                                                            { method declarations }
  public
    Drawing: Boolean;
    Origin, MovePt: TPoint;
    DrawingTool: TDrawingTool;                              { field to hold current tool }
  end;
```

Since objects (including forms) initialize all their fields to zero, the drawing tool when you start the application is *dtLine*.

Changing the tool with speed buttons

Since you have already seen how to respond to speed-button click events, you can set up *OnClick* event handlers for all the drawing-tool buttons on the tool bar.

➤ Attach the following event handlers to the *OnClick* events of the four drawing-tool buttons on the tool bar, setting *DrawingTool* to the appropriate value for each:

```
procedure TForm1.LineButtonClick(Sender: TObject);                      { LineButton }
begin
  DrawingTool := dtLine;
end;

procedure TForm1.RectangleButtonClick(Sender: TObject);            { RectangleButton }
begin
  DrawingTool := dtRectangle;
end;

procedure TForm1.EllipseButtonClick(Sender: TObject);                { EllipseButton }
begin
  DrawingTool := dtEllipse;
end;

procedure TForm1.RoundedRectButtonClick(Sender: TObject);          { RoundRectButton }
begin
  DrawingTool := dtRoundRect;
end;
```

Now that you can tell the form what kind of tool to use, the only step left is to teach it how to draw the different shapes. The only methods that do any drawing are the mouse-move and mouse-up handlers, and the only drawing code draws lines, no matter what tool is selected.

Using the drawing tools

Now that the application has the ability to specify different drawing tools, you need to make the event handlers apply the tool the user selects, which you've stored in *DrawingTool*. Your code now needs to choose how to draw, based on the selected tool.

This section describes

- Making efficient choices
- Drawing the appropriate shapes
- Adding a method to a form

Making efficient choices

If you had only a few choices, you'd probably just rewrite the drawing methods to look something like this:

```
procedure TForm1.FormMouseUp(Sender: TObject);
begin
  if DrawingTool = dtLine then { draw a line }
  else if DrawingTool = dtRectangle then { draw a rectangle }
  { ... and so on ... }
end;
```

The comments like `{ draw a line }`, of course, represent blocks of statements such as those you wrote earlier to draw a line.

Once you get more than a few choices, though, this becomes tedious and inefficient. Fortunately, Object Pascal and Delphi offer an easier way to switch among alternatives, the **case** statement. Among other things, **case** statements make it easier to add new choices later.

The method shown above could be rewritten using a **case** statement instead of the **if**..**then**..**else** statements:

```
procedure TForm1.FormMouseUp(Sender: TObject);
begin
  case DrawingTool of
    dtLine: { draw a line }
    dtRectangle: { draw a rectangle }
    { ... and so on ... }
  end;
end;
```

Drawing the appropriate shapes

Drawing shapes is just as easy as drawing lines: Each one takes a single statement, and you've already got all the coordinates you need.

➤ Rewrite the *OnMouseUp* event handler to draw shapes for all the tools you've defined:

```
procedure TForm1.FormMouseUp(Sender: TObject);
begin
  case DrawingTool of
    dtLine:
        begin
          Canvas.MoveTo(Origin.X, Origin.Y);
          Canvas.LineTo(X, Y)
        end;
      dtRectangle: Canvas.Rectangle(Origin.X, Origin.Y, X, Y);
      dtEllipse: Canvas.Ellipse(Origin.X, Origin.Y, X, Y);
      dtRoundRect: Canvas.RoundRect(Origin.X, Origin.Y, X, Y,
                     (Origin.X - X) div 2, (Origin.Y - Y) div 2);
    end;
    Drawing := False;
  end;
```

Of course, you also need to update the *OnMouseMove* handler to draw shapes:

```
procedure TForm1.FormMouseMove(Sender: TObject; Shift: TShiftState; X, Y: Integer);
begin
  if Drawing then
  begin
    Canvas.Pen.Mode := pmNotXor;
    case DrawingTool of
      dtLine: begin
                Canvas.MoveTo(Origin.X, Origin.Y);
                Canvas.LineTo(MovePt.X, MovePt.Y);
                Canvas.MoveTo(Origin.X, Origin.Y);
                Canvas.LineTo(X, Y);
              end;
      dtRectangle: begin
                     Canvas.Rectangle(Origin.X, Origin.Y, MovePt.X, MovePt.Y);
                     Canvas.Rectangle(Origin.X, Origin.Y, X, Y);
                   end;
      dtEllipse: begin
                   Canvas.Ellipse(Origin.X, Origin.Y, X, Y);
                   Canvas.Ellipse(Origin.X, Origin.Y, X, Y);
                 end;
      dtRoundRect: begin
                     Canvas.RoundRect(Origin.X, Origin.Y, X, Y,
                       (Origin.X - X) div 2, (Origin.Y - Y) div 2);
                     Canvas.RoundRect(Origin.X, Origin.Y, X, Y,
                       (Origin.X - X) div 2, (Origin.Y - Y) div 2);
                   end;
    end;
    MovePt := Point(X, Y);
  end;
  Canvas.Pen.Mode := pmCopy;
end;
```

You probably notice that there is a lot of repeated code in those methods. In fact, the code to draw each shape appears three different times. This is a good example of a time when you should move repeated code into a separate routine. In the next section, you'll move all the shape-drawing code into a single method that both mouse-event handlers can call.

Adding a method to a form

Any time you find that a number of your event handlers use the same code, you can make your application more efficient by moving the repeated code into a method that all the event handlers can share.

■ To add a method to a form,

1 Add the method declaration to the form object.

You can add the declaration in either the **public** or **private** parts at the end of the form object's declaration. If the code is just sharing the details of handling some events, it's probably safest to make the shared method **private**.

2 Write the method implementation in the **implementation** part of the form unit.

The header for the method implementation must match the declaration exactly, with the same parameters in the same order.

➤ To get rid of repetitive shape-drawing code from mouse-event handlers, you can add a method to the form called *DrawShape* and call it from each of the handlers:

1 Add the declaration of *DrawShape* to the form object's declaration.

```
type
  TForm1 = class(TForm)
    ⋮                                   { many fields and methods omitted for brevity }
  public
    { Public declarations }
    procedure DrawShape(TopLeft, BottomRight: TPoint; AMode: TPenMode);
  end;
```

2 Write the implementation of *DrawShape* in the **implementation** part of the unit.

```
implementation
{$R *.FRM}
⋮                                 { many other method implementations omitted for brevity }
procedure TForm1.DrawShape(TopLeft, BottomRight: TPoint; AMode: TPenMode);
begin
  with Canvas do
  begin
    Pen.Mode := AMode;
    case DrawingTool of
      dtLine:
        begin
          MoveTo(TopLeft.X, TopLeft.Y);
          LineTo(BottomRight.X, BottomRight.Y);
        end;
      dtRectangle: Rectangle(TopLeft.X, TopLeft.Y, BottomRight.X, BottomRight.Y);
      dtEllipse: Ellipse(TopLeft.X, TopLeft.Y, BottomRight.X, BottomRight.Y);
      dtRoundRect: RoundRect(TopLeft.X, TopLeft.Y, BottomRight.X, BottomRight.Y,
        (TopLeft.X - BottomRight.X) div 2, (TopLeft.Y - BottomRight.Y) div 2);
    end;
  end;
end;
```

3 Modify the other event handlers to call *DrawShape*.

```
procedure TForm1.FormMouseUp(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  DrawShape(Origin, Point(X, Y), pmCopy);                        { draw the final shape }
  Drawing := False;
end;


procedure TForm1.FormMouseMove(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  if Drawing then
  begin
    DrawShape(Origin, MovePt, pmNotXor);                     { erase the previous shape }
    MovePt := Point(X, Y);                                   { record the current point }
    DrawShape(Origin, MovePt, pmNotXor);                       { draw the current shape }
  end;
end;
```

Customizing pens and brushes

A graphics program that lets you only draw black-and-white images isn't very interesting. In order to use more colors, you need to modify the pen and brush the canvas uses to do its drawing and painting. In this section, you'll add more tool bars to the application, one each for the pen and brush.

Specifically, you'll see how to perform the following tasks:

- Adding hidden tool bars
- Hiding and showing tool bars
- Changing the pen style
- Changing the pen color
- Changing the pen width
- Changing the brush style
- Changing the brush color

Adding hidden tool bars

Tool bars don't have to be visible all the time. In fact, it's often convenient to be able to have a number of tool bars available, but show them only when the user wants to use them. Often you create a form that has several tool bars, but hide some or all of them.

■ To create a hidden tool bar,

1 Add a tool bar to the form. (Be sure to set *Align* to *alTop*.)
2 Set the panel's *Visible* property to *False*.

Although the tool bar remains visible at design time so you can modify it, it remains hidden at run time until the application specifically makes it visible.

- ➤ For this example, add two new hidden tool bars, and name them *PenBar* and *BrushBar*. Figure 12.11 shows the tool bars and their controls. Note that they use other controls in addition to speed buttons—a color grid, a scroll bar, and a label in the case of *PenBar*, and a color grid in *BrushBar*. You can put any kind of controls on a tool bar.
- ➤ Add controls to *PenBar* and *BrushBar* and name them as shown in the following figure, then set the values of properties as shown in Table 12.2.

Figure 12.11 The pen and brush tool bars

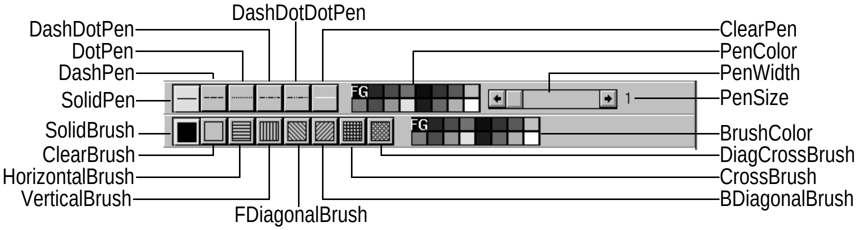


Table 12.2 Property settings for pen and brush tool bars

Component	Property	Value
SolidPen	*Glyph*	SOLID.BMP
	Down	*True*
DashPen	*Glyph*	DASHED.BMP
DotPen	*Glyph*	DOTTED.BMP
DashDotPen	*Glyph*	DASHDOT.BMP
DashDotDotPen	*Glyph*	DASHDOT2.BMP
ClearPen	*Glyph*	CLEAR.BMP
PenColor	*BackgroundEnabled*	*False*
	GridOrdering	*go8x2*
	Height	30
	Top	5
	Width	144
PenWidth	*LargeChange*	10
	Top	12
PenSize	*FocusControl*	*PenWidth*
	Caption	1
	Top	13
SolidBrush	*Glyph*	FSOLID.BMP
	Down	*True*
ClearBrush	*Glyph*	FCLEAR.BMP
HorizontalBrush	*Glyph*	FHORIZ.BMP
VerticalBrush	*Glyph*	FVERT.BMP
FDiagonalBrush	*Glyph*	FDIAG.BMP
BDiagonalBrush	*Glyph*	BDIAG.BMP
CrossBrush	*Glyph*	CROSS.BMP
DiagCrossBrush	*Glyph*	DCROSS.BMP

Table 12.2 Property settings for pen and brush tool bars (continued)

Component	Property	Value
BrushColor	*BackgroundEnabled*	*False*
	GridOrdering	*go8x2*
	Height	30
	Top	5
	Width	144

Hiding and showing tool bars

Often, you want an application to have multiple tool bars, but you don't want to clutter the form with all of them at once. Or some users might not want tool bars at all. As with all components, tool bars can be shown or hidden at run time as needed.

■ To hide or show a tool bar at run time, you set its *Visible* property to *False* or *True*, respectively. Usually you do this in response to particular user events or changes in the operating mode of the application.

A common practice is to put some kind of close button on each tool bar. When the user clicks that button, the application hides the corresponding tool bar.

➤ For this example, however, you've already provided a means to toggle these tool bars: the pen and brush buttons on the main tool bar. Since each click on one of those buttons presses or releases the button, you can add a click-event handler to each one and show or hide the corresponding tool bar depending on whether the button is up or down:

```
procedure TForm1.PenButtonClick(Sender: TObject);
begin
  PenBar.Visible := PenButton.Down;
end;

procedure TForm1.BrushButtonClick(Sender: TObject);
begin
  BrushBar.Visible := BrushButton.Down;
end;
```

If you run the application now, you'll see that the pen and brush tool bars appear and disappear on demand, and that their alignment takes care of assuring that they stack properly at the top of the frame.

Now that you've got tool bars for the pen and brush, the next sections describe using them to customize your drawing tools.

Changing the pen style

A pen's style determines what kind of lines the pen draws, such as solid, dashed, or dotted. Note that some video drivers do not support different styles for pens with a pixel width greater than one. Those drivers generally make all larger pens solid, no matter what style you specify.

■ To change the style of a pen, set the pen's *Style* property to the value corresponding to the effect you want: *psSolid*, *psDash*, *psDot*, *psDashDot*, *psDashDotDot*, or *psClear*.

For this example, you could add click-event handlers for each of the pen-style buttons on the pen's tool bar, but instead, let's see how you can share one event handler for all the pen-style buttons.

Sharing an event handler

Different controls can all use the same event handler to handle events, as long as the events are compatible, meaning their handlers take the same parameters in the same order. The most common use of this is to provide different entry points to do the same action, such as attaching the click events for a menu item and a button to the same handler, which gives a user multiple ways to perform the same action. But you can also have several different controls share a handler that does different things depending on which control called it.

■ To share an event handler, you assign the same event handler to the events of multiple controls. If you need to determine which control actually got the event, check the *Sender* parameter.

➤ In this example, you'll create a click-event handler for all the pen-style buttons on the pen's tool bar, attach the handler to each of the controls, then use *Sender* to determine which button to respond to.

1. Select all six pen-style buttons.
2. On the Events page in the Object Inspector, select *OnClick*.
3. In the Handler column, type `SetPenStyle` and press *Enter*. Delphi generates an empty click-event handler called *SetPenStyle* and attaches it to the *OnClick* events of all six buttons.
4. Fill in the click-event handler by setting the pen's style depending on the value of *Sender*, which is the control that sent the click event:

```
procedure TForm1.SetPenStyle(Sender: TObject);
begin
  with Canvas.Pen do
  begin
    if Sender = SolidPen then Style := psSolid
    else if Sender = DashPen then Style := psDash
    else if Sender = DotPen then Style := psDot
    else if Sender = DashDotPen then Style := psDashDot
    else if Sender = DashDotDotPen then Style := psDashDotDot
    else if Sender = ClearPen then Style := psClear;
  end;
end;
```

Changing the pen color

A pen's color determines the color of the lines the pen draws, including lines drawn as the boundaries of shapes, as well as other lines and polylines.

■ To change the pen color, assign a value to the *Color* property of the pen.

In this example, you'll use the color grid on the pen's tool bar to let the user choose a new color for the pen.

A color grid can set both foreground and background colors (for example, it's the same control used to pick the syntax-highlight colors in Delphi). In this case, you want only one color, so you'll use the foreground color.

➤ The user chooses a new color by clicking the grid, so change the pen's color in response to the *OnClick* event:

```
procedure TForm1.PenColorClick(Sender: TObject);
begin
  Canvas.Pen.Color := PenColor.ForegroundColor;
end;
```

Changing the pen width

A pen's width determines the thickness, in pixels, of the lines it draws. Remember that when the thickness is greater than 1, some video drivers always draw solid lines, no matter what the value of the pen's *Style* property.

■ To change the pen width, assign a numeric value to the pen's *Width* property.

In this example, you'll use the scroll bar on the pen's tool bar to set width values for the pen. You'll also update the label next to the scroll bar to provide feedback to the user.

Using the scroll bar's position to determine the pen width, you need to update the pen width every time the position changes.

➤ Handle the scroll bar's *OnChange* event as follows:

```
procedure TForm1.PenWidthChange(Sender: TObject);
begin
  Canvas.Pen.Width := PenWidth.Position;                    { set the pen width directly }
  PenSize.Caption := IntToStr(PenWidth.Position);        { convert to string for caption }
end;
```

Changing the brush style

A brush style determines what pattern the canvas uses to fill shapes. The predefined styles include solid color, no color, and various line and hatch patterns.

■ To change the style of a brush, set its *Style* property to one of the predefined values: *bsSolid*, *bsClear*, *bsHorizontal*, *bsVertical*, *bsFDiagonal*, *bsBDiagonal*, *bsCross*, or *bsDiagCross*.

➤ For this example, you can set brush styles just as you did pen styles, sharing a click-event handler for all the brush-style buttons. Select all eight brush-style buttons and type in *SetBrushStyle* for the *OnClick* handler name.

```
procedure TForm1.SetBrushStyle(Sender: TObject);
begin
  with Canvas.Brush do
  begin
    if Sender = SolidBrush then Style := bsSolid
    else if Sender = ClearBrush then Style := bsClear
```

```
      else if Sender = HorizontalBrush then Style := bsHorizontal
      else if Sender = VerticalBrush then Style := bsVertical
      else if Sender = FDiagonalBrush then Style := bsFDiagonal
      else if Sender = BDiagonalBrush then Style := bsBDiagonal
      else if Sender = CrossBrush then Style := bsCross
      else if Sender = DiagCrossBrush then Style := bsDiagCross;
    end;
  end;
```

Changing the brush color

A brush's color determines what color the canvas uses to fill shapes.

■ To change the fill color, assign a value to the brush's *Color* property.

➤ Again, you can set the brush color just as you did the pen color, in response to a click on the color grid on the brush's tool bar:

```
procedure TForm1.BrushColorClick(Sender: TObject);
begin
  Canvas.Brush.Color := BrushColor.ForegroundColor;
end;
```

Adding a status bar

A status bar is much like a tool bar, except it usually occupies the bottom of a window instead of the top, and instead of having controls on it, the status bar usually displays text. Delphi's panel component makes an excellent status bar.

Often you want to subdivide the status bar into multiple status areas and provide each with a three-dimensional bevel effect. To do this, you can use panel components nested within the status-bar panel.

Adding a status bar to an application involves the following tasks:

- Placing a status-bar panel
- Subdividing a panel
- Creating 3-D panels
- Updating the status bar

Placing a status-bar panel

In general, status bars appear at the bottom of a form. Aligning the status-bar panel to the bottom of the form takes care of both placement and resizing for you.

■ To add a status bar panel to a form,

1. Place a panel component on the form.
2. Set the panel's *Align* property to *alBottom*.
3. Clear the panel's caption.

Once you've added the status-bar panel, you can subdivide it into separate status panels. If you're not going to subdivide, you probably want to set the *BevelInner* and *BorderWidth* properties to create a 3-D effect, as explained later. Panels that just serve as containers for smaller panels generally don't change those properties.

You also want to decide how to align the text within a panel. By default, panels center their captions, but often in a status bar, you want to set *Align* to *alLeft*.

➤ For this example, add a status-bar panel to the form and name it *StatusBar*.

Subdividing a panel

Often you want to divide a panel, particularly one used for a status bar, into multiple, independent areas. Although you can achieve a similar effect by carefully formatting the text in a single panel, it's more efficient to use individual panels instead.

■ To create panels within another panel,

1. Place a new panel within the panel.
2. Set any 3-D effects you want for the new panel.
3. Set the *Align* property of the new panel to *alLeft*.
4. Move the right side of the new panel to adjust its width.
5. Clear the new panel's caption.
6. Repeat steps 1 to 5 as needed for additional panels.

As you add new left-aligned panels to the original panel, they align to each others' right sides. For the last panel, you probably want to set *Align* to *alClient*, rather than *alLeft*, so that the last panel takes up all remaining space in the original panel.

➤ For this example, add two panels to the status bar, named *OriginPanel* and *CurrentPanel*. Align *OriginPanel* to the left and *CurrentPanel* to the client area.

Creating 3-D panels

Panel components used for status-bar information usually have a 3-D effect. By default, all panels have an outer bevel to give them a slightly raised appearance. Interior text, however, usually looks better if you set it off by lowering, making the panel look like a frame around the text.

■ To create the lowered-text effect, you change two properties: *BevelInner* and *BorderWidth*.

- To create the "engraved" look for the panel, set *BevelInner* to *bvLowered*.
- To change the space between the inner and outer bevels, change the *BorderWidth* property. A *BorderWidth* of 2 gives a good appearance.

The combination of inner and outer bevels creates a frame around the text.

➤ Set the *BevelInner* and *BorderWidth* properties for both *OriginPanel* and *CurrentPanel* to *bvLowered* and 2, respectively.

Updating the status bar

Once you have a status bar in a form, you need to update the status bar information. You can set the caption text of a panel at any time to reflect the status of the application.

■ To update a status bar panel, set the panel's *Caption* property to reflect the current status. Add this caption-changing code to any event handlers that affect the status a particular panel reflects.

➤ Since the graphics program has two panels, you can update the drawing's origin point in *OriginPanel* when the user presses the mouse button and track the current position in *CurrentPanel*:

```
procedure TForm1.FormMouseDown(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  Drawing := True;
  Canvas.MoveTo(X, Y);
  Origin := Point(X, Y);
  MovePt := Origin;
  OriginPanel.Caption := Format('Origin: (%d, %d)', [X, Y]);         { update status bar }
end;

procedure TForm1.FormMouseMove(Sender: TObject; Shift: TShiftState; X, Y: Integer);
begin
  if Drawing then
  begin
    DrawShape(Origin, MovePt, pmNotXor);
    MovePt := Point(X, Y);
    DrawShape(Origin, Point(X, Y), pmNotXor);
  end;
  CurrentPanel.Caption := Format('Current: (%d, %d)', [X, Y]);       { update status bar }
end;
```

Drawing on a bitmap

The times when you want to draw directly on a form are relatively rare. More often, an application should draw on a bitmap, since bitmaps are very flexible for operations such as copying, printing, and saving. Delphi's image control is a component that can contain a bitmap, making it easy to put one or more bitmaps into a form.

In addition, the bitmap need not be the same size as the form: it can be either smaller or larger. By adding a scroll box control to the form and placing the image inside it, you can draw on bitmaps that are much larger than the form or even larger than the screen.

Adding a scrollable bitmap for drawing takes two steps:

- Adding a scrollable region
- Adding an image control

Once you move the application's drawing to the bitmap in the image control, it is easy to add printing, Clipboard, and loading and saving operations for bitmap files.

Adding a scrollable region

The are many times when an application needs to display more information than will fit in a particular area. Some controls, such as list boxes and memos can automatically scroll their contents. But other controls, and sometimes even forms full of controls, need to be able to scroll. Delphi handles these scrolling regions with a control called a *scroll box*.

A scroll box is much like a panel or a group box, in that it can contain other controls, but a scroll box is normally invisible. However, if the controls contained in the scroll box cannot all fit in the visible area of the scroll box, it automatically displays one or two scroll bars, enabling users to move controls outside the visible region into position where they can be seen and used.

■ To create a scrolling region, place a scroll-box control on a form and set its boundaries to the region you want to scroll.

You often use the *Align* property of a scroll box to allow the scroll box to adjust its area to a form or a part of a form.

➤ For this example, you'll create a scrollable region covering the entire area between the tool bar and the status bar, which can then be used for drawing large images. Place a scroll box component on the form, and set its *Align* property to *alClient*, assuring that it fills the entire portion of the form between the top- and bottom-aligned panels.

Adding an image control

An image control is a kind of placeholder component. It allows you to specify an area on a form that will contain a picture object, such as a bitmap or a metafile. You can either set the size of the image manually or allow the image control to adjust to the size of its picture at run time.

You can use an image control to hold a bitmap that isn't necessarily displayed all the time, or which an application needs to use to generate other pictures. The example in Chapter 13 uses image controls to hold bitmaps used to generate the items in an owner-draw control.

Placing the control

You can place an image control anywhere on a form. If you take advantage of the image control's ability to size itself to its picture, your only concern is setting the top left corner. If the image control is a nonvisible holder for a bitmap, you can place it anywhere, just as you would a nonvisual component.

➤ Add an image control to the graphics example's form, making sure to drop it on the scroll box already aligned to the form's client area. This assures that the scroll box will add any scroll bars necessary to access offscreen portions of the image's picture. Set the image control's properties as shown in Table 12.3:

Table 12.3 Image control properties for GRAPHEX

Property	Value
Name	*Image*
AutoSize	*True*
Left	0
Top	0

Setting the initial bitmap size

When you place an image control, it has no picture. You've created the placeholder, but haven't given it anything to display. If the control will always hold a particular picture, you can set the image control's *Picture* property at design time. The control can also load its picture from a file at run time, as described later in this chapter. If you just need a blank bitmap for drawing, however, you should create it at run time.

■ To create a blank bitmap when the application starts, attach a handler to the *OnCreate* event for the form that contains the image, create a bitmap object, and assign it to the image control's *Picture.Graphic* property.

➤ For the graphics example, the image is in the application's main form, *Form1*, so attach a handler to *Form1*'s *OnCreate* event:

```
procedure TForm1.FormCreate(Sender: TObject);
var
  Bitmap: TBitmap;                              { temporary variable to hold the bitmap }
begin
  Bitmap := TBitmap.Create;                                { construct the bitmap object }
  Bitmap.Width := 200;                                     { assign the initial width... }
  Bitmap.Height := 200;                                      { ...and the initial height }
  Image.Picture.Graphic := Bitmap;             { assign the bitmap to the image control }
end;
```

Assigning the bitmap to the picture's *Graphic* property gives ownership of the bitmap to the picture object. It will therefore destroy the bitmap when it finishes with it, so you should not destroy the bitmap object. You can assign a different bitmap to the picture, as you'll see later in this chapter on page 353, at which point the picture disposes of the old bitmap and assumes control of the new one.

If you run the application now, you see that client area of the form has a white region, representing the bitmap. If you size the window so that the client area cannot display the entire image, you'll see that the scroll box automatically shows scroll bars to allow display of the rest of the image. But if you try to draw on the image, you don't get any graphics, because the application is still drawing on the form, which is now behind the image and the scroll box.

Drawing on the bitmap

➤ There are two things you need to do to make the drawing code you already wrote apply to the bitmap instead of the form:

1 Use the image control's canvas instead of the form's canvas.

The easiest way to make that change is to use the editor's search-and-replace dialog box to change every instance of "`Canvas`" to "`Image.Canvas`".

2 Attach the mouse-event handlers to the appropriate events in the image control.

In the Object Inspector, drop down the handler list next to *OnMouseDown* for the image control, and choose *FormMouseDown*, then do the same for *OnMouseMove* and *OnMouseUp*. If you want, you can also detach the methods from the form's events, but it's not necessary. Since there are now controls on all parts of the form, the form will never receive any mouse clicks or drags.

Now when you run the application, you can draw as before, but only on the image control. Note also that if you hide and show the pen and brush tool bars, the scroll box moves the bitmap so that you can still draw on the upper part of the image.

Adding a menu

Up to this point, all the features you added to the graphics application use either direct interaction with the mouse or manipulation of tool-bar controls to activate them. The next few steps, however, deal with printing, loading, saving, and Clipboard operations. Although you can invoke these operations from tool bar buttons, the standard, expected interface for them uses menu commands.

Menu creation is not a major topic of this example, however. If you do not know how to use the Menu Designer or how to attach event handlers to menu-item clicks, see Chapter 3.

➤ Add a MainMenu component to the application. You can place it anywhere on the form, but off to the side on the main tool bar is probably convenient. Create File and Edit menu titles and the items shown in Table 12.4:

Table 12.4 Graphics example File and Edit menus

&File	**&Edit**
&New	Cu&t
&Open...	&Copy
&Save	&Paste
Save &as...	
&Print	
- <hyphen>	
E&xit	

The remaining steps in this chapter assume that you created these menus with the specified captions and accepted the *Name* property values created by Delphi. If you choose other names, or if you choose to activate these features with tool bar buttons, you need to make the necessary adjustments.

Now that you have a menu, it's a good idea to attach a handler to the File|Exit item, to provide the standard method to terminate the application.

➤ Attach the following event handler to the *OnClick* event of the File | Exit menu item:

```
procedure TForm1.Exit1Click(Sender: TObject);
begin
  Close;
end;
```

You will attach event handlers to the other menu items in the remaining sections of this chapter.

As you work with the menus, you might sometimes notice that the application draws an extra line or shape after the user clicks a menu item. Windows sometimes sends a mouse-up message to a form that didn't see the mouse-down message. Because the application always draws in its *OnMouseUp* event handler, these extra mouse-up messages can disrupt your drawing.

The solution is the same one used to filter out unwanted mouse movements on page 326: execute the drawing code only if the *Drawing* flag is set.

➤ Modify the event handler for *OnMouseUp* events to check the *Drawing* field before drawing the shape:

```
procedure TForm1.FormMouseUp(Sender: TObject; Button: TMouseButton;
  Shift: TShiftState; X, Y: Integer);
begin
  if Drawing then
  begin
    DrawShape(Origin, Point(X, Y), pmCopy);
    Drawing := False;
  end;
end;
```

Now the application should draw only when the user initiates the drawing by pressing the mouse button.

Printing graphics

Printing graphic images from a Delphi application is a simple task. The only requirement for printing is that you add the *Printers* unit to the **uses** clause of the form that will call the printer. The *Printers* unit declares a printer object called *Printer* that has a canvas that represents the printed page.

■ To print a graphic image, copy the image to the printer's canvas.

You can use the printer's canvas just as you would any other canvas. In particular, that means you can copy the contents of a graphic object, such as a bitmap, to the printer directly.

➤ In this example, you'll print the contents of the image control in response to a click on Print item on the File menu:

```
procedure TForm1.Print1Click(Sender: TObject);
begin
  with Printer do
```

```
    begin
      BeginDoc;                                                         { start printing }
      Canvas.Draw(0, 0, Image.Picture.Graphic);         { draw Image at upper left of page }
      EndDoc;                                                          { finish printing }
    end;
  end;
```

Working with graphics files

Graphic images that exist only for the duration of one running of an application are of very limited value. Often, you either want to use the same picture every time, or you want to save a created picture for later use. Delphi's image control makes it easy to load pictures from a file and save them again. Once you add the ability to load and save files, this sample application becomes a much more powerful tool.

The logic for loading and saving graphics files is the same as for any other files, so this chapter doesn't cover the mechanics in great detail. The purpose of this section is to introduce the file-loading and file-saving capabilities of the graphics objects, including

- Loading a picture from a file
- Saving a picture to a file
- Replacing the picture

➤ Before you start to load or store files, add three things to the application:

- An open-file dialog box
- A save-file dialog box
- An object field named *CurrentFile* of type **string**, to the form object

Adding common dialog boxes is part of the sample application in Chapter 10. Adding object fields is covered in this chapter, on page 326.

Loading a picture from a file

The ability to load a picture from a file is important if your application needs to modify the picture or if you want to store the picture outside the application so a person or another application can change the picture without changing code.

■ To load a graphics file into an image control, call the *LoadFromFile* method of the image control's *Picture* object.

➤ Attach the following handler to the *OnClick* event of the File|Open menu item:

```
procedure TForm1.Open1Click(Sender: TObject);
begin
  if OpenDialog1.Execute then
  begin
    CurrentFile := OpenDialog1.FileName;
    Image.Picture.LoadFromFile(CurrentFile);
  end;
end;
```

Saving a picture to a file

When you have created or modified a picture, you often want to save the picture in a file for later use. The Delphi picture object can save graphics in several formats, and application developers can create and register their own graphic-file formats so that picture objects can store them as well.

■ To save the contents of an image control in a file, call the *SaveToFile* method of the image control's *Picture* object.

The *SaveToFile* method requires the name of a file to save into. If the picture is newly created, it might not have a file name, or a user might want to save an existing picture in a different file. In either case, the application needs to get a file name from the user before saving, as shown in the next section.

➤ The following pair of event handlers, attached to the File|Save and File|Save As menu items, respectively, handle the resaving of named files, saving of unnamed files, and saving existing files under new names.

```
procedure TForm1.Save1Click(Sender: TObject);
begin
  if CurrentFile <> '' then
    Image.Picture.SaveToFile(CurrentFile)                    { save if already named }
  else SaveAs1Click(Sender);                                  { otherwise get a name }
end;

procedure TForm1.Saveas1Click(Sender: TObject);
begin
  if SaveDialog1.Execute then                                      { get a file name }
  begin
    CurrentFile := SaveDialog1.FileName;                { save the user-specified name }
    Save1Click(Sender);                                           { then save normally }
  end;
end;
```

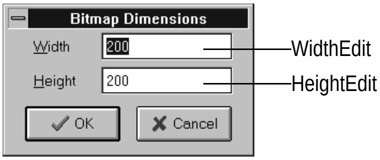
Replacing the picture

You can replace the picture in an image control at any time. If you assign a new graphic to a picture that already has a graphic, the new graphic replaces the existing one.

■ To replace the picture in an image control, assign a new graphic to the image control's *Picture* object.

Creating the new graphic is the same process you used to create the initial graphic (see page 349), but you should also provide a way for the user to choose a size other than the default size used for the initial graphic. An easy way to provide that option is to present a dialog box, such as the one in Figure 12.12.

Figure 12.12 Bitmap-dimension dialog box from the BMPDlg unit.



Creating a dialog-box form is not the focus of this chapter, so it doesn't present all the details of creating the bitmap-dimensions dialog box here. You can create your own, or you can use the one in the *BMPDlg* unit included with the *GraphEx* project. The rest of this section assumes you use the dialog box in the *BMPDlg* unit.

➤ Add the *BMPDlg* unit to your project. You also need to add *BMPDlg* to the **uses** clause in the unit for the main form. You can then attach the following event handler to the File | New menu item's *OnClick* event:

```
procedure TForm1.New1Click(Sender: TObject);
var
  Bitmap: TBitmap;                               { temporary variable for the new bitmap }
begin
  with NewBMPForm do
  begin
    ActiveControl := WidthEdit;                        { make sure focus is on width field }
    WidthEdit.Text := IntToStr(Image.Picture.Graphic.Width); { use current dimensions... }
    HeightEdit.Text := IntToStr(Image.Picture.Graphic.Height);           { ...as default }
    if ShowModal <> idCancel then           { continue if user doesn't cancel dialog box }
    begin
      Bitmap := TBitmap.Create;                                { create fresh bitmap object }
      Bitmap.Width := StrToInt(WidthEdit.Text);                      { use specified width }
      Bitmap.Height := StrToInt(HeightEdit.Text);                   { use specified height }
      Image.Picture.Graphic := Bitmap;                { replace graphic with new bitmap }
      CurrentFile := '';                                           { indicate unnamed file }
    end;
  end;
end;
```

The important aspect to understand is that assigning a new bitmap to the picture object's *Graphic* property causes the picture object to destroy the existing bitmap and take ownership of the new one. Delphi handles the details of freeing the resources associated with the previous bitmap automatically.

Using the Clipboard with graphics

You can use the Windows Clipboard to copy and paste graphics within your applications or to exchange graphics with other applications. Delphi's Clipboard object makes it easy to handle different kinds of information, including graphics.

Before you can use the Clipboard object in your application, you need to add the*ClipBrd* unit to the **uses** clause of any unit that needs to access Clipboard data.

Copying graphics to the Clipboard

You can copy any picture, including the contents of image controls, to the Clipboard. Once on the Clipboard, the picture is available to all Windows applications.

■ To copy a picture to the Clipboard, assign the picture to the Clipboard object using the *Assign* method.

➤ For this example, you can assign the image control's *Picture* property to the Clipboard in response to a click on the Edit|Copy menu item:

```
procedure TForm1.Copy1Click(Sender: TObject);
begin
  Clipboard.Assign(Image.Picture);
end;
```

Cutting graphics to the Clipboard

Cutting a graphic to the Clipboard is exactly like copying it, but you also erase the graphic from the source.

■ To cut a graphic from a picture to the Clipboard, first copy it to the Clipboard, then erase the original.

In most cases, the only issue with cutting is how to effect the erasure of the original image. Setting the area to white is a common solution.

➤ For this example, you can attach the following event handler to the *OnClick* event of the Edit|Cut menu item.

```
procedure TForm1.Cut1Click(Sender: TObject);
var
  ARect: TRect;
begin
  Copy1Click(Sender);                                          { copy picture to Clipboard }
  with Image.Canvas do
  begin
    CopyMode := cmWhiteness;                                    { copy everything as white }
    ARect := Rect(0, 0, Image.Width, Image.Height);                { get bitmap rectangle }
    CopyRect(ARect, Image.Canvas, ARect);                         { copy bitmap over itself }
    CopyMode := cmSrcCopy;                                          { restore normal mode }
  end;
end;
```

Pasting graphics from the Clipboard

If the Windows Clipboard contains a bitmapped graphic, you can paste it into any image object, including image controls and the surface of a form.

■ To paste a graphic from the Clipboard,

1 Call the Clipboard's *HasFormat* method to see whether the Clipboard contains a graphic.

HasFormat is a Boolean function. It returns *True* if the Clipboard contains an item of the type specified in the parameter. To test for graphics, you pass *CF_BITMAP*.

2 Assign the Clipboard to the destination.

➤ In this example, you can paste a bitmap from the Clipboard into the image control's picture in response to a click on the Edit|Paste menu item:

```
procedure TForm1.PasteButtonClick(Sender: TObject);
var
    Bitmap: TBitmap;
begin
    if Clipboard.HasFormat(CF_BITMAP) then
    { check to see if there's a bitmap on the clipboard )
    begin
        {create a bitmap to hold the contents on the clipboard }
        Bitmap := TBitmap.Create;
        try
            { Get the bitmap off the clipboard using Assign }
            Bitmap.Assign(Clipboard);
            { Copy the bitmap to the Image }
            Image.Canvas.Draw(0, 0, Bitmap);
        finally
            Bitmap.Free;
        end;
    end;
end;
```

```
The graphic on the Clipboard could come from this application, or you could have copied
it from another application, such as Windows Paintbrush.
```

Summary

The sample application described in this chapter covers quite a number of issues, but leaves several others unresolved. In particular, a polished version of the application would likely display the name of the current bitmap file in the main form's caption, and would track whether the user makes changes to a picture, prompting the user whether to save the changes before loading or creating another picture.

The skills presented, however, apply to a number of different kinds of applications. In particular, tool bars and status bars appear in nearly all commercial applications. Using different combinations of panels in your applications, you can make many functions easily accessible to users.

In addition, the application uses the standard printer and Clipboard objects with graphics, much as the sample application in Chapter 10 does with text.

Topics presented in this chapter included:

- Responding to the mouse
- Adding a field to a form object
- Refining line drawing
- Adding a tool bar to a form

- Adding speed buttons to a tool bar
- Responding to clicks
- Drawing with different tools
- Customizing pens and brushes
- Adding a status bar
- Drawing on a bitmap
- Adding a menu
- Printing graphics
- Working with graphics files
- Using the Clipboard with graphics

Chapter

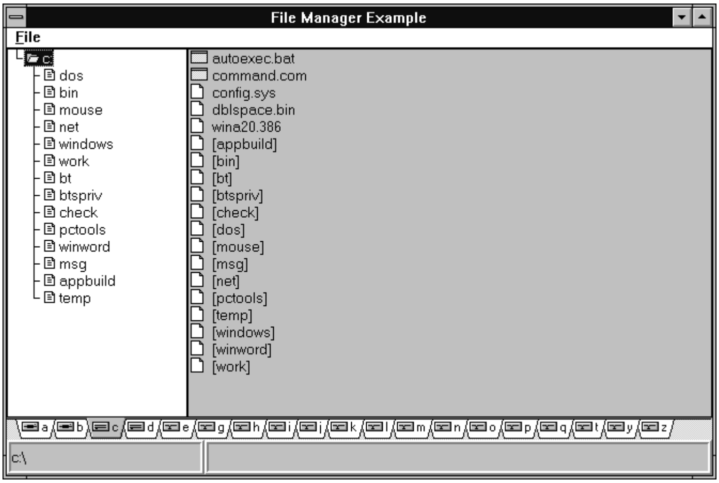
13

File manager example

This chapter presents all the steps necessary to create a small file manager application. Each section in the chapter builds on the previous sections, but the individual sections also explain discrete tasks. The material assumes you already know how to perform most of the basic Delphi tasks, such as placing components on a form and creating a menu. Those tasks are described in Chapter 2 and Chapter 3.

The complete application appears under the DEMOS\DOC directory and is called FILMANEX.DPR. Figure 13.1 shows the completed application.

Figure 13.1 The complete file manager example



The topics presented in this example include

- Creating the file-manager form
- Building the drive list
- Creating an owner-draw control

- Manipulating files
- Dragging and dropping

The file manager example makes use of a number of routines in a unit called *FMXUtils*, located in the same directory with the project file. The implementation of those routines is outside the scope of this chapter, but you can look at the source code to see examples of routines that, for example, copy and move files or return the size of a specified file.

Creating the file-manager form

The first step in creating the file manager application is designing the form. The following sections describe briefly how to lay out the form, place the controls, and design the menu.

Laying out the form

➤ Start by creating a new project. Then use the Object Inspector to set the following properties on the project's main form:

Table 13.1 Property values for the file manager example's main form

Property	Value
Caption	File Manager Example
Name	*FMForm*
Position	*poDefault*

Placing the controls

➤ Next you need to add controls to the form. Because you'll align all the controls to each other, it's important that you place them and set their properties in the order indicated in Table 13.2. Note that *DirectoryPanel* and *FilePanel* go inside *StatusBar* to form a subdivided status bar. For more information on creating status bars and their panels, see "Subdividing a panel" in Chapter 12.

Table 13.2 Property values for the main-form components in FILMANEX

Component	Property	Value
Panel	*Align*	*alBottom*
	Caption	<leave blank>
	Name	*StatusBar*
	BevelOuter	*bvNone*
Panel	*Align*	*alLeft*
	Caption	<leave blank>
	Name	*DirectoryPanel*
	BevelInner	*bvLowered*
	BevelWidth	2
Panel	*Align*	*alClient*

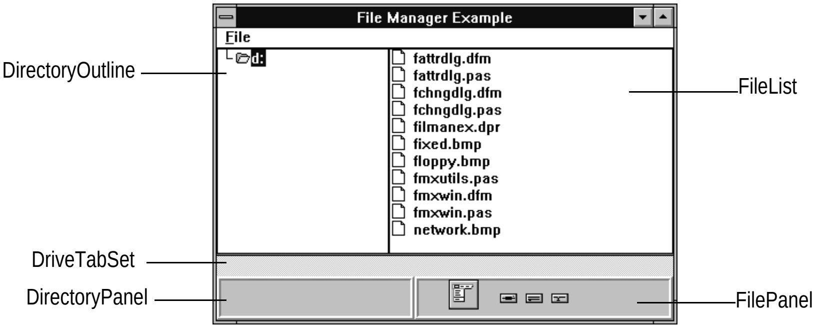
Table 13.2 Property values for the main-form components in FILMANEX (continued)

Component	Property	Value
	Caption	<leave blank>
	Name	*FilePanel*
	BevelInner	*bvLowered*
	BevelWidth	2
TabSet	*Align*	*alBottom*
	Name	*DriveTabSet*
DirectoryOutline	*Name*	*DirectoryOutline*
	Align	*alLeft*
FileListBox	*Align*	*alClient*
	Name	FileList
	ShowGlyphs	*True*

Note that for the DirectoryOutline component, you can use either the DirectoryOutline on the Samples page of the Component palette or the standard DirectoryListBox component from the System page. The DirectoryOutline component can display a more detailed view of the directory structure of a disk.

The form with all its controls now looks like Figure 13.2.

Figure 13.2 File-manager form with controls



➤ Once you have added all the components and set their properties, you should save the project. When prompted for names, rename *Unit1* to *FMXWin*, and *Project1* to *FilManEx*. Add *FMXUtils* to the **uses** clause at the top of the *FMXWin* unit.

Designing the menu

Finally, you need to add a menu bar to the form. Menu creation is not a major topic of this example, however. If you do not know how to use the Menu Designer or how to attach event handlers to menu-item clicks, see Chapter 3.

➤ Add a MainMenu component to the application. You can place it anywhere on the form, but off to the side on the status bar is probably convenient. Create a File menu with the menu items listed in Table 13.3. Note that this File menu differs from the standard File-menu template.

Table 13.3 File-menu items for the file manager example

Caption	Shortcut
&Open	*Enter*
&Move...	*F7*
&Copy...	*F8*
&Delete...	*Del*
&Rename...	
&Properties...	*Alt+Enter*
-<hyphen>	
E&xit	

➤ Before proceeding, create an *OnClick* event handler for the File | Exit menu item that closes the application's main form:

```
procedure TFMForm.Exit1Click(Sender: TObject);
begin
  Close;
end;
```

Although you can generally terminate the application by double-clicking the Control-menu box on the caption bar, it's a good idea to provide the File | Exit option and respond to it by closing down the application.

Now that you have the application set up, the following sections lead you through connecting the controls and updating the status bar.

Building the drive list

When you added the tab set to the form, you probably noticed that it didn't have any tabs on it. The tab set creates tabs for each item in its list of tabs, represented by the*Tabs* property. Initially, that list is empty. You can edit the list at design time through the Object Inspector, but you can also build or change the list at run time.

In this example, you need to build a list of disk drives at run time, since you can't be sure at design time what drives will be present at run time.

Determining valid drives

The Windows API provides a function,*GetDriveType*, that returns information about the type of a specified drive.

■ To determine whether a drive is valid, pass the number of the drive to*GetDriveType*. The return value indicates the type of drive present: a return value greater than zero indicates a valid drive. Zero or a negative value indicates that the drive is not valid.

For now, you can just check to see if there is a drive of any kind. Later on, you'll use the information to determine what kind of drive it is.

➤ Attach the following code to the *OnCreate* event of the form to build a list of tabs for a tab set when the form is first created. The tab list contains a tab for each valid drive on the system.

```
procedure TFMForm.FormCreate(Sender: TObject);
var
  Drive, AddedIndex: Integer;
begin
  for Drive := 0 to 25 do                          { iterate through all possible drives }
    if GetDriveType(Drive) > 0 then                  { positive values mean valid drives }
    begin
      AddedIndex := DriveTabSet.Tabs.Add(Chr(Drive + ord('a')));             { add a tab }
      if Chr(Drive + ord('A')) = FileList.Drive then          { if it's current drive... }
        DriveTabSet.TabIndex := AddedIndex;                   { ...make that current tab }
    end;
end;
```

Of course, just putting drive letters on tabs doesn't provide a very large target to click, and doesn't provide any information on what kind of drive each tab represents. In the next section you'll make the tab set into an owner-draw tab set, which will provide graphical information for each drive.

Connecting the controls

Now that you have controls to represent disk drives, directories, and files, you need to connect them so that they all represent their different aspects of the file and directory information. That is, when you choose a different drive with the tab set, you want the directory outline to reflect the directory structure of that drive, and the file list to display the contents of selected directory.

In order to connect the controls, you need to handle events caused by tab selections and outline changes. Note that in one case, the tab set, you handle*clicks*, while the others have *changes*.

Responding to tab-set changes

When the user selects a tab in a tab-set control by clicking a tab or using the keyboard, the tab set generates an *OnClick* event. Any other controls that depend on the setting of the tab set need to have their values updated in response to those click events.

For example, with a tab set that contains tabs for each valid disk drive, a click on a different tab indicates a change of drive selection. Other controls, such as directory lists, need to respond to the change.

■ To respond to changes in a tab set, attach an event handler to the tab set's*OnClick* event.

➤ The following code, attached to the *OnClick* event of a tab set named *DriveTabSet*, sets the *Drive* property in a directory-outline control to the first letter of the clicked tab:

```
procedure TFMForm.DriveTabSetClick(Sender: TObject);
begin
```

```
    with DriveTabSet do
      DirectoryOutline.Drive := Tabs[TabIndex][1];
  end;
```

If you select a tab on the drive list now, it causes the directory outline to display the directory structure of the specified drive.

Responding to outline changes

When the user selects an item in an outline by clicking it or using an arrow key, the outline generates a click. Any controls that depend on the currently selected item in the outline need to update themselves in response to those clicks.

For example, in a directory outline, a click usually indicates a change in the current directory. Other controls, such as file lists, need to respond to this change. However, it is possible that the click was on the directory already selected. Instead of handling the *OnClick* event, it is more useful to handle the *OnChange* event, which indicates that something in the directory outline has changed.

■ To respond to changes in an outline, attach a handler to the outline's *OnChange* event.

➤ The following code updates both a file list box and a status-bar panel to reflect the current directory in a directory outline every time the directory outline changes:

```
  procedure TFMForm.DirectoryOutlineChange(Sender: TObject);
  begin
    FileList.Directory := DirectoryOutline.Directory;
    DirectoryPanel.Caption := DirectoryOutline.Directory;
  end;
```

Any change in the directory outline, whether caused by changing to a different drive (and therefore replacing the entire directory list) or changing to a different directory in the same outline, now causes the status-bar panel to reflect the current directory path and causes the file list box to display the contents of that directory.

Responding to list box changes

When the user clicks an item in a list box or uses an arrow key to move to one, that item becomes the selected item, and the list box generates an *OnChange* event. The application can handle the change and update any dependent controls.

■ To respond to changes in a list box, attach an event handler to the list box's *OnChange* event.

For example, a file list box can have an associated panel that displays information about the selected file or files.

➤ The following event handler for a file list box's *OnChange* event updates a status-bar panel with the name and size of the file currently selected in a file list box:

```
  procedure TFMForm.FileListChange(Sender: TObject);
  var
    TheFileName: string;
  begin
    with FileList do
    begin
```

```
      if ItemIndex >= 0 then                                  { is there a selected item? }
      begin
        TheFileName := Items[ItemIndex];                              { get the file name }
        FilePanel.Caption := Format('%s, %d bytes', [TheFileName,
          GetFileSize(TheFileName)]);                       { set caption to file name/size }
      end
      else FilePanel.Caption := '';                          { blank panel if none selected }
    end;
  end;
```

GetFileSize is a function in the *FMXUtils* unit.

Changing the selected file in the list box now causes the status-bar panel to display the name of the current file and its size. If there is no selected file, the panel is blank.

The next section of this chapter deals with turning the drive tab set into an owner-draw control that shows bitmaps next to the drive letters. The application works fully without the owner-draw feature, however, so if you want to skip it for now, you can jump right to the section "Manipulating files" on page 369.

Creating an owner-draw control

Windows list-box and combo-box controls have a style available called "owner draw," which means that instead of using Windows' standard method of drawing text for each item in the control, the control's owner (generally, the form) draws each item at run time. The most common application for owner-draw controls is to provide graphics instead of, or in addition to, text for items. The Delphi tab-set control also has a similar owner-draw style.

Owner-draw controls have one thing in common: they all contain lists of items. By default, those lists are lists of strings, which Windows displays as text. Delphi enables you to associate an object with each item in a list and gives you the chance to use that object when drawing items. String lists are explained in more detail in Chapter 9.

In general, creating an owner-draw control in Delphi takes three steps:

1 Setting the owner-draw style
2 Adding graphical objects to a string list
3 Drawing owner-draw items

Setting the owner-draw style

Each control that has an owner-draw variant has a property called *Style*. *Style* determines whether the control uses the default drawing (called the "standard" style) or owner drawing.

For list boxes and combo boxes, there is also a choice of owner-draw styles, called *fixed* and *variable*, as Table 13.4 describes. Owner-draw tab sets are always variable. Although the size of each row and column in an owner-draw grid might vary, the size of each cell is fixed before drawing the grid.

Table 13.4 Fixed vs. variable owner-draw styles

Owner-draw style	Meaning	Examples
Fixed	Each item is the same height, with that height determined by the *ItemHeight* property.	*lbOwnerDrawFixed*, *csOwnerDrawFixed*
Variable	Each item might have a different height, determined by the data at run time.	*lbOwnerDrawVariable*, *csOwnerDrawVariable*, *tsOwnerDraw*

➤ For this example, set *DriveTabSet*'s *Style* property to *tsOwnerDraw*.

Adding graphical objects to a string list

Every Delphi string list has the ability to hold a list of objects in addition to its list of strings. That is, in addition to its indexed *Strings* property, which contains strings, a string list also has an *Objects* property. "Adding objects to a string list" on page 275 explains more about using objects with string lists.

For the file manager example, you need to add bitmaps indicating the type of drive along with the letter of the drive. To do that, you need to add the bitmap images to the application, then copy those images into the proper places in the string list.

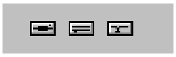
Adding images to an application

An image control is a nonvisual control that contains a graphical image, such as a bitmap. You use image controls to display graphical images on a form, but you can also use them to hold hidden images that you'll use in your application. For example, you can store bitmaps for owner-draw controls in hidden image controls.

➤ For this example,

1. Add three image controls to the main form.
2. Set their *Name* properties to *Floppy*, *Fixed*, and *Network*.
3. Set the *Visible* property for each image control to *False*.
4. Set the *Picture* property of each image to the correct bitmap:
    1. In the Object Inspector, double-click the Value column for the *Picture* property to open the Picture editor.
    2. Choose Load in the Picture editor to open a file dialog box.
    3. Choose the bitmap file corresponding to the name of each control: FLOPPY.BMP for *Floppy*, and so on.

You should now have three small images on the form, as shown in the following figure. The image controls will be invisible when you run the application.



Adding images to a string list

Once you have graphical images in an application, you can associate them with the strings in a string list. You can either add the objects at the same time as the strings, or associate objects with already-added strings. If you have all the needed data available, you should generally add strings and objects together.

For the file manager example, that means along with a letter for each valid drive, you need to add a bitmap indicating each drive's type, so update the*OnCreate* event handler as follows:

```
procedure TFMForm.FormCreate(Sender: TObject);
var
  Drive, AddedIndex: Integer;
  DriveLetter: Char;
begin
  for Drive := 0 to 25 do                           { iterate through all possible drives }
  begin
    DriveLetter := Chr(Drive + ord('a'));
    case GetDriveType(Drive) of                     { positive values mean valid drives }
      DRIVE_REMOVABLE:                                                      { add a tab }
        AddedIndex := DriveTabSet.Tabs.AddObject(DriveLetter, Floppy.Picture.Graphic);
      DRIVE_FIXED:                                                          { add a tab }
        AddedIndex := DriveTabSet.Tabs.AddObject(DriveLetter, Fixed.Picture.Graphic);
      DRIVE_REMOTE:                                                         { add a tab }
        AddedIndex := DriveTabSet.Tabs.AddObject(DriveLetter, Network.Picture.Graphic);
    end;
    if UpCase(DriveLetter) = UpCase(DirectoryOutline.Drive) then        { current drive? }
      DriveTabSet.TabIndex := AddedIndex;                    { then make that current tab }
  end;
end;
```

Drawing owner-draw items

When you set a control's style to owner draw, Windows no longer draws the control on the screen. Instead, it generates events for each visible item in the control. Your application handles the events to draw the items.

■ To draw the items in an owner-draw control, follow these steps. The steps are repeated for each visible item in the control, but you use a single event handler for all items.

1. Size the item.

   If the owner-draw items are all the same size (for example, with a list box style of *lsOwnerDrawFixed*), you don't need to do this step.

2. Draw the item.

Sizing owner-draw items

Before giving your application the chance to draw each item in a variable owner-draw control, Windows generates a measure-item event. The measure-item event tells the application where the item will appear on the control.

Windows determines what size the item will probably be (generally just large enough to display the item's text in the current font). Your application can handle the event and change the rectangle Windows chose. For example, if you plan to substitute a bitmap for the item's text, you'd change the rectangle to be the size of the bitmap. If you want the bitmap and text, you adjust the rectangle to be big enough for both.

■ To change the size of an owner-draw item, attach an event handler to the measure-item event in the owner-draw control. Depending on the control, the name of the event will vary. List boxes and combo boxes use *OnMeasureItem*. Tab sets use *OnMeasureTab*. Grids have no measure-item event.

The sizing event has two important parameters: the index number of the item and the size of that item. That size is variable: the application can make it either smaller or larger. The positions of subsequent items depend on the size of preceding items.

For example, in a variable owner-draw list box, if the application sets the height of the first item to five pixels, the second item starts at the sixth pixel down from the top, and so on. In list boxes and combo boxes, the only aspect of the item the application can alter is height of the item. The width of the item is always the width of the control. In tab sets, only the width of the tabs varies, since the size of the control fixes the height of the tabs.

Note Owner-draw grids cannot change the sizes of their cells as they draw. The size of each row and column is set before drawing by the *ColWidths* and *RowHeights* properties.

For a tab set, the default width of each tab is the width of the text it contains. To accommodate bitmaps next to the text, you need to handle the measure-item event, increasing the tab width value to include enough space for both the graphic and the text.

➤ The following code, attached to the *OnMeasureItem* event of an owner-draw tab set, increases the width of each tab to accommodate its associated bitmap:

```
procedure TFMForm.DriveTabSetMeasureTab(Sender: TObject; Index: Integer;
  var TabWidth: Integer);                        { note that TabWidth is a var parameter}
var
  BitmapWidth: Integer;
begin
  BitmapWidth := TBitmap(DriveTabSet.Tabs.Objects[Index]).Width;
  { increase tab width by the width of the associated bitmap plus two }
  Inc(TabWidth, 2 + BitmapWidth);
end;
```

Note You must typecast the items from the *Objects* property in the string list. *Objects* is a property of type *TObject* so that it can hold any kind of object. When you retrieve objects from the array, you need to typecast them back to the actual type of the items.

Drawing each owner-draw item

When an application needs to draw or redraw an owner-draw control, Windows generates draw-item events for each visible item in the control.

■ To draw each item in an owner-draw control, attach an event handler to the draw-item event for that control. The names of events for owner drawing always start with *OnDraw*, such as *OnDrawItem*, *OnDrawTab*, or *OnDrawCell*.

The draw-item event contains parameters indicating the index of the item to draw, the rectangle in which to draw, and usually some information about the state of the item (such as whether the item has focus). The application handles each event by rendering the appropriate item in the given rectangle.

➤ For example, to draw tabs in a tab set that has bitmaps associated with each string, attach the following handler to the *OnDrawItem* event for the tab set:

```
procedure TFMForm.DriveTabSetDrawTab(Sender: TObject; TabCanvas: TCanvas;
  R: TRect; Index: Integer; Selected: Boolean);
var
  Bitmap: TBitmap;
begin
  Bitmap := TBitmap(DriveTabSet.Tabs.Objects[Index]);
  with TabCanvas do
  begin
    Draw(R.Left, R.Top + 4, Bitmap);                                 { draw bitmap }
    TextOut(R.Left + 2 + Bitmap.Width,                             { position text }
      R.Top + 2, DriveTabSet.Tabs[Index]);      { and draw it to the right of the bitmap }
  end;
end;
```

Note Most draw-item events don't pass a canvas object as a parameter; you normally use the canvas of the control being drawn. Because the tab set also has to render its tab separators between items, it passes a special canvas for item drawing as a parameter.

Manipulating files

There are several common file operations built into Object Pascal's run-time library. The procedures and functions for working with files operate at a high level: you specify the name of the file you want to work on, and the routine makes the necessary calls to the operating system for you. In addition, the *FMXUtils* unit in the directory with the file-manager sample application provides some supplementary routines useful for this example.

Previous versions of the Pascal language perform similar operations on files themselves, rather than on file names. That is, you have to locate a file and assign it to a file variable before you can, for example, rename the file. By operating at the higher level, Object Pascal reduces your coding burden and streamlines your applications. The lower-level functions are still available, but you shouldn't need them as often.

These are the file manipulations that Object Pascal handles for your applications:

- Deleting a file
- Changing a file's attributes
- Moving, copying, and renaming files
- Executing an application

The file manager example attaches all these operations to items on the File menu. Before attaching functions to the menu items, though, it's a good idea to make sure those items are available only when you have a file selected. Otherwise, you would have to check whether a file was selected each time you performed one of those functions. It's much easier and more efficient to ensure that menu items and controls are enabled only when the user can actually use them.

➤ To selectively enable and disable items on a menu, attach a handler to the *OnClick* event for the File item on the main menu bar:

```
procedure TFMForm.File1Click(Sender: TObject);
var
  FileSelected: Boolean;
begin
  FileSelected := FileList.ItemIndex >= 0;            { True if there is a file selected }
  Open1.Enabled := FileSelected;
  Delete1.Enabled := FileSelected;
  Copy1.Enabled := FileSelected;
  Move1.Enabled := FileSelected;
  Rename1.Enabled := FileSelected;
  Properties1.Enabled := FileSelected;
end;
```

Now, whenever the user opens the File menu, the application disables all the items except Exit unless there is a file selected in the file list box.

Deleting a file

Deleting a file erases the file from the disk and removes the entry from the disk's directory. There is no corresponding operation to restore a deleted file, so applications should generally allow users to confirm deletions of files.

■ To delete a file, pass the name of the file to the *DeleteFile* function. *DeleteFile* returns *True* if it deleted the file and *False* if it did not (for example, if the file did not exist or if it was read-only).

➤ The following code handles a click on a File | Delete menu item by deleting the selected file in a file list box, then updating the list so it reflects the deletion.

```
procedure TFMForm.Delete1Click(Sender: TObject);
begin
  with FileList do
    if DeleteFile(FileName) then Update;
end;
```

The application now deletes the selected file in response to either File | Delete or the *Del* key, which is the shortcut for that menu item.

Confirming file deletions

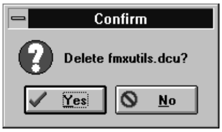
A safer way to approach deleting files, however, would provide a chance for the user to confirm that the application should delete the file. You can use a message dialog box to tell the user which file the application is about to delete, providing the option to cancel the operation.

➤ Add the following handler, attached to the File | Delete menu item's *OnClick* event. The *MsgDlg* unit must appear in the **uses** clause for the unit containing this handler.

```
procedure TFMForm.Delete1Click(Sender: TObject);
begin
  with FileList do
    if MessageDlg('Delete ' + FileName + '?', mtConfirmation,
      [mbYes, mbNo], 0) = mrYes then
      if DeleteFile(FileName) then Update;
end;
```

The application now displays a message dialog box and requests confirmation from the user before deleting any files. This gives the user a chance to cancel the deletion if necessary. Figure 13.3 shows the message dialog box generated by this example.

Figure 13.3 Confirming a file deletion



Changing a file's attributes

Every file has various attributes stored by the operating system as bitmapped flags. File attributes include such items as whether a file is read-only or a hidden file.

■ Changing a file's attributes requires three steps:

1. Reading file attributes
2. Changing individual file attributes
3. Setting file attributes

You can use the reading and setting operations independently, if you only want to determine a file's attributes, or if you want to set an attribute regardless of previous settings. To change attributes based on their previous settings, however, you need to read the existing attributes, modify them, and write the modified attributes.

Reading file attributes

Operating systems store file attributes in various ways, generally as bitmapped flags.

■ To read a file's attributes, pass the file name to the *FileGetAttr* function. The return value is a group of bitmapped file attributes of type *Word*.

The file manager example handles a click on the File | Properties menu item by opening a file-attribute dialog box in which the user can see each attribute represented as a check box, as shown in Figure 13.4.

➤ Add a new form to the project and set its properties as indicated in Table 13.5. When you save the updated project, name the new unit *FAttrDlg*.

Table 13.5 Property values for the file-attribute dialog box form

Property	Value
Name	*FileAttrForm*
Caption	*File Attributes*

Table 13.5 Property values for the file-attribute dialog box form (continued)

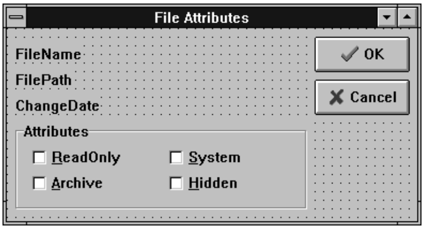
Property	Value
Position	*poScreenCenter*
BorderIcons	[*biSystemMenu*]
BorderStyle	*bsDialog*

Next, add controls as indicated in Table 13.6 and Figure 13.4.

Table 13.6 Property values for the file-attribute dialog box components

Component	Property	Value
Label	*Name*	*FileName*
Label	*Name*	*FilePath*
Label	*Name*	*ChangeDate*
Group Box	*Caption*	*Attributes*
CheckBox	*Name*	*ReadOnly*
	Caption	*&Read Only*
Check Box	*Name*	*Archive*
	Caption	*&Archive*
Check Box	*Name*	*System*
	Caption	*&System*
Check Box	*Name*	*Hidden*
	Caption	*&Hidden*
Bitmap Button	*Kind*	*bkOK*
Bitmap Button	*Kind*	*bkCancel*

Figure 13.4 The file-attribute dialog box



Changing individual file attributes

Because Delphi represents file attributes in a set, you can use normal bitwise operators to manipulate the individual attributes. Each attribute has a mnemonic name defined in the *SysUtils* unit.

For example, to set a file's read-only attribute, you would do the following:

```
Attributes := Attributes or faReadOnly;
```

You can also set or clear several attributes at once. For example, to clear both the system-file and hidden attributes, do the following:

```
Attributes := Attributes and not (faSysFile or faHidden);
```

Setting file attributes

Delphi enables you to set the attributes for any file at any time.

■ To set a file's attributes, pass the name of the file and the attributes you want to the *FileSetAttr* procedure.

➤ The following code reads a file's attributes into a set variable, sets the check boxes in the file-attribute dialog box to represent the current attributes, then executes the dialog box. If the user changes and accepts any dialog box settings, the code sets the file attributes to match the changed settings:

```
procedure TFMForm.Properties1Click(Sender: TObject);
var
  Attributes, NewAttributes: Word;
begin
  with FileAttrForm do
  begin
    FileDirName.Caption := FileList.Items[FileList.ItemIndex];         { set box caption }
    PathName.Caption := FileList.Directory;                        { show directory name }
    ChangeDate.Caption := DateTimeToStr(FileDateTime(FileList.FileName));
    Attributes := FileGetAttr(FileDirName.Caption);               { read file attributes }
    ReadOnly.Checked := (Attributes and faReadOnly) = faReadOnly;
    Archive.Checked := (Attributes and faArchive) = faArchive;
    System.Checked := (Attributes and faSysFile) = faSysFile;
    Hidden.Checked := (Attributes and faHidden) = faHidden;
    if ShowModal <> mrCancel then                                   { execute dialog box }
    begin
      NewAttributes := Attributes;                      { start with original attributes }
      if ReadOnly.Checked then NewAttributes := NewAttributes or faReadOnly
      else NewAttributes := NewAttributes and not faReadOnly;
      if Archive.Checked then NewAttributes := NewAttributes or faArchive
      else NewAttributes := NewAttributes and not faArchive;
      if System.Checked then NewAttributes := NewAttributes or faSysFile
      else NewAttributes := NewAttributes and not faSysFile;
      if Hidden.Checked then NewAttributes := NewAttributes or faHidden
      else NewAttributes := NewAttributes and not faHidden;
      if NewAttributes <> Attributes then                         { if anything changed... }
        FileSetAttr(FileDirName.Caption, NewAttributes);         { ...write the new values }
    end;
  end;
end;
```

The file manager application now lets you change the attributes on any selected file.

Moving, copying, and renaming files

Moving, copying, and renaming files are all similar operations, in that they all produce a file from another file. The difference is in how they treat the original file. Copying leaves the original file alone. Renaming changes the name of the original file. Moving deletes the original file after copying it to its new location.

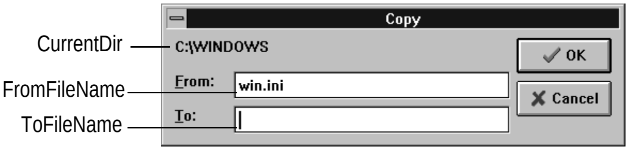
The run-time library provides a function called *RenameFile* that handles renaming. The *FMXUtils* unit provides similar procedures called *MoveFile* and *CopyFile* for those operations. Each routine takes two string parameters: the name of the original file and the name of the destination file. In fact, you can easily provide a single method in your application that handles any of the three operations.

The following code shows a method called *ConfirmChange* that displays a confirmation dialog box, then performs the specified operation if confirmed:

```
procedure TFMForm.ConfirmChange(const ACaption, FromFile, ToFile: string);
begin
  if MessageDlg(Format('%s %s to %s?', [ACaption, FromFile, ToFile]),
    mtConfirmation, [mbYes, mbNo], 0) = mrYes then
  begin
    if ACaption = 'Move' then
      MoveFile(FromFile, ToFile)
    else if ACaption = 'Copy' then
      CopyFile(FromFile, ToFile)
    else if ACaption = 'Rename' then
      RenameFile(FromFile, ToFile);
    FileList.Update;
  end;
end;
```

Because all three operations are so similar, the file manager application can share much of the code involved. In particular, you can create a dialog box that prompts the user for an original name and a destination name, and use the same dialog box no matter which operation the user requests. Figure 13.5 shows the dialog box and the names of its components.

Figure 13.5 The change-file dialog box


Copy

C:\WINDOWS

From: win.ini

To:

Once you've designed the dialog box, you can open it from an event handler shared by the Move, Copy, and Rename items on the File menu by doing the following:

1 Double-click the main-menu component (not the File menu itself) on the main form to open the Menu Designer.

2 In the Menu Designer window, choose File | Move.

3 Choose the Events page in the Object Inspector.

4 Click in the Handler column next to the *OnClick* event.

5 Type in `FileChange` and press *Enter*.

Delphi generates an event handler called *FileChange*.

6 In the Menu Designer window, choose File | Copy and set its *OnClick* handler to *FileChange*.

7 Repeat step 6 for File | Rename.

➤ You can then fill in the empty *FileChange* handler as follows:

```
procedure TFMForm.FileChange(Sender: TObject);
begin
  with ChangeDlg do
  begin
    if Sender = Move1 then Caption := 'Move'
    else if Sender = Copy1 then Caption := 'Copy'
    else if Sender = Rename1 then Caption := 'Rename'
    else Exit;
    CurrentDir.Caption := DirectoryOutline.Directory;
    FromFileName.Text := FileList.FileName;
    ToFileName.Text := '';
    if (ShowModal <> mrCancel) and (ToFileName.Text <> '') then
      ConfirmChange(Caption, FromFileName.Text, ToFileName.Text);
  end;
end;
```

The application now displays the file-change dialog box with the correct caption, and performs the correct operation.

Executing an application

Many times an application needs to execute another application, either to perform a specific task or just to have that application run concurrently. The Windows API provides a function, *ShellExecute*, that executes an application, but it requires a number of parameters superfluous to Delphi applications. The *FMXUtils* unit provides a more useful alternative, called *ExecuteFile*.

ExecuteFile operates in two different ways. If passed the name of an executable file, *ExecuteFile* runs that application. If passed the name of a document with an associated application, *ExecuteFile* runs the application, automatically opening that document at startup.

Executing a file from a file list box

ExecuteFile takes three string parameters and a fourth parameter that indicates how it should display the window containing the executed application. The three strings represent the name of the file, any command-line parameters to pass to the application, and the directory to use as the startup directory.

The last parameter should be one of Windows' constants used for the *ShowWindow* API function. For example, *SW_SHOW* shows the window normally, *SW_SHOWMINIMIZED* shows the window initially as an icon, and so on.

A file list box contains all the information you need to execute a file in the list. The following code shows a simple use of *ExecuteFile* to execute the currently selected file in the file list box:

```
procedure TFMForm.Open1Click(Sender: TObject);
begin
  with FileList do
    ExecuteFile(FileName, '', Directory, SW_SHOW);
end;
```

➤ If you add the *Open1Click* method to handle the File | Open menu item's click event, you can execute the selected file. You can attach the same handler to the file list box's double-click event, so that double-clicking an item executes it.

Of course, it doesn't always make sense to execute a file. If the selected item is a directory; for example, instead of executing it, you probably want to open it, or change to that directory.

The following code shows another version of *Open1Click* that handles directories differently from files:

```
procedure TFMForm.Open1Click(Sender: TObject);
begin
  with FileList do
  begin
    if HasAttr(FileName, faDirectory) then
      DirectoryOutline.Directory := FileName
    else ExecuteFile(FileName, '', Directory, SW_SHOW);
  end;
end;
```

HasAttr is a Boolean function in the *FMXUtils* unit that returns *True* if the file named in its first parameter has the specified attribute set and *False* otherwise.

Setting the directory outline's *Directory* property to the new directory changes to that directory. Because you handle the directory outline's change event by updating the file list box, double-clicking a directory in the file list box now has the effect of changing directories.

Dragging and dropping

Dragging and dropping of items on a form can be a handy way to enable users to manipulate objects in a form. You can let users drag entire components, or let them drag items out of components such as list boxes into other components.

There are four essential elements to drag-and-drop operations:

1. Starting a drag operation
2. Accepting dragged items
3. Dropping items
4. Ending a drag operation

Starting a drag operation

Every control has a property called *DragMode* that controls how the component responds when a user begins dragging the component at run time. If *DragMode* is *dmAutomatic*, dragging begins automatically when the user presses a mouse button with the cursor on the control. A more common usage is to set *DragMode* to *dmManual* (which is the default) and start the dragging by handling mouse-down events.

■ To start dragging a control manually, call the control's *BeginDrag* method.

BeginDrag takes a Boolean parameter called *Immediate*. If you pass *True*, dragging begins immediately, much as if *DragMode* were *dmAutomatic*. If you pass *False*, dragging doesn't begin until the user actually moves the mouse a short distance. Calling `BeginDrag(False)` allows the control to accept mouse clicks without beginning a drag operation.

You can also place conditions on whether to begin dragging, such as checking which button the user pressed, by testing the parameters of the mouse-down event before calling *BeginDrag*.

➤ The following code, for example, handles a mouse-down event on a file list box by beginning dragging only if the left mouse button was pressed:

```
procedure TFMForm.FileListBox1MouseDown(Sender: TObject;
  Button: TMouseButton; Shift: TShiftState; X, Y: Integer);
begin
  if Button = mbLeft then                          { drag only if left button pressed }
    with Sender as TFileListBox do                   { treat Sender as TFileListBox }
    begin
      if ItemAtPos(Point(X, Y), True) >= 0 then              { is there an item here? }
        BeginDrag(False);                                             { if so, drag it }
    end;
end;
```

Once you run the program, you'll see that you can drag items from the file list box, but that the cursor always indicates that you can't drop the item anywhere. The cursor never changes from the slashed circle. Before you can drop items, you have to have controls that accept drops. You'll add those in the next section.

Accepting dragged items

When a user drags something over a control, that control receives an*OnDragOver* event, at which time it must indicate whether it can accept the item if the user drops it there. Delphi changes the drag cursor to indicate whether the control can accept the dragged item.

■ To accept items dragged over a control, attach an event handler to the control's *OnDragOver* event. The drag-over event has a variable parameter called*Accept* that the event handler can set to *True* if it will accept the item.

Setting *Accept* to *True* specifies that if the user releases the mouse button at that point, dropping the dragged item, the application can then send a drag-drop event to the same control. If *Accept* is *False*, the application won't drop the item on that control. This means that a control should never have to handle a drag-drop event for an item it doesn't know how to handle.

The drag-over event includes several parameters, including the source of the dragging and the current location of the mouse cursor. The event handler can use those parameters to determine whether to accept the drop. Most often, a control accepts or rejects a dragged item based on the type of the sender, but it can also accept items only from specific instances.

➤ In the following example, a directory outline accepts dragged items only if they come from a file list box:

```
procedure TFMForm.DirectoryOutline1DragOver(Sender, Source: TObject; X,
  Y: Integer; State: TDragState; var Accept: Boolean);
begin
  if Source is TFileListBox then
    Accept := True;
end;
```

Dropping items

Once a control indicates that it can accept a dragged item, it should then also define some way to handle the item should it be dropped. If a user sees the mouse cursor change to indicate that a control will accept the item being dragged, it is reasonable for the user to then expect that dropping the item there will accomplish some task.

■ To handle dropped items, attach an event handler to the *OnDragDrop* event of the control accepting the dropped item.

Like the drag-over event, the drag-drop event indicates the source of the dragged item and the coordinates of the mouse cursor over the accepting control. These parameters enable the drag-drop handler to get any needed information from the source of the drag and determine how to handle it.

➤ For example, a directory outline accepting items dragged from a file list box can move the file from its current location to the directory dropped on:

```
procedure TFMForm.DirectoryOutline1DragDrop(Sender, Source: TObject; X,
  Y: Integer);
begin
  if Source is TFileListBox then
    with DirectoryOutline do
      ConfirmChange('Move', FileList.FileName, Items[GetItem(X, Y)].FullPath);
end;
```

Dragging and dropping now has the same effect as using File|Move, but the user doesn't need to type in the file name.

Ending a drag operation

When a dragging operation ends, either by dropping the dragged item or by the user releasing the mouse button over a control that doesn't accept the dragged item, Delphi sends an end-drag event back to the control the user dragged.

■ To enable a control to respond when items have been dragged from it, attach an event handler to the *OnEndDrag* event of the control.

The most important parameter in an *OnEndDrag* event is called *Target*, which indicates which control, if any, accepts the drop. If *Target* is **nil**, it means no control accepts the dragged item. Otherwise, *Target* is the control that accepts the item. The *OnEndDrag* event also includes the *x*- and *y*-coordinates on the receiving control where the drop occurs.

➤ In this example, a file list box handles an end-drag event by refreshing its file list, assuming that dragging a file from the list changes the contents of the current directory:

```
procedure TFMForm.FileListBox1EndDrag(Sender, Target: TObject; X, Y: Integer);
begin
  if Target <> nil then FileList.Update;
end;
```

Summary

The sample application in this chapter demonstrates a number of widely useful tasks, including specific applications of some outline, list-box, and tab-set controls, using image controls to store hidden bitmaps, dragging and dropping within an application, and manipulating files.

There are a number of other features you would probably want to add to the application for real use, such as dragging and dropping to the drive tab set, handling of multiple file selections, and display of file information other than the size. All of these are straightforward extensions to the existing application.

Chapter

14

Exchanging data with DDE or OLE

Exchanging data among applications is an important feature of multitasking environments such as Microsoft Windows. You're probably already familiar with one way to share data: the Windows Clipboard. With Clipboard objects and methods such as *CopyToClipboard*, Delphi enables you to take advantage of the Clipboard. See Chapter 10 for an example that uses the Clipboard, or search online Help for *TClipboard* for more information about using Clipboard objects.

Data sharing methods such as Dynamic Data Exchange (DDE) and Object Linking and Embedding (OLE) are even more powerful. With them, you can automatically reflect changes in one data file to many users using many instances of your application. You can create a front end that integrates the data and functionality of a word processor, spreadsheet, and database all in one application. You can even run and control other applications from within your application.

This chapter discusses

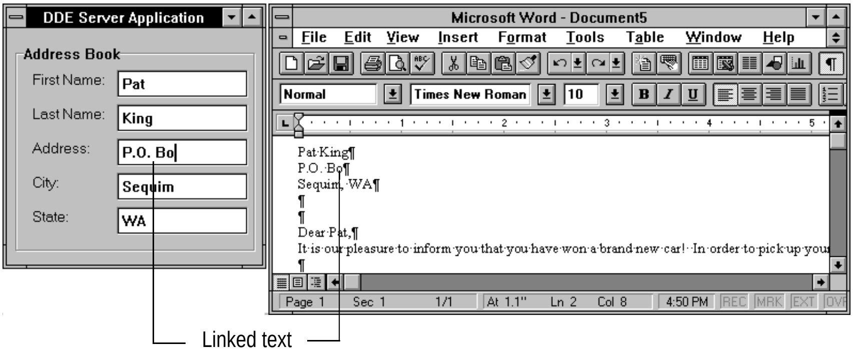
- Using DDE
- Using OLE
- Comparing DDE and OLE

Using DDE

Dynamic Data Exchange (DDE) sends data to and receives data from other applications. With Delphi, you can use this data to exchange text with other applications. You can also send commands and macros to other applications, so your application can control other applications.

Here's a typical way to use DDE: a link between two applications is established, either by your application or the other application. Once this link (called a *conversation*) is established, the two applications can continuously and automatically send data back and forth. A typical use for DDE is to exchange text data. When the text changes in one application, DDE automatically updates the text in the other. For example, in the following figure, text changes in the Delphi application are automatically reflected in Word.

Figure 14.1 A DDE conversation between a Delphi application and Microsoft Word 6.0.



Address Book

First Name: Pat
Last Name: King
Address: P.O. Bo
City: Sequim
State: WA

Pat·King¶
P.O.·Bo¶
Sequim,·WA¶
¶
¶
Dear·Pat,¶
It·is·our·pleasure·to·inform·you·that·you·have·won·a·brand·new·car!··In·order·to·pick·up·you
¶

Linked text

Note Not all applications support DDE. To determine whether an application supports DDE, refer to its documentation.

To understand DDE applications, you need to become familiar with the concept of DDE conversations.

DDE conversations

In order to have a DDE conversation, there must be a DDE *client* application and a DDE *server* application. The application that requests data is the client. The application that provides the requested data, and updates the DDE client, is the DDE server. With Delphi, you can create both DDE clients and DDE servers. In fact, a single Delphi application can be both a DDE client and a DDE server at the same time. A DDE conversation is defined by its *service*, *topic*, and *item*.

Note Sometimes DDE clients are called *destinations*, and DDE servers are called *sources*. The terminology is interchangeable.

This section explains

- DDE services
- DDE topics
- DDE items

DDE services

The *service* of a conversation is the name of the DDE server. Typically, this is the server application's main executable file without the .EXE extension. For example, if you want your application to establish a conversation with Novell Quattro Pro 6.0 (QPW.EXE), the conversation service is QPW.

Sometimes, however, the service differs from the main executable file name. For example, if you want your application to establish a conversation with Borland ReportSmith 2.0 (RPTSMITH.EXE), the DDE service would be ReportSmith.

If the server is a Delphi application, the service is the project name without the .DPR or .EXE extension. For example, to establish a conversation with PROJ1.DPR the service is PROJ1.

Note The DDE service depends on the DDE server application. Refer to the documentation of the DDE server for specific information about specifying the DDE service.

Note Sometimes DDE services are called *application names*. The terminology is interchangeable.

DDE topics

The topic of a DDE conversation is a unit of data, identifiable to the server, containing the linked information. Typically, the topic is a file. For example, if the data you want to share is in the Quattro Pro notebook file NOTEBK1.WB2, the topic would be NOTEBK1.WB2; the full file name is used, including the extension.

If the server is a Delphi application, the topic is (by default) the caption of the form containing the data you want to link. For example, if you want to link to text in a form with a *Caption* of MyApp, the topic would be MyApp. (Optionally, you could use the name of a DDEServerConv component as explained in “Creating DDE server applications” on page 388.)

DDE items

The item of a DDE conversation identifies the actual piece of data to link. The syntax used for specifying the DDE item depends on the DDE server application. Examples of possible DDE items are spreadsheet cells or database fields. For example, to link to cell A1 on page A in a Quattro Pro notebook, the item would be $A:$A$1..$A$1.

If the server is a Delphi application, the item is the name of the linked DDEServerItem component. For example, to establish a conversation with the DDE server component named *DDEServer1*, the item would be DDEServer1. DDEServerItems are discussed in “Creating DDE server applications” on page 388.

Note See the documentation for the DDE server for specific information about specifying the application, topic, and item of a conversation.

Creating DDE client applications

DDE client applications initiate conversations and typically request to receive data from DDE servers. Client applications can also send data to servers, which is called *poking* data. They can also execute macros of servers with macro capabilities.

■ To create a DDE client to be automatically updated by a DDE server,

1 Add a DDEClientConv and a DDEClientItem component to a form.

2 Assign the name of the DDEClientConv component to the *DDEConv* property of the DDEClientItem component. To establish a link at design time, choose this value from a list of possible conversations for *DDEConv* in the Object Inspector. To establish a link at run time, your application should execute code that assigns the value to the *DDEConv* property.

➤ For example, the following code links an DDEClientItem component named *DDEClientItem1* to a DDEClientConv component named *DDEClientConv1*:

```
DDEClientItem1.DDEConv := 'DDEClientConv1';
```

■ To create a DDE client to be manually updated by a DDE server, add only a DDEClientConv component to a form. To be updated, your client application must execute code that calls the *RequestData* method of the DDEClientConv component. See "Requesting data" on page 386 for more information.

Of course, no DDE conversation is yet taking place, because the *DDEClientConv* component has not yet been connected to a DDE server. Nonetheless, you have "set the stage" for this conversation to take place from your Delphi application. The next sections explain

- Establishing a link with a DDE server
- Requesting data
- Poking data
- Controlling other applications

Establishing a link with a DDE server

If you have access to the DDE server application and data, you can establish a DDE link by pasting it from the Clipboard at design time.

■ To paste a DDE link from the Clipboard at design time,

1 Activate the server application and select the data to link to your client application.

➤ For example, to link to a cell in a Quattro Pro notebook called C:\NOTEBK1.WB2, run Quattro Pro, load the notebook, and select the cell.

2 Copy the data and DDE link information to the Clipboard from the server application. Typically, you do this by choosing Copy from the Edit menu of the server.

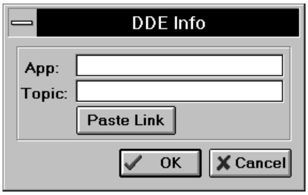
➤ For example, in Quattro Pro choose Edit | Copy.

3 Activate Delphi and select the DDEClientConv component.

4 Click either the *DDEService* or the *DDETopic* property in the Object Inspector, then click the ellipsis (...) button.

The DDE Info dialog box appears.

Figure 14.2 The DDE Info dialog box



5 Choose Paste Link.

The App and Topic boxes are filled in with the correct values automatically. If the Paste Link button is disabled, then the application you intended to be the server does not support DDE, or the DDE information was not successfully copied to the Clipboard.

➤ For example, if you copy from the Quattro Pro notebook C:\NOTEBK1.WB2, App is QPW and Topic is C:\NOTEBK1.WB2.

6 Choose OK.

The *DDEService* and *DDETopic* properties now contain the appropriate values to establish a DDE link.

7 Select the DDEClientItem component and choose the name of the linked DDEClientConv component for the *DDEConv* property from the list in the Object Inspector.

8 If the contents of the Clipboard haven't changed since you completed step 2, then the Clipboard contains a value for the DDE item of the conversation. Choose this value for the *DDEItem* property from the drop-down list in the Object Inspector. If the contents of the Clipboard do not contain a value for the DDE item, type the appropriate value for *DDEItem* in the Object Inspector.

➤ For example, if you copy cell A1 from page A in the Quattro Pro notebook, select or type $A:$A$1..$A$1 for *DDEItem*. Remember that you also need to provide your application with an area and a means to display the data being exchanged. The *DDEItem* component is nonvisual, so it serves only as a means of access, not a means of display.

■ To establish a DDE link at run time, specify the service and topic of the conversation, using the *SetLink* method of the DDEClientConv component.

The first parameter of *SetLink* is a string specifying the service, and the second parameter is a string specifying the topic. *SetLink* assigns these strings to the *DDEService* and *DDETopic* properties of the DDEClientConv component, respectively. For more information about this method, search online Help for *SetLink*.

Note Simply assigning values to the *DDEService* and *DDETopic* properties of a DDEClientConv component does not establish a link at run time. You need to use the *SetLink* method to property initiate a DDE conversation.

➤ For example, execute the following line of code to link to a Quattro Pro notebook named C:\NOTEBK1.WB2:

```
DDEClientConv1.SetLink('QPW', 'C:\NOTEBK1.WB2');
```

■ After using the *SetLink* method, you need to assign the DDE item of the conversation to the *DDEItem* property of the DDEClientItem component.

➤ For example, execute the following line of code to link to cell A1 on page A of the Quattro Pro notebook:

```
DDEClientItem1.DDEItem := '$A:$A$1..$A$1';
```

When a DDE link has been established, the linked data appears in the *Text* and *Lines* properties of the DDEClientItem component. *Text* specifies a **string**, and *Lines* specifies a

TStrings object. *Text* can contain up to 255 characters of linked text data. If the text data from the DDE server is longer than 255 characters, use *Lines* to access the data. The data is continuously updated by the DDE server, and an *OnChange* event of the DDEClientItem component occurs whenever the data changes.

■ One way to process linked text data is to display it in an edit box (*Edit* component). To do this, you assign the value of the *Text* property of the DDEClientItem to the *Text* property of the edit box (or, for larger bodies of text, you could assign the *Lines* property of the DDEClientItem to the *Lines* property of a memo). Attach the assignment statement to the *OnChange* event handler of the DDEClientItem.

➤ For example, if the DDEClientItem component is named *DDEClientItem1* and the edit box is named *Edit1*, execute the following code:

```
Edit1.Text := DDEClientItem1.Text;
```

Requesting data

Some DDE items aren't passed automatically in a DDE conversation. Instead, the client must explicitly request a specific item to be updated by the DDE server. Also you might want your client application to obtain data from a DDE server once, and not be continually updated by the DDE server. In these cases, your DDE client should request to be updated with the *RequestData* method.

Note To determine if your DDE client must explicitly request to be updated, see the documentation of the DDE server application.

■ To request data, use the *RequestData* method of a DDEClientConv component. Specify the item to request as a parameter of *RequestData.* The item is the simply a DDE item. *RequestData* returns a *PChar* null-terminated string containing the requested text.

The requested data is given to the DDE client only in the return value of *RequestData*. Even if the DDEClientConv component is connected to a DDEClientItem component, *RequestData* won't update the values of the *Text* or *Lines* properties of the DDEClientItem. Search online Help for *RequestData* for more information about this method.

➤ For example, to request the data from cell A1 on page A in a Quattro Pro notebook, and store the data in a *PChar* variable named *TheData*, execute the following code:

```
TheData := DDEClientConv1.RequestData('$A:$A$1..$A$1');
```

Note The memory for the *PChar* string returned by *RequestData* must be freed after your application is finished with it. Use the *StrDispose* function to do this.

➤ For example, after your application has processed *TheData*, you should deallocate it with the following code:

```
StrDispose(TheData);
```

Poking data

Poking data means sending data from your DDE client application to the DDE server application, directly opposite the usual data flow direction for DDE.

- To poke data, use the *PokeData* or *PokeDataLines* methods of a DDEClientConv component. *PokeData* pokes a *PChar* string, while *PokeDataLines* pokes a *TStrings* object.

  The first parameter of *PokeData* specifies the item of the DDE conversation (usually specified in the *DDEItem* property of the associated DDEClientItem component). The second parameter of *PokeData* is a *PChar* containing the text to send. *PokeDataLines* functions similarly, except its second parameter is of type *TStrings*. Search online Help for *PokeData* or *PokeDataLines* for more information about these methods.

➤ For example, to send the text 'Hello' from a DDEClientConv component named *DDEClientConv1* to a linked DDE server, execute the following code, assuming that *TheText* is of type *PChar*:

```
StrPCopy(TheText, 'Hello');
DDEClientConv1.PokeData(DDEClientItem1.DDEItem, TheText);
```

The text string "Hello" is inserted into the DDE item specified in the *DDEItem* property of *DDEClientItem1*.

Note *StrPCopy* simply copies a Pascal-style **string** into a null-terminated *PChar* string.

Just as you need to provide an area and a means to display DDE data in your application, so you also need to provide a source for the data you want your application to poke. In the previous example, the text string itself was passed as a parameter, but in most of your "real world" applications, the DDEClientConv control probably obtains this data from another control.

Controlling other applications

All DDE client applications can control server applications in one particular way: clients attempt to run servers, when necessary. When your DDE client tries to establish a link with a DDE server that isn't running, the client attempts to activate the server and load the conversation topic (specified in the *DDETopic* property of the DDEClientConv component).

- To activate a DDE server when the client form is created, set the value of the *ConnectMode* property of a DDEClientConv component to *dmAutomatic.*

  If the value of *ConnectMode* is *dmManual*, your application must execute the *OpenLink* method of the DDEClientConv component.

  Another way to control other applications is to execute macro commands.

- To execute a macro in the DDE server from within the DDE client, use the *ExecuteMacro* or *ExecuteMacroLines* methods of the DDEClientConv component to send text containing one or more macro commands to the server. The server then processes the macro. *ExecuteMacro* sends a *PChar* string, while *ExecuteMacroLines* sends a *TStrings* object.

➤ For example, you could tell Microsoft Word 6.0 to close its active worksheet by executing the following code in your client application, assuming that *TheMacro* is of type *PChar*:

```
StrPCopy(TheMacro, '[FileClose(2)]');
DDEClientConv1.ExecuteMacro(TheMacro, False);
```

In this example, the second parameter is a "wait flag." It specifies whether your client application should wait for the server application to indicate that it has finished processing the macro before sending any more DDE data to the server. If *False*, your application sends more data to the server if you execute another *ExecuteMacro, ExecuteMacroLines, PokeData*, or *PokeDataLines* method. If *True*, subsequent calls to these methods before the server has indicated the completion of the first macro do not send data. Search online Help for *ExecuteMacro* or *ExecuteMacroLines* for more information about these methods.

Note Not all DDE servers can process macros. See the documentation for the server application to determine whether it supports macros and for its macro syntax.

Creating DDE server applications

DDE server applications respond to DDE clients. Typically, they contain data to which the client application needs access. Servers simply update clients.

■ To create a DDE server, add a DDEServerItem component to a form.

The *Text* or *Lines* properties of the DDEServerItem component contain the data to link. Your server application continuously updates all clients with the value of the *Text* or *Lines* properties.

As with the DDEClientItem component, *Text* specifies a **string**, while *Lines* specifies a *TStrings* object. If the text to exchange is longer than 255 characters, use the *Lines* property to specify the data. When either *Text* or *Lines* is modified, the other is automatically updated to reflect the change. The value of *Text* always equals the value of the first line of *Lines*.

Optionally, you can add a DDEServerConv component and link the DDEServerItem and DDEServerConv together. When you add a DDEServerConv component, the DDE topic becomes the name of the DDEServerConv component (instead of the *Caption* of the form containing the DDEServerItem component). You should use a DDEServerConv component in the following situations:

- The value of the *Caption* property of the form containing the DDEClientItem component might change, or might not be unique at run time. If this value is not unique or constant, the link might not be able to be established.
- The DDE client might send a macro to your server application for processing. If this happens, an *OnMacroExecute* event of the DDEServerConv component occurs. The *OnMacroExecute* event contains a string parameter that specifies the macro sent from the DDE client. Search online Help for *OnMacroExecute* for more information about this event.

■ To create a DDE server using a DDEServerConv component,

1 Add DDEServerItem component and a DDEServerConv component to a form.

2 Assign the name of the DDEServerConv component to the *ServerConv* property of the DDEServerItem component.

At design time, choose this value from a list of possible conversations for *ServerConv* in the Object Inspector. To establish this link at run time, your application should execute code that assigns the value to the *ServerConv* property.

➤ For example, the following code links a DDEServerItem component named *DDEServerItem1* to a DDEServerConv component named *DDEServerConv1*:

```
DDEServerItem1.ServerConv := 'DDEServerConv1';
```

Establishing a link with a DDE client application

Typically, it is up to the DDE client to establish the link with a DDE server application. If you want to test a link from your DDE server, you can use the Clipboard to paste a link.

■ To establish a DDE link,

1 Use the *CopyToClipboard* method of the DDEServerItem component to copy the value of the *Text* (or *Lines*) property, along with DDE link information, to the Clipboard.

2 Insert the linked data into the DDE client application. Typically, do this by choosing the appropriate command (such as Edit | Paste Special or Edit | Paste Link) of the client application.

Search online Help for *CopyToClipboard* for more information about this event.

➤ For example, to create a link from a DDEServerItem component named *DDEServerItem1* to a WordPerfect 6.0 document, perform the following steps. (If you don't have WordPerfect installed, this example is worth examining because the steps required are similar for any other DDE client application that can paste links.)

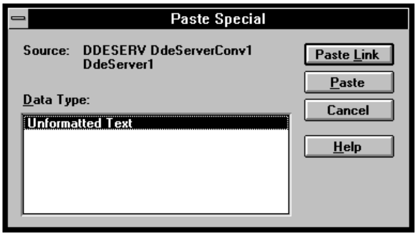
1 At run time, your DDE server application should execute the following code:

```
DDEServerItem1.CopyToClipboard;
```

2 Activate WordPerfect and choose Edit | Paste Special.

The WordPerfect Paste Special dialog box appears.

Figure 14.3 The WordPerfect Paste Special dialog box



Paste Special

Source: DDESERV DdeServerConv1 DdeServer1

Data Type:

Unformatted Text

3 Choose Paste Link.

The Paste Special dialog box closes and the linked text from the *Text* (or *Lines*) property of *DDEServerItem1* appears at the insertion point in the WordPerfect document. When the value of *Text* (or *Lines*) changes, the text in the WordPerfect document is updated automatically.

Note The method for establishing a DDE link depends on the DDE client application. See the documentation for the client for specific information about establishing DDE links. If the DDE client is another Delphi application, refer to "Establishing a link with a DDE server" on page 384.

■ One way to process linked text data is to keep the client updated to changes in an edit box (Edit component) in your DDE server application. Assign the value of the *Text* property of an edit box to the *Text* property of the DDEServerItem (or, for larger bodies of text, you could assign the *Lines* property of a memo to the *Lines* property of the DDEClientItem). Attach the assignment statement to the *OnChange* event of the edit box or memo.

➤ For example, if the edit box is named *Edit1* and the DDEServerItem component is named *DDEServerItem1*, execute the following code:

```
DDEServerItem1.Text := Edit1.Text;
```

Using OLE

This section explains

- What is OLE?
- Creating OLE container applications
- OLE data in files

What is OLE?

Object Linking and Embedding (OLE) is a method for sharing data among applications. To use OLE, one application must be an *OLE server*, and another application must be an *OLE container*. With Delphi, you can create OLE container applications.

An OLE server is an application that can create and edit an *OLE object*. An OLE container is an application that can contain an OLE object. An OLE object is simply the data shared by the two applications. Examples of OLE objects are documents, spreadsheets, pictures, and sounds.

Here's a typical way to use OLE: the OLE container application displays a picture representing the OLE object. The user activates the OLE object, typically by double-clicking the picture. When the OLE object is activated, the OLE server application opens, and the user can edit the OLE object using the OLE server. Then the user updates the OLE object within the OLE container and closes the OLE server.

Note Not all applications support OLE. To determine whether an application supports OLE, refer to its documentation.

This section explains

- OLE 1.0 and OLE 2.0
- Design-time and run-time object creation
- Linking and embedding
- OLE classes

- OLE documents
- OLE items

OLE 1.0 and OLE 2.0

There are two versions of OLE at the time of this writing: OLE 1.0 and OLE 2.0. When the user activates an OLE object that was created with an OLE 1.0 server application, the server application opens in its own window in the foreground and receives focus. The OLE container application exists in a separate window in the background.

When the user activates an OLE object that was created with an OLE 2.0 server application, the object might try to activate in place. *In-place activation* means the OLE server's menu is merged with the OLE container's menu. The server's tool bar replaces the container's tool bar, and the server might try to use the container's status bar. The object is edited from within the OLE container application window, but all the processing is handled by the OLE server.

Note The mode of activation depends upon the server with which the OLE object was created, not the container application in which it is linked or embedded. If an OLE 1.0 object is opened within an OLE 2.0-compliant application, it still opens in the OLE 1.0 style (not in place).

Design-time and run-time object creation

This chapter discusses creating OLE objects at design time. Chapter 15 discusses creating objects at run time. The following table discusses the differences between creating OLE objects at design time and at run time:

Design-time OLE object creation	Run-time OLE object creation
The object is stored in the executable file, increasing the size of the compiled application.	The object is stored in a file or exists only at run time, reducing the size of the compiled application.
The developer needs access to the OLE server application at design time.	The developer does not need access to the OLE server application at design time.
The OLE object is already created at run time, reducing application execution time.	The OLE object must be created at run time, increasing application execution time.
The OLE object can be edited at design time or run time.	The OLE object can be edited only at run time.
The application can contain only as many OLE objects as the number of OLEContainer components added at design time.	The application can create new OLEContainer components at run time to contain more OLE objects than were created at design time.

Note At design time, an object can't be activated in place. The OLE server activates in its own window, not in place, even if the object supports in-place activation. At run time, however, objects that support in-place activation are activated in place.

Linking and embedding

Data in a linked OLE object is stored in a file by the OLE server that created it. Data in an embedded OLE object is stored in the OLE container application. Here are guidelines for when to link or to embed OLE objects:

When to link	When to embed
You want to be able to make changes to the original object and have those changes reflected in all applications or documents linked to that original.	You want to be able to make changes to the object and have those changes reflected only in one particular application or document.
The original object is likely to be frequently modified, or modified from multiple OLE container applications.	The original object is unlikely to be frequently modified, or modified from only one instance of an OLE container application.
The original object file is unlikely to be frequently moved, and won't be deleted.	The original object file is likely to be frequently moved, or possibly deleted.
The object is large, and you will be distributing it via a network or electronic mail.	The object is small, or when the object is large but you won't be distributing it via a network or electronic mail.
You need to conserve disk space by having only one copy of the object.	You don't need to conserve disk space by having only one copy of the object.

Linked objects

Linked objects are stored in files. You can't create a new OLE link unless the OLE object has previously been saved to a file from within the OLE server application.

The data in an linked OLE object file can be modified by your OLE container application and by other applications. The OLE server application and other OLE container applications can all access and modify the OLE object. Data can exist in one location but be accessible from multiple applications.

You can program your OLE container application in Delphi to continually obtain the latest data from the OLE object file. When the OLE object data is modified, even by other applications, the changes will appear in all OLE container applications that contain a link to the file, including your own.

Embedded objects

Embedded objects are stored in your OLE container application. Other OLE container applications can't access the OLE object. The only time the embedded OLE object can be edited is when the user activates the object from your OLE container application. Only then can the OLE server edit the OLE object data.

Embedded OLE objects don't need to exist in files. All the data can be stored in your container application. This ensures that the OLE data cannot be accidentally deleted, modified, or corrupted by being stored in an external file. The drawback is that the size of your OLE container application increases by the size of the included OLE data.

If you want to make the changes you make to the embedded OLE object appear the next time you run your application, save the OLE data to a file. See "OLE data in files" on page 395 for more information.

OLE classes

The *class* of an OLE object determines the OLE server application that created the OLE object. Sometimes, you can link or embed more than one type of object from an OLE server application. For example, you could link or embed an entire spreadsheet, a range of cells, or a graph from a spreadsheet application. The OLE class also determines which type of data the OLE object contains.

For example, if the OLE object is a Quattro Pro notebook, the class would be Quattro Pro Notebook.

Note The OLE class must be specified for both linked and embedded objects.

OLE documents

The *document* of an OLE object determines the source file that contains the data for the OLE object. The object document must be used for a linked object, because linked objects exist in files. The object document is used for an embedded object only if you create the object from an existing source file. If you create a new embedded object that doesn't yet exist in a file, you would not specify an OLE document.

For example, if the OLE object is linked to the Quattro Pro notebook TUTOR.WB2 stored in the D:\OFFICE\QPW directory, the OLE document would be D:\OFFICE\QPW\TUTOR.WB2.

Note The OLE document must be specified only for linked objects. For embedded objects, only the OLE class should be specified.

OLE items

The item of an OLE object determines what portion of an OLE document contains the data to link or embed. Items are used when you want the OLE object to contain a smaller piece of data than an entire document file.

For example, if the OLE object is linked to the cell range B4 to B5 of the page titled GasCosts in a Quattro Pro notebook, the OLE document would be $GasCosts:$B$4..$B$5.

Note The OLE item must be specified only for linked objects. For embedded objects, only the OLE class should be specified.

Note You don't need to use the OLE item if the OLE object will not contain a piece of data more specific than the file specified in the OLE document.

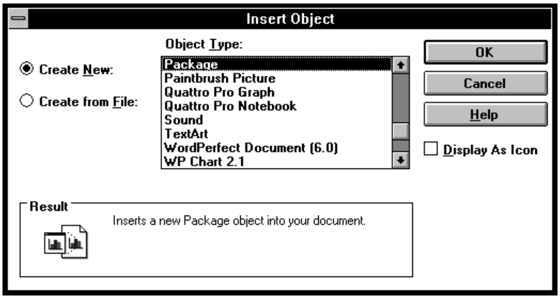
Creating OLE container applications

OLE container applications simply hold OLE objects.

- To create an OLE container application, add an OLEContainer component to a form for every OLE object you want the form to contain.
- To insert the OLE object at design time, if you have access to the OLE server and data, you specify the OLE class, and optionally, the document and item:

1. Select the OLEContainer component on your form.
2. Click the ellipsis button for either the *ObjClass* or *ObjDoc* property in the Object Inspector. The Insert Object dialog box appears.

   Figure 14.4 The Insert Object dialog box

   Inserts a new Package object into your document.

3. If you want to insert an object that has already been created and saved in a file by the OLE server, choose Create From File. Specify the file name and path to the OLE object file. To link the object, select the Link check box.

   If you want to embed a new object, choose Create New and select an OLE object from the Object Type list. You cannot link a new object, since it has not yet been saved as a file.

4. Choose OK.

   If you are creating a new object, the OLE server becomes active. From the OLE server, you can edit the OLE object. When you have finished creating the OLE object, update the OLE server and close the OLE object in your OLE container application. Typically, do this by choosing File | Close or File | Update within the OLE server application.

5. The *ObjClass* property now contains the appropriate value for the OLE class, and the OLEContainer component contains a picture representing the OLE object. If the OLE object was created from an existing file and you inserted a linked object, the*ObjDoc* property contains the appropriate value for the OLE document.

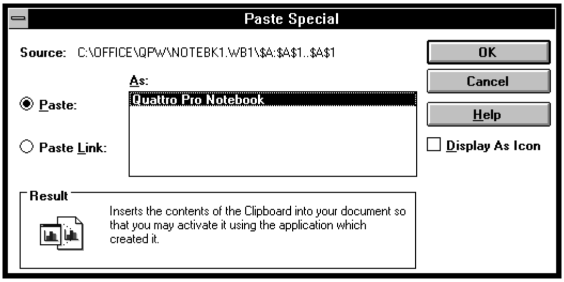
- If you have access to the OLE server application and data, you can paste an OLE object containing an OLE item at design time:

  1. Activate the server application and select the item to be contained (in the OLE object) by your OLEContainer component.
  2. Copy the data and OLE object information to the Clipboard from the server application. Typically, do this by choosing Edit | Copy.
  3. Activate Delphi and select the OLEContainer component.

4 Click the ellipsis (...) button for the *ObjItem* property in the Object Inspector.

The Paste Special dialog box appears with the currently available OLE object in the As list.

Figure 14.5 The Paste Special dialog box



Source: C:\OFFICE\QPW\NOTEBK1.WB1\$A:$A$1..$A$1

As: Quattro Pro Notebook

● Paste:

○ Paste Link:

Result

Inserts the contents of the Clipboard into your document so that you may activate it using the application which created it.

5 Select the OLE object from the As list.

6 Select Paste to create an embedded object or Paste Link to create a linked object.

7 Choose OK.

The OLEContainer component is now initialized. If you pasted an embedded object, the *ObjClass* property now contains the appropriate value for the OLE object. If you pasted a link to an OLE object in a file, the *ObjClass*, *ObjDoc*, and *ObjItem* properties are all specified. The OLEContainer component contains a picture representing the OLE object.

- If you have access to an OLE server application that supports drag-and-drop of OLE objects, you can create an OLE container component and embed an OLE object in a form by dragging the object from the server and dropping it on the form at design time:

1 Activate the server application and select the object to be embedded in the Delphi form.

2 Drag the OLE object by clicking the mouse button while the mouse pointer is over the selected object in the server and move the mouse pointer over the design-time form.

3 Drop the OLE object by releasing the mouse button.

An OLE container is created in the form and it is initialized to contain the dropped OLE object.

Note For information about initializing OLEContainer components at run time, see Chapter 15.

OLE data in files

If you want to save changes made to an OLE object from within your OLE container application, the object data should be saved in a file. If the object is linked, the data is automatically stored in the original source file, and the object is automatically updated every time the data changes.

If the object is embedded, however, the original data is stored in the form. To save any edits to the embedded object, your application must save the data in a special OLE file. To update an embedded object that has been saved to a file, your application must load the OLE object from the file. Otherwise, the OLEContainer will contain only the originally embedded OLE object. The OLE data file is not in the same format used by the application that created the original OLE object, though.

For example, if your container application saves an embedded spreadsheet to a file, the OLE server spreadsheet application wouldn't be able to open your file as a spreadsheet. Only your OLE container application can use the data saved in this file.

■ To save an OLE object, call the *SaveToFile* method of the OLEContainer component.

➤ For example, to store the OLE data in a file called SALES.OLE in the C:\TIPPER directory, execute the following code. The OLEContainer component is named *OleContainer1*.

```
OleContainer1.SaveToFile('C:\TIPPER\SALES.OLE');
```

■ To obtain OLE data from a file saved with the *SaveToFile* method, use the *LoadFromFile* method.

➤ To load the OLE data from the file saved by the previous code, execute the following code:

```
OleContainer1.LoadFromFile('C:\TIPPER\SALES.OLE');
```

If you attached the code above to the *OnCreate* event of the form containing the OLEContainer component, your application would restore the latest version of the OLE object every time you run your OLE container application.

For an example that uses *SaveToFile* and *LoadFromFile*, refer to Chapter 15. Search online Help for more information about *SaveToFile* and *LoadFromFile*.

Comparing DDE and OLE

DDE and OLE are both for sharing data between applications. When should you use DDE and when should you use OLE?

DDE is good for exchanging distinct text strings. If all you want to know is the bottom line of a profits spreadsheet, it makes sense to link the cell that contains the bottom line to a Delphi DDE client application. Then you could output the data in an edit box or label. DDE protects the data in the spreadsheet by not allowing the user to activate and edit the spreadsheet from your client application.

OLE is able to exchange more complex information than DDE, such as sounds and documents. Control transfers to the OLE server application when you activate an object in your OLE container, so the user can access all the functionality of the server application from within your container application. The server does all the processing and you don't have to program your container to edit the OLE object. This would be good if you wanted to allow your users to modify the profits spreadsheet from within your application.

The final factor in determining when to use DDE and when to use OLE is the capabilities of the applications involved. Some Windows applications don't support DDE. Some don't support OLE. Other applications can be OLE containers, but can't be OLE servers. For more information, see the documentation for the application with which you want to exchange data.

Summary

This chapter presented these topics:

- DDE conversations

  A DDE client application and DDE server application exchange text data in a DDE conversation. A conversation is defined by its service (name of the server), topic (file containing the linked data), and item (the actual text to link).

- Creating DDE client applications

  To create a DDE client, add a DDEClientConv component and a DDEClientItem component to a form. Client applications can request to be updated by the server with the *RequestData* method. Client applications can poke data (send data to the server) with the *PokeData* method. Clients can control the server by running it or sending macros with the *ExecuteMacro* method.

- Creating DDE server applications

  To create a DDE server, add a DDEServerItem component (and optionally, a DDEServerConv component) to a form. You can then copy DDE data to the Clipboard with the *CopyToClipboard* method and paste the link in the client application.

- What is OLE?

  With OLE you can link or embed OLE objects in a container application. An OLE link is defined by its class (name of the application that created the object), document (name of the file containing the object), and item (the portion of the document containing the OLE object to link).

- Creating OLE container applications

  To create an OLE container application, add an OLEContainer component to a form. Then, you can use the Insert Object dialog box to specify the *ObjClass* or *ObjDoc* properties, and the Paste Special dialog box to specify the *ObjItem* property. You can also drag-and-drop from an OLE server to embed an OLE object at design time.

- OLE data in files

  You can use the *SaveToFile* method to save OLE data in a file, and the *ReadFromFile* method to read OLE data from a file.

- Comparing DDE and OLE

  DDE exchanges text strings between applications and does not give the user access to the functionality of the source application. OLE can exchange more complex forms of information, such as documents, and allows the user to activate the source application to make changes to the data.

More advanced features of OLE such as run-time creation and drag-and-drop of OLE objects are covered in Chapter 15.

Chapter

15

OLE example

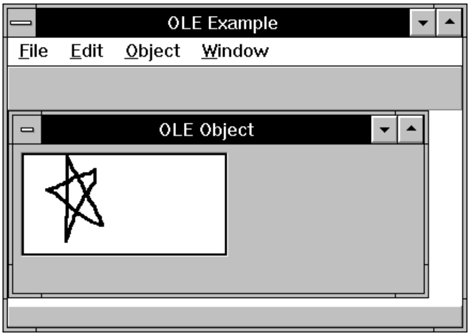
Now that you have read the material in Chapter 14, you're ready to practice exchanging data with Object Linking and Embedding (OLE) by building a simple application.

This chapter assumes you are familiar with basic OLE terms such as objects, linking, embedding, and OLE servers. It presents the steps involved in building a simple OLE container application that allows the user to insert, paste, and drop OLE objects into Multiple Document Interface (MDI) child windows. The application uses Windows common dialog boxes to save and open OLE objects.

Note The material presented in this chapter assumes you are familiar with the MDI application and common dialog material discussed in Chapter 10. The OLE example is also an MDI application that uses Windows common dialog boxes, but this example focuses on creating an OLE container application. If you are unfamiliar with creating MDI applications or using common dialog boxes, read Chapter 10 first.

The complete application appears under the DEMOS\DOC directory, and is called OLE.DPR. Figure 15.1 shows the application as it appears the first time a new window is opened.

Figure 15.1 The completed OLE container application



The topics discussed in the context of creating this application are

- Creating the MDI framework
- Inserting objects
- Pasting objects
- Dropping objects
- Working with objects in files

Creating the MDI framework

This application will allow the user to create multiple OLE objects, each within its own MDI child window. This gives the user an easy way to manipulate each object.

When an OLE object is activated, control switches to the OLE server that created the object. If the server uses OLE 1.0, the server is activated in a separate window. If the server uses OLE 2.0, the server might activate the object within your container application window (this is called *in-place activation*).

Two conditions must be met for an OLE object to activate in place within your OLE container application:

- The OLE server must support in-place activation.
- The main form of the OLE container application must contain a MainMenu component.

Note If you don't program your container application for in-place activation, an OLE object that supports in-place activation will be activated in its own window (not in place). See the documentation for the OLE server for information about whether it supports in-place activation.

This section describes the following steps involved in creating an MDI application framework for in-place activation of OLE objects:

- Creating the frame and child forms
- Adding the OLE container component
- OLE application menus
- OLE tool bars and status bars

Creating the frame and child forms

The first step in creating the OLE container application is to create an MDI frame form. The frame form displays "OLE Example" in the title bar and will contain multiple MDI child windows.

➤ Start by creating a new project. Then use the Object Inspector to set the following properties of the project's main form:

Property	Value
Caption	OLE Example

Property	Value
FormStyle	fsMDIForm
Name	OLEFrameForm

Next, you need to add an MDI child form. The MDI child will be displayed within *OLEFrameForm* at run time.

➤ Add a new form to the project and use the Object Inspector to set the following properties of the new form:

Property	Value
Caption	OLE Object
FormStyle	fsMDIChild
Name	OLEObjectForm

Since this application will create instances of *OLEObjectForm* dynamically at run time, it should not create an instance of *OLEObjectForm* automatically.

➤ Remove *OLEObjectForm* from the Auto-create list for the project.

1 Choose Options | Project to display the Project Options dialog box.

2 On the Forms page of the Project Options dialog box, move *OLEObjectForm* from the Auto-create forms list box to the Available forms list box.

3 Choose OK.

➤ Save the project now, using the following names:

Default name	Save as
UNIT1.PAS	OLEFRAME.PAS
UNIT2.PAS	OLEOBJ.PAS
PROJECT1.DPR	OLE.DPR

Adding the OLE container component

In this example, a child window can contain an OLE object. You'll add an OLEContainer component to *OLEObjectForm* to contain the OLE object. An OLEContainer component can contain only one object at a time. To contain more than one OLE object in a form, you need to add a new OLEContainer for each OLE object. However, this sample application will contain only one OLE object per *OLEObjectForm*.

You'll program the OLEContainer component to contain an actual OLE object at run time in the section "Inserting objects."

■ To create an OLE container application, add an OLEContainer component to a form.

➤ Add an OLE container component (from the System page of the Component palette) to *OLEObjectForm*, and use the Object Inspector to set the following properties of the OLE container component:

Property	Value
Name	OLEContainer
Top	8
Left	8
Height	96
Width	192

OLE application menus

The menus of an OLE container application behave like the menus of any other non-OLE application until an OLE 2.0 object that supports in-place activation is activated. If you aren't familiar with designing menus, see Chapter 3.

When you activate an object created by an OLE 2.0 server application, the server might try to merge its menus with the menus of your container application, depending on the OLE server application.

Note See the documentation for the OLE server for information about whether it attempts menu merge during in-place activation.

The *GroupIndex* property of each of the container application's menus determines where merging menu items appear in the container's menu bar. Merged menu items from the OLE server might replace those on the main menu bar, or they might be inserted beside existing container application menu items.

The OLE server will merge up to three groups of menu items: the Edit, View, and Help groups. Each group is distinguished by a unique group index and can contain any number of menu items. The following table summarizes which menu item groups the OLE server application will merge:

Group	Index	Description	Source (when OLE active)
File	0	Menu item(s) for using files and exiting the application	OLE container application
Edit	1	Menu item(s) for editing the active OLE object	OLE server application
Object	2	Menu item(s) for manipulating the deactivated OLE object	OLE container application
View	3	Menu item(s) for modifying the view of the OLE object	OLE server application
Window	4	Menu item(s) for manipulating windows	OLE container application
Help	5	Menu item(s) for accessing the server's online Help	OLE server application

Any menu items in your container application that have a *GroupIndex* property value of 1, 3, or 5 will be replaced by the menu items with corresponding index values from the OLE server application when an OLE object is activated in place. In this example, you'll create an Edit menu item with a *GroupIndex* value of 1; it will be replaced by an OLE server's Edit menu item group when the OLE object is activated.

The menu items from your OLE container that won't be replaced by the server are any that have a *GroupIndex* value other than 1, 3, or 5.

■ To prevent a menu item from an OLE container application from being replaced with menu items from an OLE server application when an OLE object is activated in place, assign a value of 0, 2, or 4 (or greater than 5) to the *GroupIndex* property of the menu item.

This section describes the following steps involved in creating the menus for the OLE example:

- Creating the frame form menu
- Creating the child form menu

Creating the frame form menu

■ To allow OLE objects to be activated in place, the main form of an application must contain a MainMenu component.

➤ To create the *OLEFrameForm* menu,

1 Add a MainMenu component (from the Standard page of the Component palette) to *OLEFrameForm*, and open the Menu Designer.

2 Create the File menu title and underlying menu items as shown in the following table. For each menu item, specify the values for the *Caption* property, and accept the values Delphi creates for the *Name* property.

&File
&New
&Open...
- <hyphen>
E&xit

By default the value of the *GroupIndex* property for the File menu title is 0, which is what you want. Later in the example, when you activate an OLE object, the menus merged from the OLE server application will be inserted to the right of the File menu because their index values are greater than 0.

Next, you will program the sample application to create and show a new *OLEObjectForm* window.

➤ To be able to create OLE object forms, the unit where *OLEObjectForm* is declared must be referenced by the *OLEFrame* unit. Add the *OLEObj* unit name to the **uses** clause of the **interface** section of the *OLEFrame* unit.

```
interface

uses ... , OLEObj;                                                     {Refer to unit OLEOBj.PAS}
```

```
type
⋮
```

➤ Write the following *CreateChild* method in the **implementation** part of the *OLEFrame* unit. This method will be called by the File | New *OnClick* event handler, so you won't use the Object Inspector to generate it.

```
function TOLEFrameForm.CreateChild: TOLEObjectForm;
begin
  CreateChild := TOLEObjectForm.Create(Self);           {Create the OLEObjectForm window}
end;
```

You need to declare *CreateChild* in order to call it at run time:

➤ Add the following line to the **private** part of the *TOLEFrameForm* type declaration in the **interface** part of the *OLEFrame* unit:

```
interface
⋮
type
  TOLEFrameForm = class(TForm)
  ⋮
  private
    function CreateChild: TOLEObjectForm;  {Add this line to declare CreateChild function}
  public
    { Public declarations }
  end;
⋮
```

Next, you will attach the *CreateChild* method to the *OnClick* event of the File | New menu item.

➤ Write the following event handler for the *OnClick* event of the File | New item on the *OLEFrameForm* menu bar.

```
procedure TOLEFrameForm.New1Click(Sender: TObject);
begin
  CreateChild                                                   {Call the CreateChild method}
end;
```

The code to create an *OLEObjectForm* child window was put in a separate method because it will also be called from the *OnDragDrop* event handler of *OLEFrameForm* (discussed in "Dropping objects"), as well as from the *OnClick* event handler for the File | Open menu item (discussed in "Working with objects in files"). This way, the child window creation code can be shared.

Next, you'll write the code to exit the application.

➤ Write the following event handler for the *OnClick* event of the File | Exit item on the *OLEFrameForm* menu bar.

```
procedure TOLEFrameForm.Exit1Click(Sender: TObject);
begin
  Close                             {close the main form, which terminates the application}
end;
```

You'll write the event handler for the File | Open item later in the example, in the section "Loading objects from files."

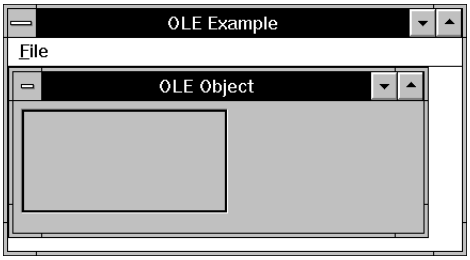
➤ Save the project now, then run it:

1 Choose File | New to create a new OLE Object window.

The application should resemble 2.

2 Choose File | Exit to close the application.

Figure 15.2 The OLEFrameForm and OLEObjectForm windows



Creating the child form menu

The menu items in *OLEObjectForm* provide users with ways to manipulate the object and object window in the running application. At run time, the File menu from *OLEObjectForm* replaces the File menu from *OLEFrameForm*. The other menu items from *OLEObjectForm* will be merged with the menu bar of *OLEFrameForm*.

➤ To create the *OLEObjectForm* menu,

1 Add a MainMenu component to *OLEObjectForm* and open the Menu Designer.

2 Create the File, Edit, Object, and Window menu titles and underlying menu items as shown in the following table. For each menu item, specify the value for the *Caption* property, and accept the values Delphi creates for the *Name* property.

&File	&Edit	&Object	&Window
&New	&Insert Object...	&Deactivate	&Cascade
&Open...	&Paste Special...		&Tile
&Save As...	- <hyphen>		&Arrange Icons
- <hyphen>	&Object		
E&xit			

3 Specify the *GroupIndex* property values for the File, Edit, Object, and Window menu titles as shown in the following table:

Menu	*GroupIndex*
File	0 (default)
Edit	1

Menu	*GroupIndex*
Object	2
Window	4

Note The *GroupIndex* property of the Edit menu has the same value (1) as the index of the Edit menu group from the OLE server. When an OLE object is activated in place, the Edit menu item group from the OLE server replaces the Edit menu from *OLEObjectForm*. The other menu item groups from the OLE server are merged with the menu of *OLEObjectForm*.

The *OnClick* event handlers for the New and Exit menu items on the File menu of the *OLEObjectForm* menu bar simply call the corresponding event handlers of the *OLEFrameForm* menu bar.

➤ To be able to call methods of *OLEFrameForm*, the unit where *OLEFrameForm* is declared must be referenced by the *OLEObj* unit. Add a **uses** clause to the **implementation** part of the *OLEObj* unit, and refer to the *OLEFrame* unit.

```
implementation

uses OLEFrame;                                                    {Refer to unit OLEFRAME.PAS}
⋮
```

Note Do not add *OLEFrame* to the **uses** clause in the **interface** section of *OLEObj*. This would cause a circular unit reference error at compile time.

➤ Write the following event handler for the *OnClick* event of the File | New item on the *OLEObjectForm* menu bar:

```
procedure TOLEObjectForm.New1Click(Sender: TObject);
begin
  OLEFrameForm.New1Click(Sender)                      {Call OLEFrameForm's File|New handler}
end;
```

➤ Write the following event handler for the *OnClick* event of the File | Exit item on the *OLEObjectForm* menu bar:

```
procedure TOLEObjectForm.Exit1Click(Sender: TObject);
begin
  OLEFrameForm.Exit1Click(Sender)                    {Call OLEFrameForm's File|Exit handler}
end;
```

The *OnClick* event handlers for the Tile, Cascade, and Arrange Icons menu items on the Window menu of the *OLEObjectForm* menu bar call the corresponding method of *OLEFrameForm*. These methods simply control the appearance of the *OLEObjectForm* MDI child window(s).

➤ Write the following event handler for the *OnClick* event of the Window | Cascade item on the *OLEObjectForm* menu bar:

```
procedure TOLEObjectForm.Cascade1Click(Sender: TObject);
begin
  OLEFrameForm.Cascade                             {Cascade the MDI children of OLEFrameForm}
end;
```

➤ Write the following event handler for the *OnClick* event of the Window | Tile item on the *OLEObjectForm* menu bar:

```
procedure TOLEObjectForm.Tile1Click(Sender: TObject);
begin
  OLEFrameForm.Tile                                {Tile the MDI children of OLEFrameForm}
end;
```

➤ Write the following event handler for the *OnClick* event of the Window | Arrange Icons item on the *OLEObjectForm* menu bar:

```
procedure TOLEObjectForm.ArrangeIcons1Click(Sender: TObject);
begin
  OLEFrameForm.ArrangeIcons         {Arrange the icons of the MDI chilren of OLEFrameForm}
end;
```

You'll write the *OnClick* event handlers for the Edit and Object menu items, as well as for File | Open and File | Save As later in the example.

The OLE object menu item

The Edit | Object menu command of the *OLEObjectForm* menu bar is a special menu item. It will be the *OLE object menu item*. This item enables the user to open, edit, or convert an OLE object when an OLE container containing an object is selected at run time. You don't program your OLE container application for this functionality; it comes from OLE itself.

■ To designate a menu item as the OLE Object menu item, assign the name of the menu item to the *ObjectMenuItem* property of the form that owns the menu item.

➤ To make the Edit | Object menu command the OLE object menu item,

1 Open the Menu Designer for the menu of *OLEObjectForm.*

2 Change the value of the *Name* property of the Edit | Object menu item from *Object1* to *OLEObjectMenuItem*.

   This is simply to make this menu command easier to identify. The OLE object menu item can have any valid value for its *Name* property, including *Object1*.

3 In the Object Inspector, change the value of the *OLE object form's ObjectMenuItem* property to *OLEObjectMenuItem.*

➤ Save the project now, then run it:

1 Choose File | New to create a new OLE Object window.

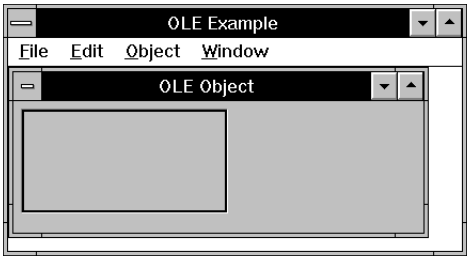
   The application should look like Figure 15.3. Note that the *OLEObjectForm* menu has merged with the *OLEFrameForm* menu.

2 Choose the various menu commands of the application.

   The Window menu commands should control the appearance of any *OLEObjectForm* MDI child windows. Note that the Edit | Object menu item is disabled automatically, because *OLEContainer* does not contain an OLE object yet.

3 Choose File | Exit to close the application.

Figure 15.3 The OLE container application menu



OLE tool bars and status bars

When an OLE object is activated in place, the OLE server might try to replace the container application's tool bar and status bar messages with its own, depending on the OLE server application. If you intend the container application to contain OLE objects that can be activated in place, you should program your application to allow the OLE server to use your container's tool bar and status bar.

This section describes the following steps involved in allowing an OLE server to use the tool bar and status bar of your container application:

- Setting up tool bars and status bars
- Adding the tool bar to the container application
- Adding the status bar to the container application

Setting up tool bars and status bars

Usually, you create tool bars and status bars by modifying Panel components. When an OLE object is activated in place, Panels (and any other aligned controls) are candidates for client-space negotiation with the OLE server. This means that the OLE server can replace controls (except those that have been locked) aligned to any edge of the client area of a form of the OLE container application. For example, if a Panel is aligned*alTop*, *alLeft*, *alBottom*, or *alRight* and is not locked, the OLE server can replace it. If the Panel is aligned *alClient* or *alNone*, the OLE server will not replace it.

■ To prevent an OLE server application from replacing the tool bar or status bar of an OLE container application, lock the tool bar or status bar Panel by assigning True to its*Locked* property.

Adding the tool bar

You create a tool bar for OLE in-place activation the same way you create a tool bar for a non-OLE application. If you are unfamiliar with creating tool bars, see Chapter 12 for information about this process.

■ To allow an OLE server to replace the tool bar of an OLE container application with its own when an OLE object is activated in place, assign*alTop*, *alBottom*, *alLeft*, or *alRight* to the *Align* property of a Panel component which is not locked.

➤ Add a Panel component (from the Standard page of the Component palette) to *OLEFrameForm* and use the Object Inspector to set the following properties of the panel component:

Property	Value
Name	*ToolBarPanel*
Align	*alTop*
Caption	<Blank>
Locked	False (default)

Note The OLE server will replace *ToolBarPanel* when an OLE object is activated in place because the control is not locked.

Adding the status bar

You create a status bar for OLE in-place activation the same way you create a status bar for a non-OLE application. If you are unfamiliar with creating status bars, see Chapter 12 for information about this process.

➤ Add another Panel component to the *OLEFrameForm* and use the Object Inspector to set the following properties of the panel component:

Property	Value
Name	*StatusBarPanel*
Align	*alBottom*
Caption	<Empty string>
Locked	True

Note The OLE server cannot replace *StatusBarPanel* when an OLE object is activated in place because the control is locked.

When an OLE object is active and the OLE server has a message to display in the status bar, an *OnStatusLineEvent* event of the OLE container component occurs. A text string is passed from the OLE server to this event handler. The *Msg* parameter of the *OnStatusLineEvent* event handler contains the text from the OLE server.

■ To display status bar messages from OLE server applications, assign the value of the *Msg* parameter of the *OnStatusLineEvent* handler to the *Caption* property of the status bar panel.

➤ Write the following event handler for the *OnStatusLineEvent* event of *OLEContainer* in *OLEObjectForm*:

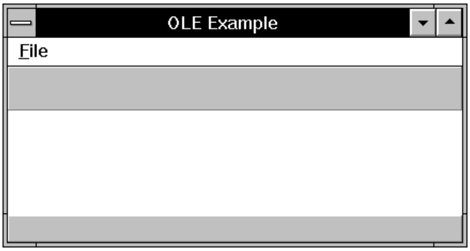
```
procedure TOLEObjectForm.OleContainerStatusLineEvent(Sender: TObject; Msg: String);
begin
  OLEFrameForm.StatusBarPanel.Caption := Msg                 {Display Msg in status bar}
end;
```

➤ Save the project now, then run it.

The application should look like Figure 15.4.

➤ Choose File | Exit to close the application.

Figure 15.4 The OLE container application tool bar and status bar



Inserting objects

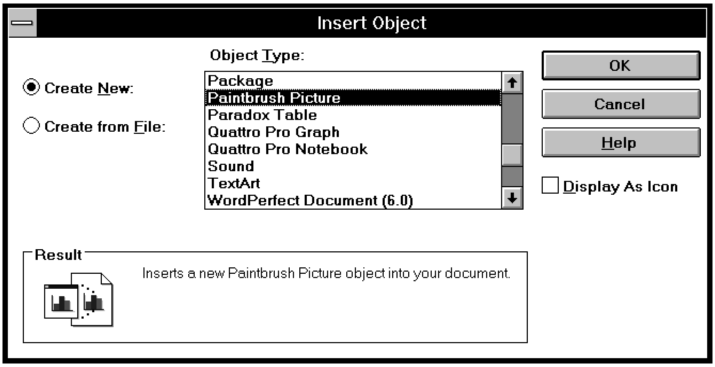
At this point, the OLE example application is ready to contain OLE objects. This section describes the following steps involved in inserting OLE objects at run time:

- Using the Insert Object dialog box
- Initializing the OLE container
- Deactivating objects

Using the Insert Object dialog box

To insert an OLE object into an OLEContainer component, use the Insert Object dialog box. Recall from Chapter 14 that specifying the *ObjClass* or *ObjDoc* property of an OLEContainer component at design time displays the Insert Object dialog box. At run time, the *InsertOLEObjectDlg* function displays the Insert Object dialog box. Figure 15.5 shows this dialog box.

Figure 15.5 The Insert Object dialog box


Insert Object

● Create New:

○ Create from File:

Object Type:

Package
Paintbrush Picture
Paradox Table
Quattro Pro Graph
Quattro Pro Notebook
Sound
TextArt
WordPerfect Document (6.0)

□ Display As Icon

Result

Inserts a new Paintbrush Picture object into your document.

Note *InsertOLEObjectDlg* is an independent function, not a method of the OLEContainer component.

To see the parameters used with *InsertOLEObjectDlg*, examine its declaration:

```
function InsertOleObjectDlg(Form: TForm; HelpContext: THelpContext;
  var PInitInfo: Pointer): Boolean;
```

The parameters of *InsertOLEObjectDlg* are as follows:

- *Form* is the form that owns the Insert Object dialog box. In the *Form* parameter, pass the name of the form that contains the OLEContainer component.
- *HelpContext* is used to identify the Insert Object dialog box for online Help. If your application is not programmed for online Help, pass 0 (zero) for *HelpContext*. Then a Help button won't appear in the Insert Object dialog box. Pass an integer other than 0 to use *HelpContext* as the context-sensitive online Help identification number for the dialog box.
- *PInitInfo* is a pointer to an internal data structure of OLE initialization information necessary to initialize the OLE container. (The internal details of the data structure are not documented here, as this information is meaningful only to the OLE container component.) *InsertOLEObjectDlg* modifies this pointer so that it points to a valid structure containing initialization information for the OLE object selected in the Insert Object dialog box. After the pointer has been used, you should deallocate the memory set aside for the OLE initialization information by calling the *ReleaseOLEInitInfo* procedure.

■ To enable the user to select an OLE object from the Insert Object dialog box, use the *InsertOLEObjectDlg* function to call the Insert Object dialog box.

You'll write the code to do this in the next section, but you should first have an understanding of the options available in this dialog box.

- To embed an object that has already been created and saved in a file by the OLE server, the user chooses Create From File, specifying the file name and path to the OLE object file.
- To link an object that has already been created and saved in a file by the OLE server, the user follows the previous step, also selecting the Link check box.
- To embed a new object, the user chooses Create New and selects an OLE object type from the Object Type list. The user cannot link a new object, as it has not yet been saved as a file.
- To display the linked or embedded object as an icon, the user checks the Display As Icon check box.

  The Change Icon button appears when Display As Icon is checked.

  - To change the default icon or the label of the OLE object, the user chooses Change Icon.

When the user chooses OK to close the Insert Object dialog box, *InsertOLEObjectDlg* returns *True.* It then stores the information necessary to initialize the OLE container in the data structure pointed to by the *PInitInfo* parameter.

Initializing the OLE container

In order to contain an OLE object in an OLEContainer component, you need to initialize the component. Initializing the component means the OLE class is specified, as well as the OLE document (if the object is linked) and the OLE item (if the object is a more specific unit of data than is specified by the OLE document). After initialization, the OLEContainer component contains the OLE object.

■ To initialize an OLEContainer component, notify the OLEContainer where the OLE initialization information exists.

Assigning the pointer passed in the *PInitInfo* parameter of *InsertOLEObjectDlg* to the *PInitInfo* property of the OLEContainer component initializes the component. The *ObjClass*, *ObjDoc*, and *ObjItem* properties of the component is specified automatically.

When you initialize the OLE container component, the OLE object is activated. The OLE server will take control, and the user can edit the object through the OLE server. After you deactivate the OLE object, an initialized OLE container component contains a picture representing the OLE object or an icon. The object can be reactivated in the manner specified by the *AutoActivate* property of the OLEContainer component. By default, activate the OLE object by double-clicking the OLEContainer component.

Next, you will write code to initialize the OLEContainer. You will write code to specify the *Info* parameter later, with a call to *InsertOLEObjectDlg* in the *OnClick* event handler for Edit | Insert Object.

➤ Open the Code Editor, and write the following *InitializeOLEObject* method in the **implementation** part of the *OLEObj* unit. This method is called by an event handler, so you won't use the Object Inspector to generate it. Note that after initialization, the allocated memory is freed with *ReleaseOLEInitInfo*.

```
procedure TOLEObjectForm.InitializeOLEObject(Info: Pointer);
begin
  OLEContainer.PInitInfo := Info;           {Initialize the container by pointing to Info}
  ReleaseOLEInitInfo(Info)
end;
```

You need to declare *InitializeOLEObject* in order to call it at run time.

➤ Add the following line to the **private** part of the *TOLEObjectForm* type declaration in the **interface** part of the *OLEObj* unit.

```
interface
⋮
type
  TOLEObjectForm = class(TForm);
  ⋮
  private
    procedure InitializeOLEObject(Info: Pointer);     {Add this line to declare procedure}
  public
  ⋮
end;
⋮
```

Next, you will attach *InitializeOLEObject* to the *OnClick* event for the Edit | Insert Object menu item.

➤ Write the following event handler for the *OnClick* event of the Edit | Insert Object menu item on the *OLEObjectForm* menu bar.

```
procedure TOLEObjectForm.InsertObject1Click(Sender: TObject);
var
  Info: Pointer;                     {Declare the pointer to the OLE initialization info}
begin
  if InsertOLEObjectDlg(OLEFrameForm, 0, Info) then             {Insert Object dialog box}
    InitializeOLEObject(Info);                                 {Initialize the OLE object}
end;
```

The code to initialize the OLE container was put in a separate method because it will also be called from the *OnClick* event handler for Edit | Paste Special (discussed in "Pasting objects"). This way, the OLE container initialization code can be shared.

Deactivating objects

If the OLE object was created by an OLE 1.0 server, it is activated in the OLE server's window. Focus and control transfer to the OLE server when an OLE object is activated within its own window.

■ To deactivate an OLE object created by an OLE 1.0 server, choose the OLE server's File | Exit command (or its equivalent in the command structure of the OLE server).

If the OLE object was created by an OLE 2.0 server, it might activate in the OLE container application's window (if the OLE server application supports in-place activation and you've added a MainMenu component to the main form of your container application). The File | Exit command from the OLE server isn't available because the available File menu (or any menu with a *GroupIndex* of 0) is from the OLE container application.

■ To deactivate an OLE object created by an OLE 2.0 server, focus must shift to a control in the OLE container application other than the OLEContainer component containing the active OLE object. You can also deactivate the object by clicking in the client area of the form that contains the OLEContainer.

Note Shifting focus to another control does not deactivate an OLE object activated in its own window (rather than in place). Also, shifting focus to a menu item does not deactivate an OLE object.

■ Another way to deactivate an in-place active OLE object is to set the value of the *Active* property of the OLEContainer component to *False*.

In the sample application, use the Object | Deactivate menu command from the menu bar of *OLEObjectForm* to do this. Recall that the Object menu was given a *GroupIndex* property value of 2, so it is still available when an OLE server merges menus with the OLE container application.

➤ Write the following event handler for the *OnClick* event of the Object | Deactivate item on the *OLEObjectForm* menu bar.

```
procedure TOLEObjectForm.Deactivate1Click(Sender: TObject);
begin
  OLEContainer.Active := False                                  {Deactivate the OLE object}
end;
```

➤ Save the project now, then run it.

1 Choose File | New to display an OLE Object window.

2 Choose Edit | Insert Object to display the Insert Object dialog box.

3 Choose an object to link or embed, then choose OK.

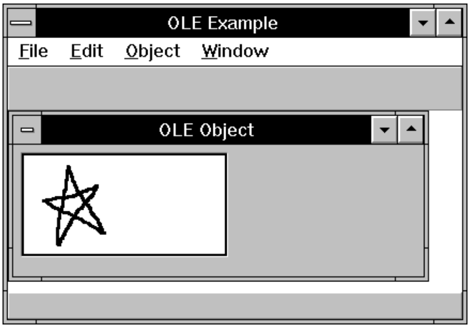
4 If the object is activated in place, choose Object | Deactivate to deactivate an OLE object.

If the object is activated in its own window (rather than in place), choose File | Exit (or its equivalent in the command structure of the OLE server application) to deactivate the object.

The OLEContainer is initialized and contains a picture representing the OLE object. For example, if you chose to insert a Windows Paintbrush picture object, the OLE Object window contains the object as in Figure 15.6.

Note If the Insert As Icon check box of the Insert OLE Object dialog box is checked, the OLE object is inserted as an icon representing the server application associated with the object. An object inserted as an icon is *always* activated in its own window, rather than in place.

Figure 15.6 A Paintbrush picture OLE object



5 Double-click the OLEContainer component.

Because the *AutoActivate* property of the OLEContainer component has not been changed from its default value (*aaDoubleClick*), this reactivates the OLE object.

6 Experiment with creating new OLE Object windows and embedding and linking OLE objects with the Edit | Insert Object command.

7 Choose File | Exit to close the application.

Pasting objects

Some OLE server applications allow the user to copy or cut OLE objects to the Clipboard. If an OLE object is stored on the Clipboard, you can initialize an OLEContainer by allowing the user to use the Paste Special dialog box to paste the object into the OLE container application.

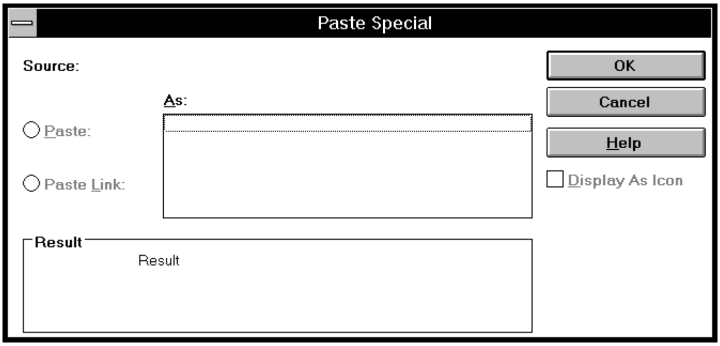
This section describes the following steps involved in pasting OLE objects at run time:

- Using the Paste Special dialog box
- Using OLE objects with the Clipboard
- Pasting the OLE object

Using the Paste Special dialog box

To paste an OLE object into an OLEContainer component, use the Paste Special dialog box. Recall from Chapter 14 that specifying the *ObjItem* property of an OLEContainer component at design time displays the Paste Special dialog box. At run time, the *PasteSpecialDlg* function displays the Paste Special dialog box. Figure 15.7 shows this dialog box.

Figure 15.7 The Paste Special dialog box



Note *PasteSpecialDlg* is an independent function, not a method of the OLEContainer component.

To see the parameters used with *PasteSpecialDlg*, examine its declaration:

```
function PasteSpecialDlg(Form: TForm; const Fmts: array of BOleFormat;
  HelpContext: THelpContext; var Format: Word; var Handle: THandle;
  var PInitInfo: Pointer): Boolean;
```

The parameters of *PasteSpecialDlg* are as follows:

- *Form* is the form that owns the Paste Special dialog box. You should pass the name of the form that contains the OLEContainer component in the *Form* parameter.
- *Fmts* is the array of object formats to register. Each format is specified by an array element of type *BOLEFormat*. For this example, you will register two object formats: *FEmbedClipFmt* for embedded OLE objects and *FLinkClipFmt* for linked OLE objects.

To understand more about object formats, examine the declaration of the *BOLEFormat* record:

```
BOleFormat = Record
  fmtId: Word; { Clipboard format id }
  fmtName: array [0..31] of char; { for paste special listbox - %s if ole fmt }
  fmtResultName: array [0..31] of char; { for paste special results box - %s if ole fmt}
  fmtMedium: BOleMedium; { based upon clip format id }
  fmtIsLinkable: Bool;
end;
```

The fields of *BOLEFormat* are as follows:

  - *fmtId* is the Clipboard format ID of the object format. *fmtId* can be the standard Clipboard formats such as *CF_TEXT* and *CF_BITMAP*. (See the *HasFormat or Formats* property in online Help for more information about standard Clipboard formats.) For OLE objects, however, you should register new Clipboard formats to handle OLE objects. You do this with the *RegisterClipboardFormat* Windows API function.
  - *fmtName* is the name of the object. This field specifies the name of the object to appear in the list box of the Paste Special dialog box. For this example, you should assign '%s' to *fmtName*. The format name from the OLE server application is automatically substituted for '%s' for each object. For example, if the OLE server is Paintbrush, 'Paintbrush Picture Object' will be substituted for '%s' at run time.
  - *fmtResultName* specifies the name to appear in the Results box of the Paste Special dialog box. For this example, you should assign '%s' to *fmtResultName*. The format result name from the OLE server application is automatically substituted for '%s' for each OLE object. For example, if the OLE server is Paintbrush, 'Paintbrush Picture' is substituted for '%s' at run time.
  - *fmtMedium* is of type *BOLEMedium*. This is simply a numeric constant used by Windows to determine the type of data of an object format. You should use *BOLE_MED_STREAM* for linked OLE objects and *BOLE_MED_STORAGE* for embedded OLE objects. You use the *BOLEMediumCalc* function to calculate the *BOLEMedium* type required for this field. Search online Help for *BOLEMedium* for more information about the *BOLEMedium* type.
  - *fmtIsLinkable* determines if the object format is linkable. Set *fmtIsLinkable* to *True* for linked OLE objects, or *False* for embedded OLE objects.

- *HelpContext* is used to identify the Paste Special dialog box for online Help. If your application is not programmed for online Help, pass 0 (zero) for *HelpContext*. Then a Help button won't appear in the Paste Special dialog box. Pass an integer other than 0 to use *HelpContext* as the context-sensitive online Help identification number for the dialog box.

- *Format* is modified by *PasteSpecialDlg* to specify the Clipboard format of the data on the Clipboard. Since you can't be sure what type of data is on the Clipboard when the Paste Special dialog box is used, use *Format* to determine how to process the data on the Clipboard. Pass a variable of type Word in this parameter. For this example, *PasteSpecialDlg* will modify this variable to specify either the *FEmbedClipFmt* or *FLinkClipFmt* formats registered in the *OnCreate* event of *OLEFrameForm* (this is discussed in the section "Registering Clipboard formats"). If the data on the

Clipboard is not an OLE object, *Format* will be modified to specify some other format of data (such as *CF_TEXT* for text data).

- *Handle* is modified by *PasteSpecialDlg* to specify the handle of the data on the Clipboard. Use *Handle* to access the Clipboard data if it is of some type other than an OLE object, such as text. Pass a handle variable in the *Handle* parameter. For this example, you will only process the pasting of OLE objects, so the value of the *Handle* parameter is not important.
- *PInitInfo* is a pointer to an internal OLE object initialization information structure, which is required to initialize the OLE container in the same way as described in "Initializing the OLE container." You should pass a pointer in the *Info* parameter. *PasteSpecialDlg* modifies this pointer so that it points to a valid data structure containing initialization information for the OLE object selected in the Paste Special dialog box.

■ To enable the user to paste an OLE object from the Paste Special dialog box, use the *PasteSpecialDlg* function to call the Paste Special dialog box.

You'll write the code to do this in the following section, but you should first have an understanding of the options available in this dialog box.

- To insert the contents of the Clipboard into the OLE container application, so that the data is embedded, the user chooses Paste.
- To create a link between the OLE server source file and the OLE container application, so that the data is linked, the user chooses Paste Link. Recall that linked data must exist in an external file.
- To display the linked or embedded object as an icon, the user chooses Display As Icon.
  When this check box is checked, the Change Icon button appears.

  To change the default icon or the label of the OLE object, the user chooses Change Icon.
- If the data is not one of the registered formats, the Paste and Paste Link options are disabled in the Paste Special dialog box. The user won't be allowed to paste data from the Clipboard. For this example, the data on the Clipboard must be of type *FEmbedClipFmt* (embedded OLE object) or *FLinkClipFmt* (linked OLE object).
- The user chooses the type of data from the As list. Sometimes, data might be interpreted in a variety of ways. For example, if you copy text from some word processor OLE servers, you could choose to paste the data as text or as an OLE object. The values of the As list are determined by the OLE server application.

When the user chooses OK to close the Paste Special dialog box, *PasteSpecialDlg* returns *True.* It then stores the information necessary to initialize the OLE container in the data structure pointed to by the *PInitInfo* parameter.

Using OLE objects with the Clipboard

This section discusses the following steps involved in registering and specifying the object formats for pasting:

- Registering Clipboard formats
- Specifying OLE formats

Registering Clipboard formats

OLE objects should be registered with Windows as Clipboard formats. Before you can paste an OLE object into the OLEContainer component, you need to register two new Clipboard formats for linked and embedded OLE objects with the Windows API function *RegisterClipboardFormat*. These formats can then be used in the *fmtId* field of the *BOLEFormat* record.

■ To register a Clipboard format for OLE objects, call *RegisterClipboardFormat*. Pass a description of the format as a parameter. *RegisterClipboardFormat* returns a *Word* value that uniquely identifies the newly registered format.

Next, you'll write code to register two new Clipboard formats for linked and embedded OLE objects, using *RegisterClipboardFormat*.

➤ *RegisterClipboardFormat* returns a *Word* value identifying the registered Clipboard format. Declare *FEmbedClipFmt* and *FLinkClipFmt* in the **private** part of the *OLEFrameForm* type declaration, before the declaration of the *CreateChild* method:

```
type
  TOLEFrameForm = class(TForm)
  ⋮
  private
    FEmbedClipFmt: Word;               {Declare the embedded OLE object Clipboard format}
    FLinkClipFmt: Word;                  {Declare the linked OLE object Clipboard format}
    function CreateChild: TOLEObjectForm;
  public
    { Public declarations }
end;
```

➤ For this example, the OLE object Clipboard formats should be registered as soon as the user runs the application. Therefore, attach the following code to the *OnCreate* method of *OLEFrameForm*:

```
procedure TOLEFrameForm.FormCreate(Sender: TObject);
begin
  FEmbedClipFmt := RegisterClipboardFormat('Embedded Object');
  FLinkClipFmt := RegisterClipboardFormat('Link Source');
end;
```

Note You can pass any valid string as a parameter to *RegisterClipboardFormat*. 'Embedded Object' and 'Link Source' are appropriate choices used for this example, since that's the purpose of the formats being registered. Search for *RegisterClipboardFormat* in online Help for more information.

Specifying OLE formats

To specify which objects to allow the user to paste, you pass an array of object formats in the *Fmts* parameter of the *PasteSpecialDlg* method. Each format is specified in a *BOLEFormat* record.

It is possible to register standard Clipboard formats as well as OLE formats for pasting. For example, to register text as a paste format, specify *CF_TEXT* for the value of the *fmtId* field and *BOLE_MED_HGLOBAL* for the value of the *fmtMedium* field of a *BOLEFormat* record. (You can use the *BOLEMediumCalc* function to let Delphi calculate the *fmtMedium* value depending on which Clipboard format you're specifying.) Then, if the user copies text from another application and pastes it on your application, your application can process the pasted text. For this example, however, you will register only two formats: one for linked OLE objects and one for embedded OLE objects.

■ To specify OLE object formats, specify the fields of a *BOLEFormat* record for each object format:

- *fmtId* should be the Clipboard format (previously registered with *RegisterClipboardFormat*).
- *fmtMedium* should be *BOLE_MED_STORAGE* for embedded OLE objects or *BOLE_MED_STREAM* for linked OLE objects. Pass the Clipboard format for which you need a *BOLEFormat* as a parameter of *BOLEMediumCalc*. That function will return the correct value for any valid Clipboard format, including the ones you registered for embedded and linked OLE objects.
- *fmtIsLinkable* should be *False* for embedded objects and *True* for linked objects.
- *fmtName* should be '%s', copied into a null-terminated string by the *StrPCopy* function. This will be replaced by the object name from the source at run time automatically.
- *fmtResultName* should be '%s', also copied into a null-terminated string by *StrPCopy*. This will be replaced by the results name from the source at run time automatically.

Next, you will specify an array of *BOLEFormat* records which you will use with *PasteSpecialDlg* later.

➤ The *BOLEFormat* type is declared in the *BOLEDefs* unit, and the *BOLEMediumCalc* function is declared in the *TOCtrl* unit. Add these units to the **uses** clause of the **interface** part of the *OLEFrame* unit:

```
interface

uses ... , BOLEDefs, TOCtrl;                                    {Refer to unit BOLEDefs}

type
⋮
```

➤ Declare the *Fmts* array in the **public** part of the *OLEFrameForm* type declaration. *Fmts* is **public** instead of **private** for this example because it is referenced from the *OLEObj* unit.

```
type
  TOLEFrameForm = class(TForm)
  ⋮
  private
    ⋮
  public
    Fmts: array[0..1] of BOleFormat;                   {Declare the array of OLE formats}
end;
```

➤ Attach the following code to the *OnCreate* method of *OLEFrameForm*, after the calls to *RegisterClipboardFormat*:

```
procedure TOLEFrameForm.FormCreate(Sender: TObject);
begin
  FEmbedClipFmt := RegisterClipboardFormat('Embedded Object');
  FLinkClipFmt := RegisterClipboardFormat('Link Source');
  Fmts[0].fmtId := FEmbedClipFmt;            {Embedded OLE object Clipboard format}
  Fmts[0].fmtMedium := BOLEMediumCalc(FEmbedClipFmt);  {Medium for embedded objects}
  Fmts[0].fmtIsLinkable := False;            {No linking to OLE server}
  StrPCopy (Fmts[0].fmtName, '%s');          {Name from OLE server}
  StrPCopy (Fmts[0].fmtResultName, '%s');    {Result name from OLE server}
  Fmts[1].fmtId := FLinkClipFmt;             {Linked OLE object Clipboard format}
  Fmts[1].fmtMedium := BOLEMediumCalc(FLinkClipFmt);   {Medium for linked objects}
  Fmts[1].fmtIsLinkable := True;             {Allows linking to OLE server}
  StrPCopy (Fmts[1].fmtName, '%s');          {Name from OLE server}
  StrPCopy (Fmts[1].fmtResultName, '%s');    {Result name from OLE server}
end;
```

Pasting the OLE object

Before pasting the OLE object, you should determine if there is an OLE object on the Clipboard.

■ To determine if the Paste Special dialog box is enabled, call *PasteSpecialEnabled*. This function determines if any of the Clipboard formats specified in the *Fmts* array are on the Clipboard. If so, the Paste Special dialog box is enabled and *PasteSpecialEnabled* returns *True*.

To paste an OLE object into the OLE example application, you need to initialize the OLEContainer component in the same way you did in "Initializing the OLE container."

➤ Write the following event handler for the *OnClick* event of the Edit | Paste Special menu item on the *OLEObjectForm* menu bar.

```
procedure TOLEObjectForm.PasteSpecial1Click(Sender: TObject);
var
  ClipFmt: Word;                            {Declare the Windows Clipboard format variable}
  DataHand: THandle;                   {Declare the Windows Clipboard data handle variable}
  Info:  Pointer;                      {Declare the pointer to the OLE initialization info}
begin
  if PasteSpecialEnabled(Self, OLEFrameForm.Fmts) then     {If there is something to paste}
    if PasteSpecialDlg(OLEObjectForm, OLEFrameForm.Fmts, 0,      {Paste Special dialog box}
      ClipFmt, DataHand, Info) then
      InitializeOLEObject(Info)                                  {Initialize the OLE object}
end;
```

You should enable the Edit | Paste menu item only when the Paste Special dialog box is enabled.

➤ Write the following event handler for the *OnClick* event of the Edit menu item on the *OLEObjectForm* menu bar.

```
procedure TOLEObjectForm.Edit1Click(Sender: TObject);
begin
  PasteSpecial1.Enabled := PasteSpecialEnabled(Self, OLEFrameForm.Fmts)
end;
```

➤ Save the project now, then run it.

1. Choose File | New to display an OLE Object window.
2. Activate an OLE server application and copy an OLE object to the Clipboard.
3. From the OLE example application, choose Edit | Paste Special to display the Paste Special dialog box.
4. Choose an object to link or embed by pasting, then choose OK.

   The OLE container in the OLE Object window is initialized. You can activate the OLE object by double-clicking the OLE container component.
5. Choose File | Exit to close the application.

Dropping objects

Dragging OLE objects from an OLE server application and dropping them on the OLE container application is an easy way to link or embed an OLE object into the OLE example application. By dragging and dropping, the user isn't required to use the Insert Object or Paste Special dialog box to specify an OLE object. The user simply "grabs" the OLE object from the OLE server with the mouse, drags it over the OLE example application, and drops it by releasing the mouse button.

Note The material presented in this section assumes you are familiar with the general concepts of drag-and-drop covered in Chapter 13. The OLE example also uses drag-and-drop, but this example focuses on the registration of OLE object formats. If you are unfamiliar with drag-and-drop in general, you should read Chapter 13 first.

This section describes the following steps involved in dragging-and-dropping OLE objects onto the OLE example application:

- Registering a form as an OLE drop target
- Dropping an OLE object onto the OLE example application

Registering a form as an OLE drop target

To accept dropped OLE objects, a form should be registered with Windows as an OLE drop target. Use the *RegisterFormAsOLEDropTarget* function to do this. To see the parameters used with *RegisterFormAsOLEDropTarget*, examine its declaration:

```
procedure RegisterFormAsOleDropTarget(Form: TForm; const Fmts: array of BOleFormat);
```

The parameters of *RegisterFormAsOLEDropTarget* are as follows:

- *Form* is the form to be registered as a possible drop target for OLE objects. For this example, you should pass *OLEObjectForm* in the *Form* parameter.

- *Fmts* is the array of object formats to register. This is an array of type *BOLEFormat*, identical in purpose to the *Fmts* array used with *PasteSpecialDlg* in the section "Pasting objects." Each type of data to be dropped must be registered by having a corresponding *BOLEFormat* element of the *Fmts* array. For this example, you will use the same *Fmts* array that has been declared in the *OnCreate* event of *OLEFrameForm*, which registers two formats, one for linked objects and one for embedded OLE objects. However, if you wanted to be able to drop types of data other than OLE objects (such as text), then *Fmts* would require an additional element for each other type of data. For example, if you also wanted to allow the dropping of text, *Fmts* should have a third element with a *fmtId* field value of *CF_TEXT* and a corresponding *BOLEMedium* field value of *BOLE_MED_HGLOBAL*.

Note The *fmtName* and *fmtResultName* fields of *BOLEFormat* are not used when dragging and dropping OLE objects. They are required fields only for pasting objects. For this example, both pasting and dropping should be enabled, so they should be specified as they are in the *OnCreate* event of *OLEFrameForm*. However, if you wanted to allow drag-and-drop but not pasting in another application, you could leave them uninitialized.

■ To register a form as an OLE drop target, call *RegisterFormAsOLEDropTarget*. Specify the object types you want to allow to be dropped on the form in the *Fmts* parameter.

Note To use *RegisterFormAsOLEDropTarget*, the *TOCtrl* unit must be referenced in the **uses** clause of the unit. Since you already added this reference for *OLEFrame* in order to call *BOLEMediumCalc*, nothing needs to be done to the OLE example application. For other applications, remember to refer to *TOCtrl*.

➤ Attach the following code to the *OnCreate* method of *OLEFrameForm*, after the specification of the *Fmts* array elements:

```
procedure TOLEFrameForm.FormCreate(Sender: TObject);
begin
  ⋮
  RegisterFormAsOleDropTarget(Self, Fmts)                  {Register form as drop target}
end;
```

Dropping an OLE object onto the OLE example application

When an object is dropped onto a form, an *OnDragDrop* event occurs. The object is specified as the *Source* parameter of the *TDragDropEvent* method, which is the event handler of *OnDragDrop* events. If the *Source* is an OLE object, it is a descendant of type *TOLEDropNotify*. *TOLEDropNotify* objects have a *PInitInfo* property that corresponds to the *PInitInfo* property of *TOLEContainer* components. To use the *Source* OLE object, you should typecast it as a *TOLEDropNotify* object.

■ To initialize an OLEContainer component when an OLE object is dropped, assign the value of the *PInitInfo* property of the *Source* object (typecast as a *TOLEDropNotify* object) to the *PInitInfo* property of the OLEContainer component in the *OnDragDrop* event handler.

Note You don't need to use *ReleaseOLEInitInfo* to release memory allocated for the *PInitInfo* property of the *Source* object. Delphi does this for you automatically.

➤ Attach the following code to the *OnDragDrop* event handler of *OLEFrameForm*. This code creates a new *OLEObjectForm* and initializes its *OLEContainer*.

```
procedure TOLEFrameForm.FormDragDrop(Sender, Source: TObject; X, Y: Integer);
var
  NewChild: TOLEObjectForm;
begin
  if Source is TOLEDropNotify then
  begin
    NewChild := CreateChild;
    with Source as TOLEDropNotify do
      NewChild.OLEContainer.PInitInfo := PInitInfo;
  end
end;
```

Note To use the *TOLEDropNotify* object, the *TOCtrl* unit must be referenced in the **uses** clause of the unit. Since you already added this reference for *OLEFrame* in order to call *BOLEMediumCalc*, nothing needs to be done to the OLE example application. For other applications, remember to refer to *TOCtrl*.

➤ Save the project now, then run it.

1. If you have access to an OLE server application that supports drag-and-drop of OLE objects, open a file within that server application.
2. Grab an OLE object from the OLE server and drag it over the OLE Example application window.

   Notice that the mouse pointer changes to the default “no-drop” pointer when over a surface (such as the Windows desktop) that doesn’t accept dragged OLE objects. When the mouse pointer is over the OLE example application window, it should change back to the “drag-and-drop” mouse pointer to indicate that the object can be dropped. To change the appearance of the mouse pointer during drag-and-drop operations, modify the *DragCursor* property. For this example, however, don’t modify the default settings of *DragCursor*.
3. Release the mouse button to drop the OLE object.

   An OLE object window is created and its OLE container component is initialized to contain the dropped OLE object.
4. Choose File | Exit to close the application.

Working with objects in files

Saving OLE objects in files and restoring OLE objects from files was discussed in the section “OLE data in files” in Chapter 14. This application will use theSaveDialog and OpenDialog components to work with OLE data in files.

This section describes the following steps involved in working with OLE objects in files:

- Saving objects to files
- Loading objects from files

Saving objects to files

■ To save an OLE object in a file, use the *SaveToFile* method of the OLEContainer component.

For this example, use a SaveDialog component to enable the user to specify a file name and location.

➤ Add a SaveDialog component (from the Dialogs page of the Component palette) to *OLEObjectForm* and use the Object Inspector to set the following properties of the SaveDialog component:

Property	Value
Name	*SaveAsDialog*
DefaultExt	*ole*
FileName	*.OLE
Filter	OLE files (*.OLE) | *.OLE

➤ Write the following event handler for the *OnClick* event of the File | Save As item on the *OLEObjectForm* menu bar.

```
procedure TOLEObjectForm.Saveas1Click(Sender: TObject);
begin
  if SaveAsDialog.Execute then
    OLEContainer.SaveToFile(SaveAsDialog.FileName)          {Save the object to FileName}
end;
```

Loading objects from files

■ To load an OLE object in a file, use the *LoadFromFile* method of the OLEContainer component.

For this example, use an OpenDialog component to enable the user to specify a file name and location.

➤ Add an OpenDialog component (from the Dialogs page of the Component palette) to *OLEFrameForm* (not *OLEObjectForm*) and use the Object Inspector to set the following properties of the Open common dialog box component:

Property	Value
Name	*OpenDialog*
DefaultExt	*ole*
FileName	*.OLE
Filter	OLE files (*.OLE) | *.OLE

➤ Write the following event handler for the *OnClick* event of the File | Open item on the *OLEFrameForm* menu bar.

```
procedure TOLEFrameForm.Open1Click(Sender: TObject);
var
```

```
  NewChild: TOLEObjectForm;
begin
  if OpenDialog.Execute then
  begin
    NewChild := CreateChild;
    NewChild.OLEContainer.LoadFromFile(OpenDialog.FileName)
  end
end;
```

➤ Write the following event handler for the *OnClick* event of the File | Open item on the *OLEObjectForm* menu bar.

```
procedure TOLEObjectForm.Open1Click(Sender: TObject);
begin
  OLEFrameForm.Open1Click(Sender)
end;
```

➤ Save the project now, then run it:

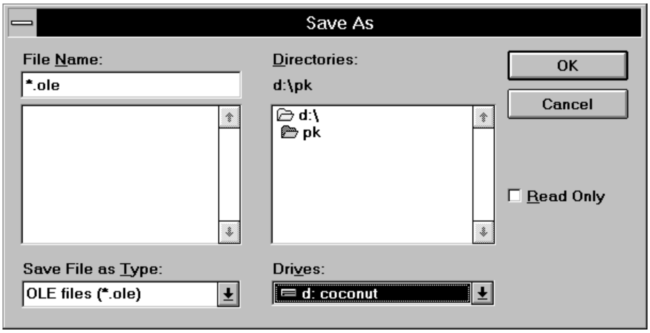
1 Drop an OLE object, or display a new OLE Object window and insert or paste an object onto the child window.

2 Edit the object, then deactivate it.

An OLE Object window now contains an inactive OLE object.

3 Choose File | Save As to display the SaveAs dialog box as in 3.

Figure 15.8 The Save As dialog box



Save As

File Name: *.ole

Directories: d:\pk

d:\
pk

□ Read Only

Save File as Type: OLE files (*.ole)

Drives: d: coconut

4 Choose a file name, then choose OK.

The OLE object in the OLE Object window that had focus when you chose File | Save As is saved to a file.

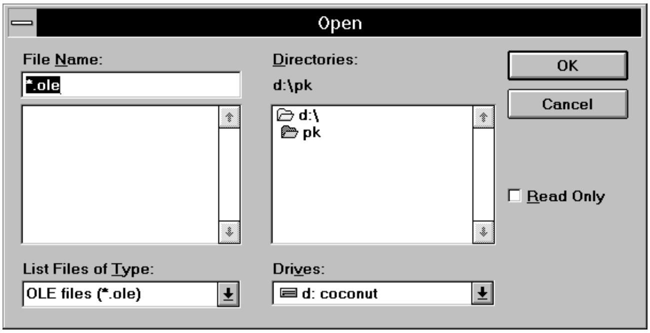
5 Close the OLE Object window.

The main OLE Example frame form now contains no OLE Object windows.

6 Choose File | Open to display the Open dialog box as in . Select the previously saved file, and choose OK.

A new OLE Object window appears, displaying the object.

Figure 15.9 The Open dialog box



7 Choose File | Exit to close the application.

Note You can also save OLE objects to memory streams. Use *SaveToStream* and *LoadFromStream* to work with objects in streams..

Summary

This chapter presented these topics:

- Creating the MDI framework

  For this example, each OLE object that is linked or embedded is contained in an OLE container component in its own MDI child window. To contain an OLE object, add an OLEContainer component to the OLE Object window. When an OLE object is activated in place, menu items from the OLE server can be merged with the OLE container application's menus. To control where menu items merge and which menu items are replaced, specify appropriate values for the *GroupIndex* property of menu items. OLE servers can also access the OLE container application's tool bar and menu bar. Use the *Locked* property to prevent the OLE server from replacing the tool bar or status bar of the OLE container application.

- Inserting objects

  To enable the user to use the Insert Object dialog box to insert an OLE object into the OLEContainer component, call *InsertOLEObjectDlg*. To initialize the OLEContainer component, assign a pointer modified by *InsertOLEObjectDlg* to the *PInitInfo* property. To deactivate the OLE object, shift focus to another control, click the client area of the form that owns the OLEContainer, or set the *Active* property to *False*.

- Pasting objects

  To register new Clipboard formats for OLE objects, call the Windows API function *RegisterClipboardFormat*. To register the Clipboard formats for OLE objects (or any other data type you want to be able to drop) in the same way as when pasting objects, call *RegisterClipboardFormat* and specify an array of *BOLEFormat* elements. To enable the user to use the Paste Special dialog box to paste an OLE object into the

OLEContainer component, call *PasteSpecialDlg*. To specify what types of objects to allow to be pasted, specify an array of *BOLEFormat* elements; one element for each type of object. This array should be passed in the *Fmts* parameter of *PasteSpecialDlg*. To initialize the OLEContainer component in the same way as when inserting objects, assign a pointer modified by *PasteSpecialDlg* to the *PInitInfo* property.

- Dropping objects

  To register a form for object drag-and-drop, call *RegisterFormAsOLEDropTarget*. To use the dropped object as an OLE object, typecast the *Source* object as a *TOLEDropNotify* object in the *OnDragDrop* event handler of the form. To initialize the container when an OLE object is dropped, assign the value of the *PInitInfo* property of the *Source* object to the *PInitInfo* property of an OLEContainer component.

- Working with objects in files

  To save objects to files, call the *SaveToFile* method. To load objects from files, call the *LoadFromFile* method.

Appendix

A

Selected Bibliography

The following third-party titles are available to help you learn more about Delphi and the Object Pascal programming language. For details concerning availability of any of these books, please consult your local bookseller.

- *The Delphi Programmer Explorer* by J. Duntemann/J. Mischel/D. Taylor
  Coriolis Group, ISBN: 1-883577-25-X$39.99

  A new type of tutorial: Theory and practice alternate in short chapters, with the emphasis on creating useful software starting on the very first page.

- *Delphi for Dummies* by Neil Rubenking
  IDG Press, ISBN: 1-56884-200-7$19.99

  Readers will learn about Borland's new language in the easy to understand style of the Dummies series.

- *Teach Yourself Delphi* by Devra Hall
  MIS Press, ISBN: 1-55828-390-0$27.95

  Here is a complete, self-guided tour to the new development environment from Borland, encompassing all the features of the language and all the tools, tricks, and advantages of Delphi.

- *Delphi Nuts and Bolts* by Gary Cornell and Troy Strain
  Osborne-McGraw-Hill

- *Software Engineering with Delphi* by Edward C. Webber, J. Neal Ford, and Christopher R. Webber
  Prentice Hall Professional, Trade & Reference

  A guide to developing client/server applications with an emphasis on Delphi’s object-oriented tools.

- *Delphi by Example* by Blake Watson
  Que, ISBN: 1-56529-757-1$29.99

Aimed at the beginning programmer who has no prior experience with other languages or development products, this book presents basic concepts of programming along with a clear explanation of the key development tools that are part of Delphi.

- *Using Delphi, Special Edition* by Namir Shammas and John Matcho
  Que, ISBN: 1-56529-823-3$29.99

  This 3-part tutorial on the most important Delphi features covers how to install the product and develop applications using Delphi's visual tools, explores the Windows application development process, and deals with some advanced programming topics.

- *Developing Client/Server Applications with Delphi* by Vince Killen and Bill Todd
  Sams Publishing

- *Delphi Developer's Guide* by Xavier Pacheco/Steve Teixeira
  Sams Publishing, ISBN: 0-672-30704-9$45.00

  Intermediate to advanced guide to developing applications using Delphi.

- *Mastering Delphi* by Charlie Calvert
  Sams Publishing, 9-6$45.00

  Comprehensive tutorial/reference for intermediate programming with Delphi.

- *Teach Yourself Delphi in 21 Days* by Andrew Wozniewicz
  Sams Publishing

- *Mastering Delphi* by Marco Cantu
  Sybex

- *Delphi How-To* by Gary Frerking
  Waite Group Press

  Presents large collection of programming problems and their solutions in standard, easy-to-use reference format, including unique solutions that use VBX controls and easy ways to build multimedia projects with Delphi.

- *Developing Windows Applications Using Delphi* by Paul Penrod
  John Wiley, ISBN: 0-471-11017-5$29.95

  This introduction for traditional C programmers who want to make the transition to rapid application development also provides detailed instructions for building sophisticated Windows applications and for creating graphical interfaces.

- *Instant Delphi* by Dave Jewell
  Wrox Press, ISBN: 1-874416-57-5$19.95

  Instant Delphi is the fast-paced tutorial guide for the programmer who wants to get up to speed on the Delphi product as quickly as possible.

Look for announcements of other books based on Borland Delphi.

Index

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Contents

Chapter 3
Building forms and menus 75

Chapter 4
Managing projects, files, and directories 115

Chapter 10
Text editor example 279

Chapter 11
Drawing graphics at run time 313

Chapter 12
Graphics example 321

Chapter 13
File manager example 359

Chapter 14
Exchanging data with DDE or OLE 381

Chapter 15
OLE example 399

Appendix A
Selected Bibliography 429

Index 431

Tables

Figures