Figure 17-22: This map has features added and removed.

Table 17-2
Available Map Features

| Map	Features
Australia	Airports, Cities, Highways, Major Cities
Canada	Airports, Cities, Forward Sortation Areas, Highways, Lakes, Major Cities
Europe	Airports, Cities, Highways, Major Cities
Mexico	Cities, Highways, Major Cities
U.K.	2-Digit Post Codes, Airports, Cities, Highways, Major Cities, Standard Regions
U.S. in North America	5-Digit Zip Code Centers, Highways, Major Cities, Great Lakes
U.S. (AK & HI Inset)	Airports, Cities, Major Cities
World	Capitals, Countries, Graticule, Oceans
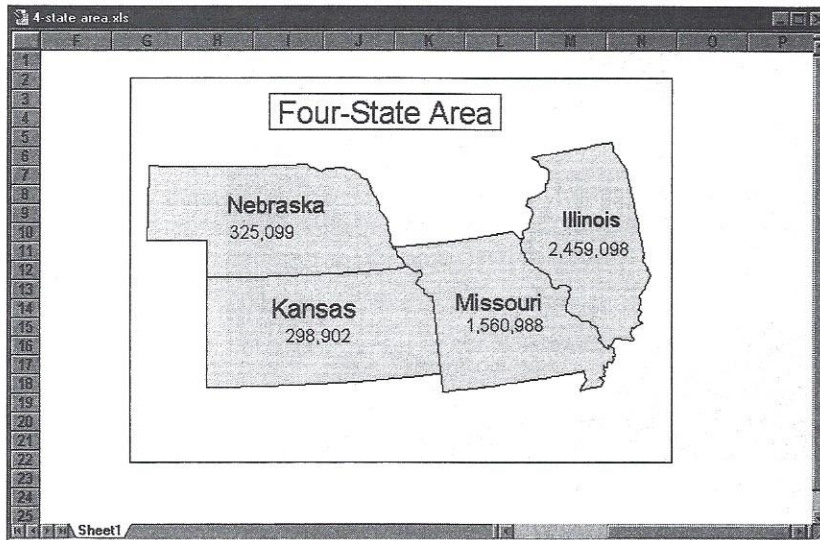
Figure 17-23: This map has all of its features removed, leaving only the states for which data is provided.

Plotting U.S. ZIP Codes

Besides recognizing geographic place names, Microsoft Map recognizes U.S. five-digit ZIP codes. If the data that you select contains more than one type of geographic data (for example, state names and ZIP codes), you need to specify which field to use in the map as the geographic data. Figure 17-24 shows the Specify Geographic Data dialog box, which warns you of the existence of more than one type of data that qualifies as geographic data.
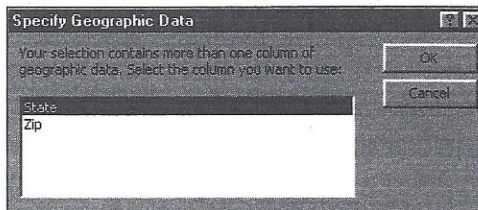
Figure 17-24: The Specify Geographic Data dialog box enables you to select the data to use as geographic data.

If you want to create a map that uses ZIP codes, make sure that your ZIP codes are formatted as values, not as text. Otherwise, Microsoft Map won't recognize them as ZIP codes.

Because ZIP codes are continually being added, Microsoft Map may not recognize all of your ZIP codes. If Microsoft Map encounters an unknown ZIP code, you receive the Resolve Unknown Geographic Data dialog box, shown in Figure 17-25. This dialog box gives you the opportunity to change the ZIP code to another one. Or, you can simply discard that item of data by clicking the Discard button.
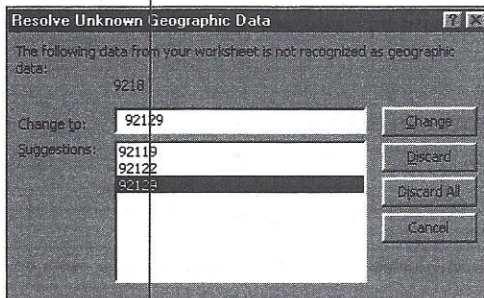
Figure 17-25: Microsoft Map displays the Resolve Unknown Geographic Data dialog box when it doesn't recognize a geographic name.

Figure 17-26 shows a map that depicts customers by their ZIP codes. This is a graduated-symbol map (the default format when ZIP codes are used as data). Note that the symbols appear on the geographic centers of the ZIP codes and don't shade the entire ZIP code areas.
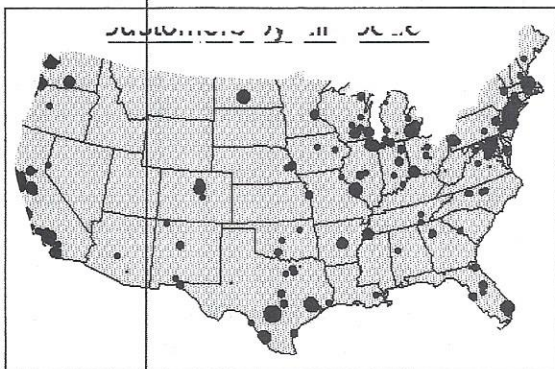
Figure 17-26: This map shows customers by ZIP code centers.

Adding More Data to a Map

After you create a map, you can add additional data to it. Use the Insert ⇨ Data command to add data from a worksheet range, or use the Insert ⇨ External Data command to add new data from a database file. Make sure that the data includes geographic labels that match the map to which you're adding data.

Map Templates

As you may have figured out by now, getting a map just right can sometimes take a lot of time. Fortunately, you can save a map template, so that you can reuse the settings for another map. To do so, create and customize the map and then choose Map ⇨ Save Map Template. You can save a template that includes the following:

✦ The features that you've added or removed

✦ A particular view (zoomed in or out)

✦ Both of the preceding items

Saved templates then appear in the Multiple Maps Available dialog box, which appears when you create a map.

Converting a Map to a Picture

You'll find that working with maps sometimes can be rather sluggish — a great deal of work goes on behind the scenes. When you finish with your map, you can convert it to a static picture that is no longer linked to the data. Click the map once to select it (don't double-click it) and then choose Edit ⇨ Copy. Then, select Edit ⇨ Paste Special and choose the Picture (Enhanced Metafile) option. This creates an unlinked picture of the map. Then, you can select the original map object and delete it.

If you convert a map to a picture, no way exists to link data back to the picture. If any of your data changes or you want to make modifications to the map, you have to re-create the map.

Learning More

The Microsoft Map feature is relatively complex, and it definitely takes time to master. The best way to master this feature is simply to create some maps and perform customizations. As previously mentioned, the user interface is different

from Excel's, so you'll have to try some new techniques. Generally, you can find your way around maps by doing the following:

✦ Double-clicking objects

✦ Right-clicking objects

✦ Exploring the menus (they change somewhat, depending on the type of map)

✦ Using the Microsoft Map toolbar

Summary

This chapter covers Excel's new Microsoft Map feature—which is actually an OLE server application developed by MapInfo Corporation. Some data is more appropriate for a map than for a chart, and this chapter demonstrates the difference. This chapter also describes the basics of creating and customizing maps and provides an example of each map format.

✦   ✦   ✦

Creating and Using Worksheet Outlines

If you use a word processor, you may be familiar with the concept of an outline. Most word processors have an outline mode that lets you view only the headings and subheadings in your document. You can easily expand a heading to show the detail (that is, the text) below it. To write this book, I used the outline feature in my word processor extensively.

Excel also is capable of using outlines, and understanding this feature can make working with certain types of worksheets much easier for you.

Introducing Worksheet Outlines

You can use outlines to create summary reports in which you don't want to show all the details. You'll find that some worksheets are more suitable for outlines than others. If your worksheet uses hierarchical data with subtotals, it's probably a good candidate for an outline.

An Example

The best way to understand how worksheet outlining works is to look at an example. Figure 18-1 shows a simple budget model without an outline. Subtotals are used to calculate subtotals by region and by quarter.

Two-Way Outline Example.xls

	A	B	C	D	E	F	G	H	I
1	State	Jan	Feb	Mar	Q1 Total	Apr	May	Jun	Q2 Total
2	California	1118	1960	1252	4330	1271	1557	1679	4507
3	Washington	1247	1238	1028	3513	1345	1784	1574	4703
4	Oregon	1460	1954	1726	5140	1461	1764	1144	4369
5	Nevada	1345	1375	1075	3795	1736	1555	1372	4663
6	**West Total**	**5170**	**6527**	**5081**	**16778**	**5813**	**6660**	**5769**	**18242**
7	New York	1429	1316	1993	4738	1832	1740	1191	4763
8	New Jersey	1735	1406	1224	4365	1706	1320	1290	4316
9	Massachusetts	1099	1233	1110	3442	1637	1512	1006	4155
10	Florida	1705	1792	1225	4722	1946	1327	1357	4630
11	**East Total**	**5968**	**5747**	**5552**	**17267**	**7121**	**5899**	**4844**	**17864**
12	Kentucky	1109	1078	1155	3342	1993	1082	1551	4626
13	Oklahoma	1309	1045	1641	3995	1924	1499	1941	5364
14	Missouri	1511	1744	1414	4669	1243	1493	1820	4556
15	Illinois	1539	1493	1211	4243	1165	1013	1445	3623

Sheet1

Figure 18-1: A typical budget model with subtotals.

Figure 18-2 shows the same worksheet after the outline was created. Notice that Excel adds a new border to the left of the screen. This border contains controls that enable you to determine which level to view. This particular outline has three levels: States, Regions (each region consists of states), and Grand Total (the sum of each region's subtotal). In Figure 18.2, the outline is fully expanded so that you can see all the data.

Two-Way Outline Example.xls

	A	B	C	D	E	F	G
1	State	Jan	Feb	Mar	Q1 Total	Apr	May
2	California	1118	1960	1252	4330	1271	1557
3	Washington	1247	1238	1028	3513	1345	1784
4	Oregon	1460	1954	1726	5140	1461	1764
5	Nevada	1345	1375	1075	3795	1736	1555
6	**West Total**	**5170**	**6527**	**5081**	**16778**	**5813**	**6660**
7	New York	1429	1316	1993	4738	1832	1740
8	New Jersey	1735	1406	1224	4365	1706	1320
9	Massachusetts	1099	1233	1110	3442	1637	1512
10	Florida	1705	1792	1225	4722	1946	1327
11	**East Total**	**5968**	**5747**	**5552**	**17267**	**7121**	**5899**
12	Kentucky	1109	1078	1155	3342	1993	1082
13	Oklahoma	1309	1045	1641	3995	1924	1499
14	Missouri	1511	1744	1414	4669	1243	1493
15	Illinois	1539	1493	1211	4243	1165	1013
16	Kansas	1973	1560	1243	4776	1495	1125
17	**Central Total**	**7441**	**6920**	**6664**	**17683**	**7820**	**6212**
18	**Grand Total**	**18579**	**19194**	**17297**	**51728**	**20754**	**18771**
19							

Sheet1

Figure 18-2: The budget model after creating an outline.

Figure 18-3 depicts the outline displayed at the second level. Now, the outline shows only the totals for the regions (the detail rows are hidden). You can partially

expand the outline to show the detail for a particular region. Collapsing the outline to level 1 shows only the headers and the Grand Total row.

State	Jan	Feb	Mar	Q1 Total	Apr	May
West Total	5170	6527	5081	16778	5813	6660
East Total	5968	5747	5552	17267	7121	5899
Central Total	7441	6920	6664	17683	7820	6212
Grand Total	18579	19194	17297	51728	20754	18771

Figure 18-3: The budget model after collapsing the outline to the second level.

Excel can create outlines in both directions. In the preceding examples, the outline was a row (vertical) outline. Figure 18-4 shows the same model after a column (horizontal) outline was added. Now, Excel displays another border at the top.

State	Jan	Feb	Mar	Q1 Total	Apr	May	Jun	Q2 To
California	1118	1960	1252	4330	1271	1557	1679	4:
Washington	1247	1238	1028	3513	1345	1784	1574	4:
Oregon	1460	1954	1726	5140	1461	1764	1144	4:
Nevada	1345	1375	1075	3795	1736	1555	1372	4(
West Total	5170	6527	5081	16778	5813	6660	5769	18:
New York	1429	1316	1993	4738	1832	1740	1191	4:
New Jersey	1735	1406	1224	4365	1706	1320	1290	4:
Massachusetts	1099	1233	1110	3442	1637	1512	1006	4
Florida	1705	1792	1225	4722	1946	1327	1357	4(
East Total	5968	5747	5552	17267	7121	5899	4844	17
Kentucky	1109	1078	1155	3342	1993	1082	1551	4(
Oklahoma	1309	1045	1641	3995	1924	1499	1941	5:
Missouri	1511	1744	1414	4669	1243	1493	1820	4:
Illinois	1539	1493	1211	4243	1165	1013	1445	3(
Kansas	1973	1560	1243	4776	1495	1125	1387	4(

Figure 18-4: The budget model after adding a column outline.

If you create both a row and a column outline in a worksheet, you can work with each outline independent of the other. For example, you can show the row outline at the second level and the column outline at the first level. Figure 18-5 shows the model with both outlines collapsed at the second level. The result is a nice summary table that gives regional totals by quarter.

Creating an Outline

In this section, you learn the two ways to create an outline: automatically and manually. But, before getting into the details of those two methods, the all-important first step is examined: getting your data ready for outlining.

Preparing the Data

Before you create an outline, you need to ensure the following:

✦ The data is appropriate for an outline

✦ The formulas are set up properly

Determining appropriate data

What type of data is appropriate for an outline? Generally, the data should be arranged in a hierarchy, such as a budget that consists of an arrangement similar to the following:

Company

   Division

     Department

      Budget Category

       Budget Item

In this case, each budget item (for example, airfare and hotel expenses) is part of a budget category (for example, travel expenses). Each department has its own budget, and the departments are rolled up into divisions. The divisions make up the company. This type of arrangement is well-suited for a row outline—although most of your outlines probably won't have this many levels.

Once created, you can view the information at any level of detail that you want. When you need to create reports for different levels of management, try using an outline. Upper management may want to see only the Division totals. Division managers may want to see totals by department, and each department manager needs to see the full details for his or her department.

As demonstrated at the beginning of the chapter, you can include time-based information that is rolled up into larger units (such as months and quarters) in a column outline. Column outlines work just like row outlines, however, and the levels need not be time-based.

Setting up the formulas

Before you create an outline, you need to make sure that all the summary formulas are entered correctly and consistently. *Consistently* means that the formulas are in the same relative location. Generally, formulas that compute summary formulas (such as subtotals) are entered below the data to which they refer. In some cases, however, the summary formulas are entered above the referenced cells. Excel can handle either method, but you must be consistent throughout the range that you outline. If the summary formulas aren't consistent, automatic outlining won't produce the results that you want.

Note If your summary formulas aren't consistent (that is, some are above and some are below the data), you still can create an outline, but you must do it manually.

Creating an Outline Automatically

Excel can create an outline for you automatically in a few seconds, whereas it might take you ten minutes or more to do the same thing manually.

To have Excel create an outline, move the cell pointer anywhere within the range of data that you're outlining. Then, choose Data ➪ Group and Outline ➪ Auto Outline. Excel analyzes the formulas in the range and creates the outline. Depending on the formulas that you have, Excel creates a row outline, a column outline, or both.

If the worksheet already has an outline, Excel asks whether you want to modify the existing outline. Click Yes to force Excel to remove the old outline and create a new one.

Note Excel automatically creates an outline when you use the Data ➪ Subtotals command, which inserts subtotal formulas automatically if you set up your data as a list.

Cross-Reference The Data ➪ Subtotals command is discussed in Chapter 23 (see the section "Creating Subtotals").

Creating an Outline Manually

Usually, letting Excel create the outline is the best approach. It's much faster and less error-prone. If the outline that Excel creates isn't what you have in mind, however, you can create an outline manually.

When Excel creates a row outline, the summary rows all must be above the data or below the data (they can't be mixed). Similarly, for a column outline, the summary columns all must be to the right of the data or to the left of the data. If your worksheet doesn't meet these requirements, you have two choices:

✦ Rearrange the worksheet so that it does meet the requirements

✦ Create the outline manually

Using an Outline for Text

If you need to present lots of textual information in a workbook — as in user instructions, for example — consider arranging the information in the form of an outline. The accompanying figure shows an example that I developed for one of my shareware products. The user manual is contained on a worksheet, and I created an outline to make locating a specific section easier. I also used a simple macro, attached to a check box, to make it easy for users to expand and collapse the outline.

The workbook shown in the figure is available on this book's CD-ROM.
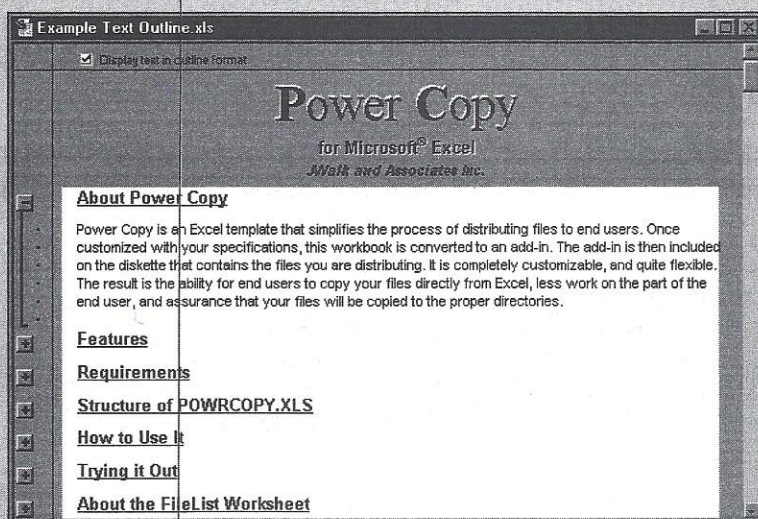
You also need to create an outline manually if the range doesn't contain any formulas. You may have imported a file and want to use an outline to display it better. Because Excel uses the formulas to determine how to create the outline, it is not able to make an outline without formulas.

Creating an outline manually consists of creating groups of rows (for row outlines) or groups of columns (for column outlines). To create a group of rows, click the row numbers for all the rows that you want to include in the group — but do not select the row that has the summary formulas. Then, choose Data ➪ Group and Outline ➪ Group. Excel displays outline symbols for the group. Repeat this for each group that you want to create. When you collapse the outline, Excel hides rows in the group. But the summary row, which is not in the group, remains in view.

Note   If you select a range of cells (rather than entire rows or columns) before you create a group, Excel displays a dialog box asking what you want to group. It then groups entire rows or columns based on the range that you select.

You also can select groups of groups to create multilevel outlines. When you create multilevel outlines, always start with the innermost groupings and then work your way out. If you realize that you grouped the wrong rows, you can ungroup the group by selecting Data ⇨ Group and Outline ⇨ Ungroup.

Excel has toolbar buttons that speed up the process of grouping and ungrouping (see the sidebar "Outlining Tools"). You also can use the following keyboard shortcuts:

✦ **Alt+Shift+right arrow:** Groups selected rows or columns

✦ **Alt+Shift+left arrow:** Ungroups selected rows or columns

Creating outlines manually can be confusing at first, but if you stick with it, you'll become a pro in no time.

Outlining Tools

Excel doesn't have a toolbar devoted exclusively to outlining, but it *does* have one that comes close. The Pivot Table toolbar (see accompanying figure) includes four tools that are handy for working with outlines.
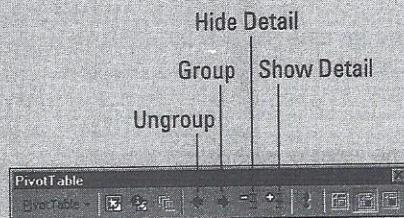
The relevant Pivot Table toolbar buttons are as follows:

Button Name	What It Does
Ungroup	Ungroups selected rows or columns
Group	Groups selected rows or columns
Show Detail	Shows details of selected summary cell
Hide Detail	Hides details of selected summary cell

Using Outlines

This section discusses the basic operations that you can perform with a worksheet outline.

Displaying Levels

To display various outline levels, click the appropriate outline symbol. These symbols consist of buttons with numbers on them (1, 2, and so on) and buttons with either a plus sign (+) or a minus sign (–).

Clicking the 1 button collapses the outline so that it displays no detail, just the highest summary level of information. Clicking the 2 button expands the outline to show one level, and so on. The number of numbered buttons depends on the number of outline levels. Choosing a level number displays the detail for that level, plus any lower levels. To display all levels—the most detail—click the highest-level number.

You can expand a particular section by clicking its + button, or you can collapse a particular section by clicking its – button. In short, you have complete control over the details that Excel exposes or hides in an outline.

If you prefer, you can use the Hide Detail and Show Detail commands on the Data ⇨ Group and Outline menu, to hide and show details, respectively. Or, you can use one of the buttons on the Pivot Table toolbar to hide or show information.

Tip If you constantly adjust the outline to show different reports, consider using the Custom Views feature to save a particular view and give it a name. Then, you can quickly switch among the named views. Use the View ⇨ Custom Views command for this.

Applying Styles to an Outline

When you create an outline, you can have Excel automatically apply named styles to the summary rows and columns.

Cross-Reference Chapter 11 discusses named styles.

Excel uses styles with names in the following formats (where n corresponds to the outline level):

✦ RowLevel_n

✦ ColLevel_n

For example, the named style that is applied to the first row level is RowLevel_1. These styles consist only of formats for the font. Using font variations makes distinguishing various parts of the outline a bit easier. You can, of course, modify the styles in any way that you want. For example, you can use the Format ⇨ Style command to change the font size or color for the RowLevel_1 style. After you do so, all the RowLevel_1 cells take on the new formatting. Figure 18-6 shows an outline with the automatic outline styles assigned.

Figure 18-6: This outline has automatic styles.

You can have Excel automatically apply the styles when it creates an outline, or you can apply them after the fact. You control this in the Settings dialog box, shown in Figure 18-7. This dialog box appears when you select Data ⇨ Group and Outline ⇨ Settings.
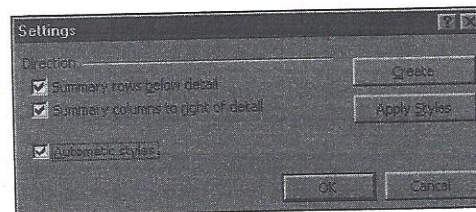

Figure 18-7: The Settings dialog box.

If the *Automatic styles* check box contains a check when you create the outline, Excel automatically applies the styles. To apply styles to an existing outline, select the outline, choose Data ⇨ Group and Outline ⇨ Settings, and then click the Apply Styles button. Notice that you also can create an outline by using this dialog box.

Tip You may prefer to use Excel's Format ➪ AutoFormat command to format an outline. Several of the AutoFormats use different formatting for summary cells.

Adding Data to an Outline

You may need to add additional rows or columns to an outline. In some cases, you may be able to insert new rows or columns without disturbing the outline, and the new rows or columns become part of the outline. In other cases, you'll find that the new row or column is not part of the outline. If you create the outline automatically, just select Data ➪ Group and Outline ➪ Auto Outline again. Excel makes you verify that you want to modify the existing outline. If you create the outline manually, you need to make the adjustments manually, as well.

Removing an Outline

If you no longer need an outline, you can remove it by selecting Data ➪ Group and Outline ➪ Clear Outline. Excel fully expands the outline by displaying all hidden rows and columns, and the outline symbols disappear. The outline styles remain in effect, however.

Caution You can't "undo" removing an outline, so make sure that you *really* want to remove the outline before you select this command.

Hiding the Outline Symbols

The outline symbols Excel displays when an outline is present take up quite a bit of space (the exact amount depends on the number levels). If you want to see as much as possible onscreen, you can temporarily hide these symbols, without removing the outline. The following are the two ways to do this:

✦ Open the Options dialog box, select the View tab, and remove the check from the Outline Symbols check box

✦ Press Ctrl+8

Note When you hide the outline symbols, the outline still is in effect, and the worksheet displays the data at the current outline level. That is, some rows or columns may be hidden.

To redisplay the outline symbols, either place a check mark in the Outline Symbols check box in the Options dialog box or press Ctrl+8.

The Custom Views feature, which saves named views of your outline, also saves the status of the outline symbols as part of the view, enabling you to name some views with the outline symbols and other views without them.

Creating Charts from Outlines

A worksheet outline also is a handy way to create summary charts. If you have a large table of data, creating a chart usually produces a confusing mess. But, if you create an outline first, then you can collapse the outline and select the summary data for your chart. Figure 18-8 shows an example of a chart created from a collapsed outline. When you expand an outline from which you created a chart, the chart shows the additional data.

Note If your chart shows all the data in the outline, even when it's collapsed, remove the check from the Plot Visible Cells Only check box in the Chart tab in the Options dialog box.
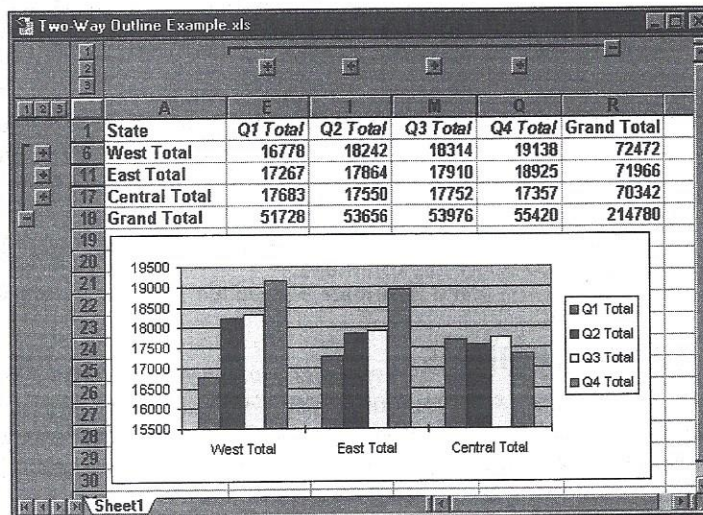
Figure 18-8: This chart was created from the summary cells in an outline.

Summary

This chapter discusses the advantages of creating an outline from worksheet data. It teaches you how to create row outlines and column outlines, either automatically or manually. It also discusses how to use an outline after it is created.

✦ ✦ ✦

Linking and Consolidating Worksheets

This chapter discusses two procedures that are common in the world of spreadsheets: linking and consolidation. *Linking* is the process of using references to cells in external workbooks to get data into your worksheet. *Consolidation* combines or summarizes information from two or more worksheets (which can be in multiple workbooks).

Linking Workbooks

When you link worksheets, you connect them together in such a way that one depends on the other. The workbook that contains the link formulas (or external reference formulas) is called the *dependent* workbook. The workbook that contains the information used in the external reference formula is called the *source* workbook. Note, importantly, that you don't need to open the source workbook when you link it to the dependent workbook.

Cross-Reference You also can create links to data in other applications, such as a database program or a word processor. This is a completely different procedure and is the topic of Chapter 29.

Why Link Workbooks?

When you consider linking workbooks, you might ask yourself the following question: If Workbook A needs to access data in another workbook (Workbook B), why not just enter the data into Workbook A in the first place? In some cases, you can. But the real value of linking becomes apparent when you continually update the source workbook. Creating a link in Workbook A to Workbook B means that, in Workbook A,

you always have access to the most recent information in Workbook B, because Workbook A is updated whenever Workbook B changes.

Linking workbooks also can be helpful if you need to consolidate different files. For example, each regional sales manager might store data in a separate workbook. You can create a summary workbook that first uses link formulas to retrieve specific data from each manager's workbook and then calculates totals across all regions.

Linking also is useful as a way to break up a large model into smaller files. You can create smaller workbook modules that are linked together with a few key external references. Often, this approach makes your model easier to deal with and uses less memory.

Linking has its downside, however. As you'll see later, external reference formulas are somewhat fragile, and accidentally severing the links that you create is relatively easy. You can prevent this from happening if you understand how linking works. Later in the chapter, some of the problems that may arise are discussed, as well as how to avoid them (see "Potential Problems with External Reference Formulas").

Creating External Reference Formulas

The following are the ways that you can create an external reference formula:

✦ **Type the cell references manually.** These references may be lengthy, because they include workbook and sheet names (and, possibly, even drive and path information). The advantage of manually typing the cell references is that the source workbook doesn't have to be open.

✦ **Point to the cell references.** If the source workbook is open, you can use the standard pointing techniques to create formulas that use external references.

✦ **With the source workbook open, select Edit ⇨ Paste Special with the Paste Link button.**

✦ **Use Excel's Data ⇨ Consolidate command.** This method is discussed later in the chapter (see "Consolidating Worksheets by Using Data ⇨ Consolidate").

Understanding the link formula syntax

This section discusses the concept of external references. The general syntax for an external reference formula is as follows:

```
=[WorkbookName]SheetName!CellAddress
```

Precede the cell address by the workbook name (in brackets), the worksheet name, and an exclamation point. Here's an example of a formula that uses cell A1 in the Sheet1 worksheet of a workbook named Budget:

```
=[Budget.xls]Sheet1!A1
```

If the workbook name or the sheet name in the reference includes one or more spaces, you must enclose the text in single quotation marks. For example, here's a formula that refers to cell A1 on Sheet1 in a workbook named Annual Budget:

```
='[Annual Budget]Sheet1'!A1
```

When a formula refers to cells in a different workbook, that other workbook doesn't need to be open. If the workbook is closed and not in the current folder, you must add the complete path to the reference; for example:

```
='C:\MSOffice\Excel\Budget Files\[Annual Budget]Sheet1'!A1
```

Creating a link formula by pointing

As previously mentioned, you can directly enter external reference formulas, but doing so can cause errors, because you must have every bit of information exactly correct. Instead, have Excel build the formula for you, as follows:

1. Open the source workbook.
2. Select the cell in the dependent workbook that will hold the formula.
3. Enter the formula. When you get to the part that requires the external reference, activate the source workbook and select the cell or range.
4. Finish the formula and press Enter.

You'll see that when you point to the cell or range, Excel automatically takes care of the details and creates a syntactically correct external reference. When you point to a cell reference by using the procedure outlined in the preceding steps, the cell reference is always an absolute reference (such as A1). If you plan to copy the formula to create additional link formulas, you can change the absolute reference to a relative reference by removing the dollar signs.

As long as the source workbook remains open, the external reference doesn't include the path to the workbook. If you close the source workbook, however, the external reference formulas change to include the full path. If you use the File ⇨ Save As command to save the source workbook with a different name, Excel changes the external references to use the new filename.

Pasting links

The Paste Special command provides another way to create external reference formulas:

1. Open the source workbook.
2. Select the cell or range that you want to link and then copy it to the Clipboard.
3. Activate the dependent workbook and select the cell in which you want the link formula to appear. If you're pasting a range, just select the upper-left cell.
4. Choose Edit ⇨ Paste Special and then click the Paste Link button.

Working with External Reference Formulas

You need to understand that a single workbook can contain links that refer to any number of different source workbooks. This section discusses what you need to know about working with links.

Creating links to unsaved workbooks

Excel enables you to create link formulas to unsaved workbooks, and even to nonexistent workbooks. Assume that you have two workbooks open and you haven't saved either of them (they have the names Book1 and Book2). If you create a link formula to Book1 in Book2 and then save Book2, Excel displays the dialog box shown in Figure 19-1. Generally, you should avoid this situation. Simply save the source workbook first.
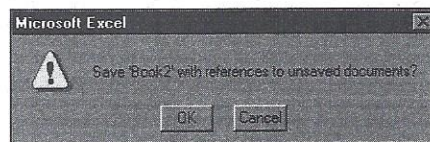

Figure 19-1: This message indicates that the workbook you're saving contains references to a workbook that you haven't yet saved.

You also can create links to documents that don't exist. You might want to do this if you'll be using a source workbook from a colleague, but the file hasn't arrived. When you enter an external reference formula that refers to a nonexistent workbook, Excel displays its File Not Found dialog box, shown in Figure 19-2. If you click Cancel, the formula retains the workbook name that you entered, but it returns an error. When the source workbook becomes available, the error goes away and the formula displays its proper value.

Opening a workbook with external reference formulas

When you open a workbook that contains one or more external reference formulas, Excel retrieves the current values from the source workbooks and calculates the formulas.

If Excel can't locate a source workbook that's referred to in a link formula, it displays its File Not Found dialog box and prompts you to supply a workbook to use for the source workbook.
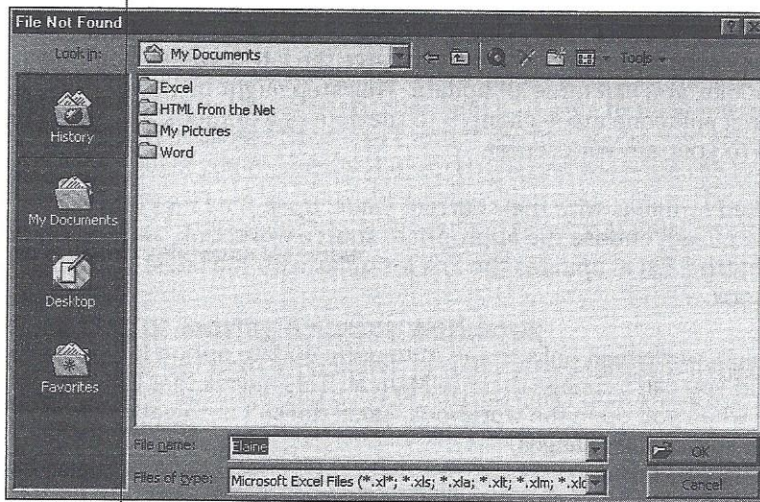
Figure 19-2: When you enter a formula that refers to a nonexistent workbook, Excel displays this dialog box to help you locate the file.

Examining links

If your workbook uses several workbook links, you might want to see a list of source workbooks. To do so, choose the Edit ⇨ Links command. Excel responds with the Links dialog box, shown in Figure 19-3. This dialog box lists all source workbooks, plus other types of links to other documents.

Cross-Reference These other types of links are explained in Chapter 29.
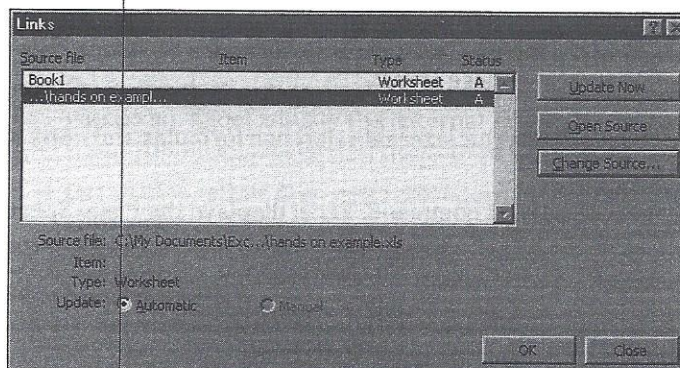
Figure 19-3: The Links dialog box lists all link sources.

Updating links

If you want to ensure that your link formulas have the latest values from their source workbooks, you can force an update. This step might be necessary if you just learned that someone made changes to the source workbook and saved the latest version to your network server.

To update linked formulas with their current value, open the Links dialog box (choose Edit ➪ Links), choose the appropriate source workbook, and then click the Update Now button. Excel updates the link formulas with the latest version of the source workbook.

Excel always sets worksheet links to the Automatic update option in the Links dialog box, and you can't change them to Manual. This means that Excel updates the links only when you open the workbook. Excel doesn't automatically update links when the source file changes.

Changing the link source

A time may come when you need to change the source workbook for your external references. For example, you might have a worksheet that has links to a workbook named Preliminary Budget, but you later receive a finalized version named Final Budget.

You *could* change all the cell links manually, or you could simply change the link source. Do this in the Links dialog box. Select the source workbook that you want to change and click the Change Source button. Excel displays a dialog box that enables you to select a new source file. After you select the file, all external reference formulas are updated.

Severing links

If you have external references in a workbook and then decide that you no longer need the links, you can convert the external reference formulas to values, thereby severing the links. To do so, follow these steps:

1. Select the range that contains the external reference formulas and copy it to the Clipboard.

2. Choose the Edit ➪ Paste Special command. Excel displays the Paste Special dialog box.

3. Select the Values option and click OK.

4. Press Esc to cancel cut-copy mode.

All formulas in the selected range are converted to their current values.

Potential Problems with External Reference Formulas

Using external reference formulas can be quite useful, but the links may be unintentionally severed. In almost every case, you'll be able to reestablish lost links. If you open the workbook and Excel can't locate the file, you're presented with a dialog box that enables you to specify the workbook and re-create the links. You also can change the source file by using the Change Source button in the Links dialog box. The following sections discuss some pointers that you must remember when you use external reference formulas.

Renaming or moving a source workbook

If you rename the source document or move it to a different folder, Excel won't be able to update the links. You need to use the Links dialog box and specify the new source document.

Using the File ⇨ Save As command

If both the source workbook and the destination workbook are open, Excel doesn't display the full path in the external reference formulas. If you use the File ⇨ Save As command to give the source workbook a new name, Excel modifies the external references to use the new workbook name. In some cases, this may be what you want. But in other cases, it may not. Bottom line? Be careful when you use the File ⇨ Save As command with a workbook that is linked to another workbook.

Modifying a source workbook

If you open a workbook that is a source workbook for another workbook, be extremely careful if you don't open the destination workbook at the same time. For example, if you add a new row to the source workbook, the cells all move down one row. When you open the destination workbook, it continues to use the old cell references — which are now invalid. You can avoid this problem in the following ways:

✦ **Open the destination workbook when you modify the source workbook.** If you do so, Excel adjusts the external references in the destination workbook when you make changes to the source workbook.

✦ **Use names rather than cell references in your link formula.** This is the safest approach.

Intermediary links

Excel doesn't place many limitations on the complexity of your network of external references. For example, Workbook A can contain external references that refer to Workbook B, which can contain an external reference that refers to Workbook C. In this case, a value in Workbook A can ultimately depend on a value in Workbook C. Workbook B is an *intermediary link*.

I don't recommend these types of links, but if you must use them, be aware that Excel doesn't update external reference formulas if the workbook isn't open. In the preceding example, assume that Workbooks A and C are open. If you change a value in Workbook C, Workbook A won't reflect the change, because you didn't open Workbook B (the intermediary link).

Consolidating Worksheets

The term *consolidation*, in the context of worksheets, refers to several operations that involve multiple worksheets or multiple workbook files. In some cases, consolidation involves creating link formulas. Here are two common examples of consolidation:

✦ The budget for each department in your company is stored in a separate worksheet in a single workbook. You need to consolidate the data and create a company-wide budget.

✦ Each department head submits his or her budget to you in a separate workbook. Your job is to consolidate these files into a company-wide budget.

These tasks can be very difficult or quite easy; the tasks are easy if the information is laid out exactly the same in each worksheet (as you'll see shortly).

If the worksheets aren't laid out identically, they may be similar enough. In the second example, some budget files submitted to you may be missing categories that aren't used by a particular department. In this case, you can use a handy feature in Excel that matches data by using row and column titles. This feature is discussed later in the chapter (see "Consolidating Worksheets by Using Data ⇨ Consolidate).

If the worksheets bear little or no resemblance to each other, your best bet may be to edit the sheets so that they correspond to one another. In some cases, simply reentering the information in a standard format may be more efficient.

You can use any of the following techniques to consolidate information from multiple workbooks:

✦ Use external reference formulas

✦ Copy the data and use the Paste Special command

✦ Use Excel's Data ⇨ Consolidate command

✦ Use a pivot table (discussed in Chapter 25)

Using Links to Recover Data from Corrupted Files

Sooner or later (with luck, later), it's bound to happen. You attempt to open an Excel workbook, and you get an error telling you that Excel can't access the file. Most of the time, this indicates that the file (somehow) got corrupted. If you're lucky, you have a recent backup. If you're *very* lucky, you haven't made any changes to the file since you backed it up. But assume that you fell a bit behind on your backup procedures, and the dead file is the only version you have.

Although I don't know of any method to fully recover a corrupt file, I'll share with you a method that sometimes enables you to recover at least some of the data from worksheets in the file (values, not formulas). Your actual success depends on how badly the file is corrupted.

This technique involves creating an external reference formula that refers to the corrupt file. You need to know the names of the worksheets that you want to recover. For example, assume that you have a workbook named Summary Data that you can't open. Further, assume that this workbook is stored on the C drive in a folder named Sheets. This workbook has one sheet, named Sheet1. Here's how to attempt to recover the data from this worksheet:

1. Open a new workbook.

2. In cell A1, enter the following external reference formula:

   ```
   ='C:\Sheets\[Summary Data]Sheet1'!A1
   ```

   If you're lucky, this formula returns the value in cell A1 of Sheet1 in the corrupt file.

3. Copy down this formula and to the right to recover as many values as you can.

4. Convert the external reference formulas in the new workbook to values and then save the workbook.

If the corrupt file has additional worksheets, repeat these steps for any other worksheets in the workbook (you need to know the exact sheet names).
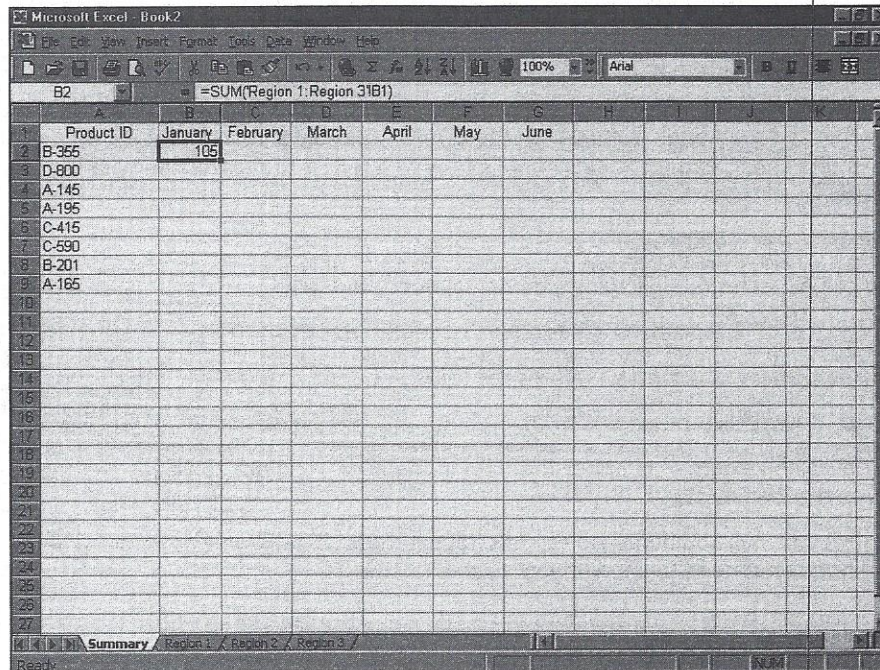
Consolidating Worksheets by Using Formulas

Consolidating with formulas simply involves creating formulas that use references to other worksheets or other workbooks. The primary advantages to using this method of consolidation are the following:

✦ Dynamic updating—if the values in the source worksheets change, the formulas are updated automatically.

✦ The source workbooks don't need to be open when you create the consolidation formulas.

If you are consolidating the worksheets in the same workbook—and if all the worksheets are laid out identically—the consolidation task is quite simple. You can just use standard formulas to create the consolidations. For example, to compute the total for cell A1 in worksheets named Sheet2 through Sheet10, enter the following formula:

```
=SUM(Sheet2:Sheet10!A1)
```

You can enter this formula manually or use the multisheet selection technique discussed in Chapter 8 (see "Selecting Multisheet Ranges"). You can then copy this formula to create summary formulas for other cells. Figure 19-4 shows this technique at work.

Figure 19-4: Consolidating multiple worksheets by using formulas.

If the consolidation involves other workbooks, you can use external reference formulas to perform your consolidation. For example, if you want to add the values in cell A1 from Sheet1 in two workbooks (named Region1 and Region2), you can use the following formula:

```
=[Region1.xls]Sheet1!A1+[Region2.xls]Sheet1!A1
```

You can include any number of external references in this formula, up to the 1,024-character limit for a formula. However, if you use many external references, such a formula can be quite lengthy and confusing, if you need to edit it.

Caution

Remember that Excel expands the references to include the full path—which can increase the length of the formula. Therefore, this expansion may cause the formula to exceed the limit, thus creating an invalid formula.

If the worksheets that you're consolidating aren't laid out the same, you can still use formulas—but you have to ensure that each formula refers to the correct cell.

Consolidating Worksheets by Using Paste Special

Another method of consolidating information is to use the Edit ⇨ Paste Special command. This method is applicable only when all the worksheets that you're consolidating are open. The disadvantage—a major disadvantage—is that the consolidation isn't dynamic. In other words, it doesn't generate a formula. So, if any data that was consolidated changes, the consolidation is no longer accurate.

This technique takes advantage of the fact that the Paste Special command can perform a mathematical operation when it pastes data from the Clipboard. Figure 19-5 shows the Paste Special dialog box.
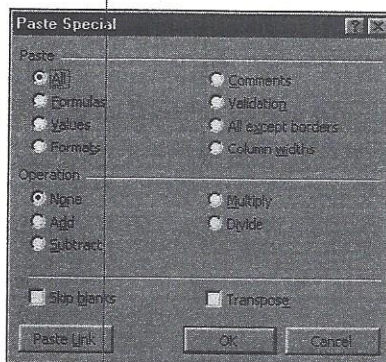
Figure 19-5: The Paste Special dialog box.

Here's how to use this method:

1. Copy the data from the first source range.

2. Activate the destination workbook and select the cell in which you want to place the consolidation formula.

3. Select Edit ⇨ Paste Special, click the Add option, and then click OK.

Repeat these steps for each source range that you want to consolidate. As you can see, this can be quite error-prone and isn't really a good method of consolidating data.

Consolidating Worksheets by Using Data ⇨ Consolidate

For the ultimate in data consolidation, use Excel's Data ⇨ Consolidate command. This method is quite flexible, and in some cases, it even works if the source worksheets aren't laid out identically. This technique can create consolidations that are static (no link formulas) or dynamic (with link formulas). The Data ⇨ Consolidate command supports the following methods of consolidation:

✦ **By position:** This method is accurate only if the worksheets are laid out identically.

✦ **By category:** Excel uses row and column labels to match data in the source worksheets. Use this option if the data is laid out differently in the source worksheets or if some source worksheets are missing rows or columns.

Figure 19-6 shows the Consolidate dialog box, which appears when you select Data ⇨ Consolidate. The following list is a description of the controls in this dialog box:
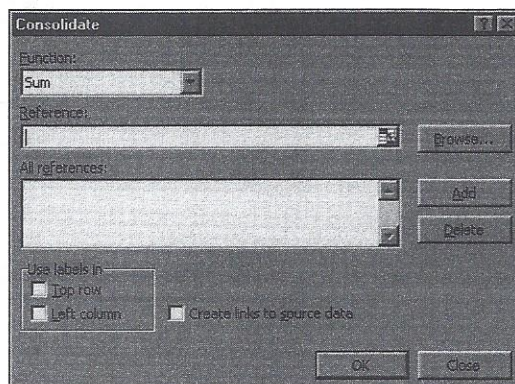
Figure 19-6: The Consolidate dialog box enables you to specify ranges to consolidate.

✦ **Function list box:** Specify the type of consolidation. Usually, you use Sum, but you also can select from ten other options: Count, Avg, Max, Min, Product, Count Nums, StdDev (standard deviation), StdDevp (population standard deviation), Var (variance), or Varp (population variance).

✦ **Reference text box:** Specify a range from a source file that you want to consolidate. You can enter the range reference manually or use any standard pointing technique (if the workbook is open). After you enter the range in this box, click the Add button to add it to the All References list. If you consolidate by position, don't include labels in the range. If you consolidate by category, *do* include labels in the range.

✦ **All references list box:** Contains the list of references that you have added with the Add button.

✦ **Use labels in check boxes:** Use to instruct Excel to perform the consolidation by examining the labels in the top row, the left column, or both positions. Use these options when you consolidate by category.

✦ **Create links to source data check box:** When you select this option, Excel creates an outline that consists of external references to the destination cells in the destination worksheet. Additionally, Excel includes summary formulas in the outline. If you don't select this option, the consolidation doesn't use formulas.

✦ **Browse button:** Displays a dialog box that enables you to select a workbook to open. It inserts the filename in the Reference box, but you have to supply the range reference.

✦ **Add button:** Adds the reference in the Reference box to the All References list.

✦ **Delete button:** Deletes the selected reference from the All References list.

An example

The simple example in this section demonstrates the power of the Data ⇨ Consolidate command. Figure 19-7 shows three single-sheet workbooks that will be consolidated. These worksheets report product sales for three months. Notice, however, that they don't all report on the same products. In addition, the products aren't even listed in the same order. In other words, these worksheets aren't laid out identically—which makes creating consolidation formulas difficult.

Region1.xls

Product ID	Jan	Feb	Mar
B-355	45	53	51
D-800	0	32	36
A-145	15	16	21
A-195	12	9	15
C-415	5	6	12
C-590	14	0	0
B-201			
A-165			

Region2.xls

Product ID	Jan	Feb	Mar
D-800	3	98	123
C-590	45	65	98
A-145	3	12	33
A-195	33	13	19
B-201	15	3	6
E-901	0	0	2
	5	0	1
	4	3	1
	5	3	0

Region3.xls

Product ID	Jan	Feb	Mar
A-145	21	15	30
A-189	14	2	2
A-195	0	1	2
C-213	2	12	5
C-415	5	5	5
C-590	34	21	11
D-800	9	66	98
E-900	5	1	0
E-904	3	5	7
E-912	0	0	2
E-923	1	0	0

Figure 19-7: Three worksheets to be consolidated.

To consolidate this information, start with a new workbook. The source workbooks can be open or not — it doesn't matter. Follow these steps to consolidate the workbooks:

1. Select Data ➪ Consolidate. Excel displays its Consolidate dialog box.

2. Select the type of consolidation summary that you want to use. Use Sum for this example.

3. Enter the reference for the first worksheet to consolidate. If the workbook is open, you can point to the reference. If it's not open, click the Browse button to locate the file on disk. The reference must include a range. Use **A1:D100**. This range is larger than the actual range to consolidate, but using this range ensures that the consolidation still works if new rows are added to the source file. When the reference in the Reference box is correct, click Add to add it to the All References list.

4. Enter the reference for the second worksheet. You can simply edit the existing reference by changing Region1 to **Region2** and then clicking Add. This reference is added to the All References list.

5. Enter the reference for the third worksheet. Again, you can simply edit the existing reference by changing Region2 to **Region3** and then clicking Add. This final reference is added to the All References list.

6. Because the worksheets aren't laid out the same, select the Left column and Top row check boxes to force Excel to match the data by using the labels.

7. Select the Create links to source data check box to make Excel create an outline with external references.

8. Click OK to begin the consolidation.

In seconds, Excel creates the consolidation, beginning at the active cell. Figure 19-8 shows the result. Notice that Excel created an outline, which is collapsed to show only the subtotals for each product. If you expand the outline, you can see the details. Examine it further, and you'll discover that each detail cell is an external reference formula that uses the appropriate cell in the source file. Therefore, the destination range is updated automatically if any data is changed.

More about consolidation

Excel is very flexible regarding the sources that you can consolidate. You can consolidate data from the following:

✦ Workbooks that are open

✦ Workbooks that are closed (you have to enter the reference manually — but you can use the Browse button to get the filename part of the reference)

✦ The same workbook in which you're creating the consolidation

Figure 19-8: The result of the consolidation.

And, of course, you can mix and match any of the preceding choices in a single consolidation.

Excel remembers the references that you entered in the Consolidate dialog box and saves them with the workbook. Therefore, if you want to refresh a consolidation later, you won't have to reenter the references.

If you perform the consolidation by matching labels, be aware that the matches must be exact. For example, *Jan* does not match *January*. The matching isn't case-sensitive, however, so *April* does match *APRIL*. In addition, the labels can be in any order, and they need not be in the same order in all the source ranges.

If you don't choose the Create links to source data check box, Excel doesn't create formulas, which generates a static consolidation. If the data on any of the source worksheets changes, the consolidation doesn't update automatically. To update the summary information, you need to select the destination range and repeat the Data ➪ Consolidate command.

Tip   If you name the destination range **Consolidate_Area**, you don't need to select it before you update the consolidation. Consolidate_Area is a name that has special meaning to Excel.

If you choose the Create links to source data check box, Excel creates an outline. This is a standard worksheet outline, and you can manipulate it by using the techniques described in Chapter 18.

Summary

This chapter discusses two important spreadsheet procedures: linking and consolidation. *Linking* is the process of referring in one worksheet to cells in external workbooks. *Consolidation* is the process of combining or summarizing information from two or more worksheets (which can be in multiple workbooks). This chapter covers various methods of linking and consolidation, and lists potential pitfalls.

✦   ✦   ✦

Creating and Using Array Formulas

This chapter introduces a concept that may be new to you: *array formulas*. Understanding this special type of formula may open a whole new world of analytical capability. Working with arrays (rather than with individual cells) requires a different type of mind-set. Some people never quite get the hang of arrays, and others take to this concept quickly. If you're in the former group, don't despair. Using array formulas can be considered an optional skill.

Introducing Arrays

This chapter discusses two concepts:

+ **Array:** A collection of cells or values that is operated on as a group. An array can be stored in cells or can be a named constant that consists of multiple elements.

+ **Array formula:** A formula that uses one or more arrays either directly or as arguments for a function. An array formula can occupy one or more cells.

If you've ever done any computer programming, you've probably been exposed to arrays. An *array* is a collection of items. Excel's arrays can be one-dimensional or two-dimensional. These dimensions correspond to rows and columns. For example, a *one-dimensional array* can be a cell range that occupies cells in one row (a horizontal array) or one column (a vertical array). A *two-dimensional array* occupies cells in one or more rows and columns.

You can perform operations on arrays by using *array formulas*. For example, if you construct an array formula to multiply a five-item vertical array by another five-column vertical array, the result is another five-column vertical array that consists of each element in the first array multiplied by each corresponding element in the second array. Because Excel can fit only one value in a cell, the results of an operation such as this one occupy five cells — and the same array formula is in each of the five cells.

Figure 20-1 illustrates this example. Each cell in the range C1:C5 holds the same formula: {=A1:A5*B1:B5}. The result occupies five cells and contains each element of the first array multiplied by each corresponding element in the second array. The brackets around the formula designate it as an array formula (more about this later in "Entering an Array Formula").
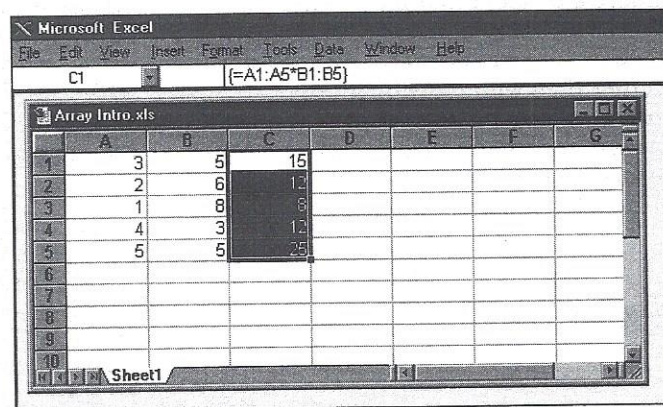
Figure 20-1: A single array formula entered in the range C1:C5 produces results in five cells.

As you will see, arrays have their pros and cons. At the very least, this feature provides an alternative way of doing some operations and is the only way to perform others.

Advantages of Array Formulas

The following are some of the advantages that may be obtained by using array formulas (as opposed to single-cell formulas):

✦ Much more efficient to work with

✦ Eliminate the need for intermediary formulas

✦ Enable you to do things that would otherwise be difficult or impossible

✦ Use less memory

Disadvantages of Array Formulas

This list shows a few disadvantages of array formulas:

✦ Some large arrays can slow your spreadsheet recalculation time to a crawl.

✦ Arrays can make your worksheets more difficult for others to understand.

✦ You must remember to enter an array formula with a special key sequence (Ctrl+Shift+Enter). Otherwise, the result isn't what you expect.

✦ Array formulas cannot be exported to other spreadsheet formats (such as Lotus 1-2-3).

Understanding Arrays

This section presents several examples to help clarify the concept of arrays. As always, you can get more from this chapter if you follow along on your own computer.

Array Formulas Versus Standard Formulas

You often can use a single array formula to substitute for a range of copied formulas. Figure 20-2 shows two examples; the upper worksheet uses standard single-result formulas. The formulas use the SQRT function to calculate the square roots of the values in column A. The formula =SQRT(A3) was entered into cell B3 and copied to the three cells below it. This example uses four different formulas to calculate the results in column B.

Figure 20-2: These workbooks accomplish the same result, but one uses standard formulas and the other uses an array formula.

The lower workbook uses a single array formula, which is inserted into all four cells. Use the following steps to enter this array formula:

1. Select the range B3:B6.

2. Enter **SQRT(A3:A6)**.

3. Press Ctrl+Shift+Enter to designate the formula as an array formula.

Excel enters the array formula into the three selected cells. It also adds brackets around the formula to indicate that it's an array formula. The key point here is that this example uses only one formula, but the results appear in four different cells, because the formula is operating on a four-cell array.

To further demonstrate that this is, in fact, one formula, try to edit one of the cells in B3:B6. You find that Excel doesn't let you make any changes. To modify an array formula that uses more than one cell, you must select the entire array before you edit the formula.

Virtually no advantage is gained by using an array formula in the preceding example (except perhaps to save the time that it takes to copy the formula). The real value of array formulas becomes apparent as you work through this chapter.

An Array Formula in One Cell

Figure 20-3 shows another example. The worksheet on the left uses standard formulas to calculate the average change from the pretest to the posttest. The worksheet on the right also calculates the average changes, but it uses an array formula. This array formula resides in only one cell, because the result is a single value. This is an example of how an array formula can eliminate the need for intermediary formulas. As you can see, you don't need to include an additional column to calculate the change in scores.

Change Scores 1.xls

	A	B	C	D
1				
2		Pretest	Posttest	Change
3	Student 1	84	87	3
4	Student 2	75	73	-2
5	Student 3	84	85	1
6	Student 4	88	92	4
7	Student 5	93	93	0
8	Student 6	84	91	7
9	Student 7	90	93	3
10				
11	Average Change:			2.285714
12			=AVERAGE(D3:D9)	

Change Scores 2.xls

	A	B	C	D
1				
2		Pretest	Posttest	
3	Student 1	84	87	
4	Student 2	75	73	
5	Student 3	84	85	
6	Student 4	88	92	
7	Student 5	93	93	
8	Student 6	84	91	
9	Student 7	90	93	
10				
11	Average Change:		2.28571	
12		{=AVERAGE(C3:C9-B3:B9)}		

Figure 20-3: Using an array formula to eliminate intermediary formulas.

The formula in cell C11 is as follows:

```
{=AVERAGE(C3:C9-B3:B9)}
```

This array formula operates on two arrays, which are stored in cells. It subtracts each element of B3:B9 from the corresponding element in C3:C9 and produces (in memory) a new seven-element array that holds the result. The AVERAGE function computes the average of the elements in the new array, and the result is displayed in the cell.

Looping with Arrays

Excel's array feature enables you to perform individual operations on each cell in a range—in much the same way as a program language's looping feature enables you to work with elements of an array. For example, assume that you have a range of cells (named Data) that contains positive and negative values. You need to compute the average of just the positive values in the range. Figure 20-4 shows an example of this.

Figure 20-4: You can use an array formula to calculate the average of only the positive values in this range.

One approach is to sort the data and then use the AVERAGE function to calculate the average on only the positive values. A more efficient approach uses the following array formula:

```
={AVERAGE(IF(Data>0,Data,""))}
```

The IF function in this formula checks each element in the input range to see whether it's greater than zero. If so, the IF function returns the value from the input range; otherwise, it returns an empty string. The result is an array that's identical to the input array, except that all nonpositive values are replaced with a null string (the third argument of the IF functions). The AVERAGE function then computes the average of this new array, and the result is displayed in the cell.

The preceding problem can also be solved with the following nonarray formula:

```
=SUMIF(Data,">0",Data)/COUNTIF(Data,">0")
```

Many similar operations can't be performed with a standard formula, however. For example, to calculate the median of the positive values in a range, an array formula is the only solution.

Some more useful examples that use arrays are presented later in this chapter, but for now, some rules are provided for how to work with arrays and array formulas.

Working with Arrays

This section deals with the mechanics of selecting arrays and entering and editing array formulas. These procedures are a little different from working with ordinary ranges and formulas.

## Entering an Array Formula

When you enter an array formula into a cell or range, you must follow a special procedure, so that Excel knows that you want an array formula rather than a normal formula. You enter a normal formula into a cell by pressing Enter. You enter an array formula into one or more cells by pressing Ctrl+Shift+Enter.

You can easily identify array formulas, because they are enclosed in brackets in the formula bar. For example, {=SQRT(A1:A12)} is an array formula.

Don't enter the brackets when you create an array formula; Excel inserts them for you. If the result of an array formula consists of more than one value, you must select all the cells before you enter the formula. If you fail to do this, only the first result shows.

Editing an Array Formula

If an array formula occupies multiple cells, you must edit the entire range as though it is a single cell. The key point to remember is that you can't change just one element of an array formula. If you attempt to do so, Excel displays the messages shown in Figure 20-5.
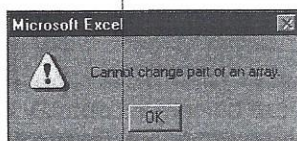
Figure 20-5: Excel's warning message reminds you that you can't edit just one cell of a multicell array.

The following rules apply to multicell array formulas. (If you try to do any of these things, Excel lets you know about it.):

✦ You can't change the contents of any cell that makes up an array formula.

✦ You can't move cells that make up part of an array formula. You can, however, move an entire array formula.

✦ You can't delete cells that form part of an array formula, but you can delete an entire array.

✦ You can't insert new cells into an array range; this rule includes inserting rows or columns that would add new cells to an array range.

To edit an array formula, select all the cells in the array range and activate the formula bar as usual (click it or press F2). Excel removes the brackets from the formula while you're editing it. Edit the formula and then press Ctrl+Shift+Enter to enter the changes. All the cells in the array now reflect your editing changes.

Selecting an Array Range

You can select an array range manually by using the normal selection procedures. Or, you can use either of the following methods:

✦ Move to any cell in the array range. Select Edit ⇨ Go To (or press F5), click the Special button, and then choose the Current Array option. Click OK to close the dialog box.

✦ Move to any cell in the array range and press Ctrl+/ to select the entire array.

Formatting Arrays

Although you can't change any part of an array formula without changing all parts, you're free to apply formatting to the entire array or to only parts of it.

Using Array Constants

So far, the examples in this chapter have used cell ranges to hold arrays. You can also use constant values as an array. These constants can be entered directly into a formula or defined by using the Define Name dialog box. Array constants can be used in array formulas in place of a reference to a range of cells. To use an array constant in an array formula, type the set of values directly into the formula and enclose it in brackets. If you defined a name for the array constant, you can use the name instead.

Array constants can be either one-dimensional or two-dimensional. One-dimensional arrays can be either vertical or horizontal. The elements in a one-dimensional horizontal array are separated by commas. The following example is a one-dimensional horizontal array:

```
{1,2,3,4,5}
```

Because this array constant has five values, it requires five cells (in a row). To enter this array into a range, select a range that consists of one row and five columns. Then, enter ={1,2,3,4,5} and press Ctrl+Shift+Enter.

When you use array constants, you must enter the brackets. Excel doesn't provide them for you. The following example is another horizontal array; it has seven elements:

```
{"Sun","Mon","Tue","Wed","Thu","Fri","Sat"}
```

Figure 20-6 demonstrates how to create a named array constant by using the Define Name dialog box.
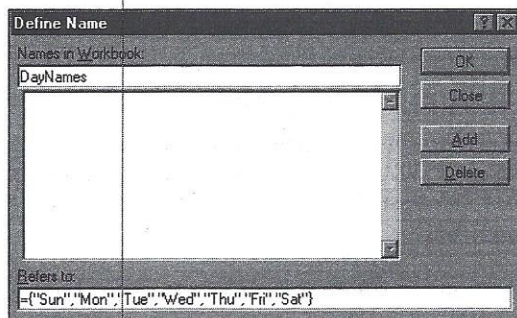
Figure 20-6: Creating an array constant in the Define Name dialog box.

The elements in a one-dimensional vertical array are separated by semicolons. The following is a six-element vertical array:

```
{10;20;30;40;50;60}
```

The following is another example of a vertical array; this one has four elements:

```
{"Widgets";"Sprockets";"Do-Dads";"Thing-A-Majigs"}
```

Two-dimensional arrays also separate the elements in a single row with commas and separate the rows with semicolons. The next example is a 3 × 4 array (three rows, each of which occupies four columns):

```
{1,2,3,4;5,6,7,8;9,10,11,12}
```

Figure 20-7 shows how this array appears in a worksheet. First, the array constant was created and named MyArray. Then, A1:D3 was selected and =MyArray was entered. The array formula was entered into the range by pressing Ctrl+Shift+Enter.
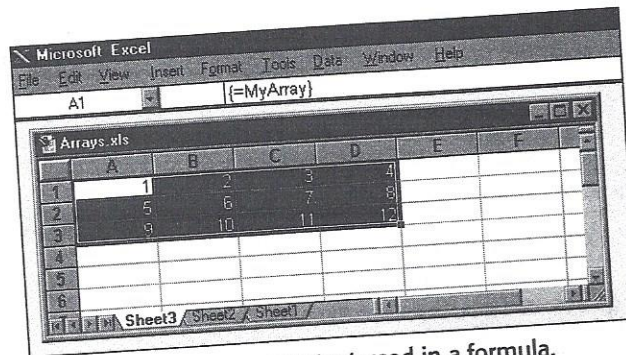
Figure 20-7: An array constant used in a formula.

You can't list cell references, names, or formulas in an array formula in the same way as you list constants. For example, {2*3,3*3,4*3} isn't valid, because it lists formulas. {A1,B1,C1} isn't valid, either, because it lists cell references. Instead, you should use a range reference, such as {A1:C1}.

You must remember an array's dimensions when you're performing operations on it. Consider the following array formula:

```
={2,3,4}*{10,11}
```

This formula multiplies a 1×3 array by a 1×2 array. Excel returns an array with three values: 20, 33, and #N/A. Because the second array wasn't large enough, Excel generated #N/A as the third element of the result.

Examples of Using Array Formulas

Perhaps the best way to learn about array formulas is by following examples and adapting them to your own needs. This section presents useful examples that give you a good idea of how you can use array formulas.

> **On the CD-ROM**
> All the examples presented in this section can be found in a workbook on this book's companion CD-ROM.

Using an Array Constant

Figure 20-8 shows a practical example of an array constant.

Figure 20-8: Using an array constant to enter the names of sales regions.

The following steps demonstrate how to create this example:

1. Define the following constant, named SalesRegions:

```
={"S. California";"Pacific NW";"SouthWest";"Central";"
SouthEast";" NorthEast"}
```

Because the elements are separated by semicolons, this is a vertical array.

2. Select A4:A9 and enter =**SalesRegions**.

3. Press Ctrl+Shift+Enter.

The worksheet in Figure 20-8 also shows the sales regions displayed horizontally. To do this, select A1:F1 and then enter the following formula (by pressing Ctrl+Shift +Enter):

```
{=TRANSPOSE(SalesRegions)}
```

The TRANSPOSE function converts a horizontal array to a vertical array (and vice versa).

The method just described is one of several ways to enter a stored list quickly into a range of cells. Perhaps a better approach is to create a custom list in the Custom Lists panel of the Options dialog box.

Identifying a Value in a Range

To determine whether a particular value is contained in a range, choose Edit ➪ Find. But, you also can make this determination by using an array formula. Figure 20-9 shows a worksheet with a list of names (named Names). An array formula in cell E4 checks the name that is entered into cell B1 (named TestValue). If the name exists, it displays the text Name is in the list. Otherwise, it displays Name not found.