Formulas and Functions

<div style="text-align: right">**10**</div>

After familiarizing yourself with Excel's list management features (using it to record mailing lists and membership rosters, for example), you'll want to explore its extensive calculation capabilities. By combining the contents of specific cells with each other or constants, you can create *formulas*. For example, you can add two cells' contents, divide the contents of one cell by that of another, or multiply a cell's contents by a constant, such as a sales tax percentage or a commission rate.

You can also use Excel *functions* in your formulas. For instance, rather than laboriously adding the contents of several dozen cells, you can use the SUM function to generate a total for the range. In support of your calculation needs, Excel provides more than 300 built-in functions.

In this chapter, you'll learn the basics of combining cell references, constants, and functions into useful formulas. Techniques for troubleshooting formulas are also presented.

About Cell References

Although a formula can be composed solely of constants, such as =12+5, you'll seldom use Excel to perform such calculations. Almost all formulas include *cell references*, such as =A2+5. This formula is interpreted by Excel as: "Take the current contents of cell A2 and add 5 to it."

A1 reference style

By default, Excel worksheets use *A1 reference style* in which columns are lettered and rows are numbered. Each *cell address* is named for the intersection of the column and row in which the cell is located. For example, G7 is the cell found at the intersection of column G and row 7. A *range* is represented as a pair of addresses separated by a colon (:). For example, B3:B6 means all cells between cells B3 and B6 inclusive—that is, B3, B4, B5, and B6. Refer to **Table 10.1** for some additional examples.

3-D reference style

Excel also provides a *3-D reference style* that allows you to include cells and ranges from other sheets in your formulas, as well as perform calculations across workbook sheets:

◆ To include a cell or range from another sheet in a formula, you precede the cell or range address with the sheet's name followed by an exclamation point:

=Sheet2!a7-8

In this example, 8 is subtracted from the contents of cell A7 on Sheet2.

◆ To consolidate data across multiple sheets, precede the cell or range address with the sheet range:

=SUM(Sales1:Sales12!G50)

Table 10.1

A1 Reference Style Examples	
EXAMPLE	EXPLANATION
R5	Cell in column R, row 5
B3:E3	Cells B, C, D, and E in row 3
3:3	Row 3
F:F	Column F
5:8	Rows 5, 6, 7, and 8
A:C	Columns A, B, and C
A1:B3	All cells between cells A1 and B3 inclusive (A1, B1, A2, B2, A3, and B3)

f_x | =SUM(Table1[@[Test 1]:[Test 3]])

Figure 10.1 In Table 1 (top), Total (column E) is a calculated column. When the formula is expressed in structured reference style (bottom), it is identical in every cell in the column.

	1	2	3
1	Date	Business Purpose	Destination
2	01/03/2006	Mail	Post Office
3	01/10/2006	Mail	Post Office

Figure 10.2 In R1C1 reference style, both rows and columns are numbered.

Table 10.2

3-D Reference Style Functions	
FUNCTION	**DESCRIPTION**
AVERAGE	Calculates the average (arithmetic mean)
COUNT	Counts the cells that contain numbers
MAX	Returns the largest value in referenced cells
MIN	Returns the smallest value in referenced cells
PRODUCT	Multiplies numbers in referenced cells
STDEV	Calculates the standard deviation, based on a sample
STDEVP	Calculates the population standard deviation
SUM	Adds numbers in referenced cells
VAR	Calculates the variance, based on a sample
VARP	Calculates the population variance

In this example, monthly sales are recorded in the first 12 sheets, each of which is named Sales, followed by the month number. Consolidating data this way assumes you have laid out the data in the sheets (Sales1–Sales12) in identical fashion; that is, the cell (G50, in this case) contains the appropriate number in each sheet, such as total monthly sales or Janice's monthly commissions.

Structured reference style

Excel 2007 introduced *structured reference style*, a simplified means of addressing table data. When you create a formula in a table (a calculated column, for example), table-based structured references are automatically used rather than specific cell addresses (**Figure 10.1**).

✔ Tips

- When referring to a table cell in a formula, you can use structured or A1 reference style. If you point to the cell to add it to the formula, structured reference style is used.

- If you prefer, you can use *R1C1 reference style,* in which both rows and columns are numbered (**Figure 10.2**). R1C1 reference style is generally used in Excel scripts (called *macros*). To enable R1C1, click the File tab to display the Backstage and then click Options. In the Excel Options dialog box, select the Formulas category, click the R1C1 reference style check box in the Working with formulas section, and then click OK.

- In 3-D reference style, only certain functions can be used to consolidate data across sheets. For a list of these functions, see **Table 10.2**. Supported variants of these functions that can be applied to text and logical values include AVERAGEA, COUNTA, MAXA, MINA, STDEVA, STDEVPA, VARA, and VARPA.

ABOUT CELL REFERENCES

Formula Essentials

This section presents the background information you'll need to create formulas.

Anatomy of a formula

A basic formula (**Figure 10.3**) consists of a combination of cell references, constants, and operators. (A *constant* is any data entered in a cell, such as text or a number, date, or time.) To distinguish a formula from data, every formula begins with an equal (=) symbol.

Operators

Operators are used to specify the type of calculation to perform, such as addition or multiplication. Operators can be divided into four categories: arithmetic, comparison, text concatenation, and reference.

◆ **Arithmetic operators.** Used to perform mathematical calculations, producing a numerical result.

◆ **Comparison operators.** Used to perform logical comparisons between two values, resulting in either `True` or `False`.

◆ **Text concatenation operator.** Used to combine two text values, producing a single text string.

◆ **Reference operators.** Used to specify cell ranges.

See **Tables 10.3–10.6** for lists of supported operators.

Figure 10.3 In this simple formula, 18 is added to the data in cell A3. As is the case with all formulas, the result is displayed in the cell containing the formula.

Table 10.3

Arithmetic Operators		
OPERATOR	DESCRIPTION	EXAMPLE
+	Addition	A3+5
−	Subtraction	18-B7
−	Negation	-17
*	Multiplication	A6*B6
/	Division	G4/3
%	Percent	35%
^	Exponentiation (raise to a power)	A4^2

Table 10.4

Comparison Operators		
OPERATOR	DESCRIPTION	EXAMPLE
=	Equal	A3=B5
>	Greater than	D2>12
<	Less than	E3<E4
>=	Greater than or equal to	A6>=15
<=	Less than or equal to	G4<=3
<>	Not equal to	B7<>5

Table 10.5

Text Concatenation Operator		
OPERATOR	DESCRIPTION	EXAMPLE
&	Concatenation	"Phone: "&B5

Table 10.6

Reference Operators		
OPERATOR	DESCRIPTION	EXAMPLE
:	Range	A3:A8 (all cells from A3 to A8)
,	Union	D2,F2:F5 (cells D2 and F2:F5)
[space]	Intersection	C4:D7 D6:D8 (cells D6 and D7)

Table 10.7

Operator Precedence	
OPERATOR	DESCRIPTION
:	Colon (range)
,	Comma (union)
[space]	Space (intersection)
−	Negation
%	Percent
^	Exponentiation
*, /	Multiplication and division
+, −	Addition and subtraction
&	Concatenation
=, <>, <=, >=	Comparison operators

Precedence

When calculating the result of a formula, Excel evaluates the elements from left to right. However, this holds true only when all operators are of the same importance (called *precedence*). Every operator has a precedence, as shown in **Table 10.7**. The higher in the table an operator appears, the higher its precedence. Thus, when a formula contains operators of differing precedence, the calculations are performed from highest to lowest precedence. Here are some examples:

4+2+3   [=9]

Explanation: All operators have the same precedence, so the formula is evaluated from left to right.

4*2+3   [=11]

Explanation: Multiplication has a higher precedence than addition. But because the multiplication occurs first in the formula, the left-to-right order is still followed (8+3).

4+2*3   [=10]

Explanation: Multiplication has a higher precedence, so 2*3 is evaluated first (4+6).

Note that you can change the order of evaluation by enclosing terms in parentheses. Such items are always evaluated first. When multiple sets of parentheses are used, items in the innermost ones are evaluated first.

4*(2+3) [=20]

Explanation: Because parentheses surround the last two terms, they are evaluated first (resulting in 5). Without the parentheses, the formula would have been evaluated in left-to-right order: 4*2 (or 8), plus 3, for a result of 11.

FORMULA ESSENTIALS

Relative, absolute, and mixed

Cell references in formulas can be relative, absolute, or mixed. When you enter a reference by typing an address (such as entering =(B2+C2+D2)/3 in cell E2), the references to cells B2, C2, and D2 are *relative* to the location of the formula cell (E2). If the formula is moved or copied to another cell, Excel adjusts the cell references to point to the correct cells. For example, copying the formula to cells E3:E7 results in the correct formula in each new cell (**Figure 10.4**).

You use an *absolute reference* (preceding both the column and row with dollar signs) for a cell address that must not change when copied or moved. For example, in a business mileage worksheet (**Figure 10.5**), you could create a formula to calculate Mileage Amount: the trip's total mileage multiplied by a fixed mileage rate (found in cell I2). The initial formula in row 2 would be =F2*$I$2 and then repeated in every cell in column G (for example, =F3*$I$2). Unlike relative references, absolute references never change, no matter where on the worksheet the formula is copied or moved.

Finally, Excel also supports *mixed references* in which the column or the row is absolute and the other is relative, such as $A1 (column A is absolute, row 1 is relative) and A$1 (column A is relative, row 1 is absolute).

✔ Tip

■ When a formula is copied or moved (**Figure 10.6**), the cell references change as shown in **Table 10.8**:

　▲ Relative references change to match the formula's new location, relative to the original location. This also applies to the relative part of a mixed reference.

　▲ Absolute references do not change. The absolute portion of a mixed reference also remains unchanged.

Formula copied to E3

Figure 10.4 When the formula =(B2+C2+D2)/3 in E2 is copied to cells E3:E7, the relative cell references in the formula automatically adjust to refer to the correct cells.

Figure 10.5 The formula in column G uses an absolute reference to the fixed mileage rate in cell I2.

Figure 10.6 If a formula in C1 is copied or moved to cell D3, it changes as described in Table 10.8.

Table 10.8

Result of Copying or Moving a Formula

Formula (C1)	Copied/Moved (D3)	Reference Type
=A1	=B3	Relative
=$A$1	=$A$1	Absolute
=$A1	=$A3	Mixed (absolute column)
=A$1	=B$1	Mixed (absolute row)

Figure 10.7 The Function Library group organizes Excel functions by category.

Search for a function   *Function categories*

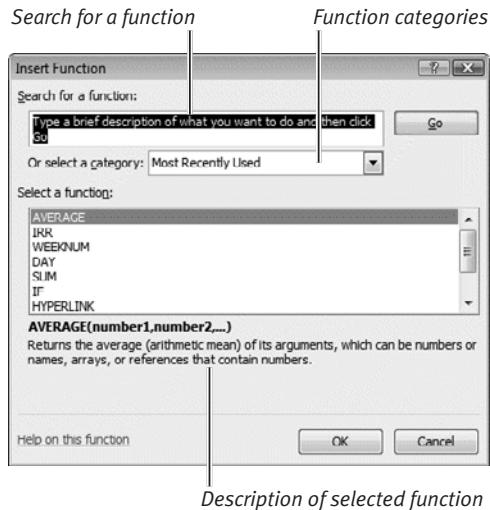
Description of selected function

Figure 10.8 Select a function, and then click OK.

Figure 10.9 You can enter arguments by typing, clicking a cell, or drag-selecting a range.

✔ Tip

■ You can also open the Insert Function dialog box by clicking the *f*x icon in the formula bar or by pressing Shift F3 .

Functions

Functions are formula helpers—built-in computational routines that you can include in formulas to simplify the creation of complex and special-purpose calculations. For instance, rather than laboriously totaling a string of cells with the formula =A1+A2+A3+A4+A5, you can use the SUM function to add the entire range: =SUM(A1:A5).

All but a few functions require *arguments,* the data on which the function operates. Arguments are enclosed in parentheses and— if there are multiple arguments—separated by commas. The argument to the SUM function above is the range A1:A5. In addition to operating on a single range, SUM can be used to total individual cells and constants, as seen in this formula:

=SUM(A1:A5,B7,23)

In this example, the total of cells A1, A2, A3, A4, A5, B7, and 23 is calculated.

When the text insertion mark is at the desired spot in a formula you're creating, you can insert a function in these ways:

◆ Functions for which you know the spelling and syntax can be typed directly into the formula.

◆ On the Formulas tab, you can choose a function by clicking an icon in the Function Library group (**Figure 10.7**).

◆ For guidance in selecting a function, click Insert Function in the Function Library group. In the Insert Function dialog box (**Figure 10.8**), select a function and then click OK.

In the latter two function-insertion methods, the Function Arguments dialog box appears (**Figure 10.9**). Using the guidance provided, enter the argument(s) and click OK to insert the function into your formula.

FORMULA ESSENTIALS

Creating Formulas

Formulas can be created from any combination of cell contents, constants, and functions. Many common formulas, such as sums or averages of a column or row, can quickly be created using the AutoSum tool.

To create a formula without functions:

1. Select the cell that will contain the formula and type an equal sign (=).

2. Construct the formula by typing constants, cell references, and operators (**Figure 10.10**). Press Enter or click the ✔ in the formula bar to complete the formula.

   The formula is replaced in the cell by the calculated result (**Figure 10.11**).

To create a formula with functions:

1. Select the cell that will contain the formula and type an equal sign (=).

2. Insert constants and cell references as needed. To insert a function at the text insertion mark, *do one of the following:*

   ▲ Type the function name, a left parenthesis, the argument(s), and a right parenthesis.

   ▲ Choose a function from the Function Library group (see Figure 10.7). In the Function Arguments dialog box (see Figure 10.9), enter the argument(s) and click OK.

   ▲ Click the Insert Function icon in the Function Library group or on the formula bar. In the Insert Function dialog box (see Figure 10.8), select a function and click OK. In the Function Arguments dialog box (see Figure 10.9), enter the argument(s) and click OK.

3. Press Enter or click the ✔ in the formula bar to complete the formula.

   The formula is replaced in the cell by the calculated result.

Referenced cell

Figure 10.10 The formula in E2 totals Michelle's three test scores. As you select cells or type their addresses, Excel displays handles around each referenced cell.

Figure 10.11 When you complete a formula, the result is displayed in the cell. Note that the formula is shown in the formula bar.
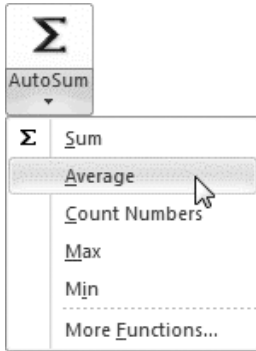
Figure 10.12 Choose a function from the drop-down menu.

Figure 10.13 To specify a range for this SUM function, type =SUM(and drag-select the range to be totaled. Type the closing parenthesis to complete the formula.

Formula in F2

Figure 10.14 Columns D and E have been named Start_Mileage and End_Mileage. To calculate total mileage for any cell in column F, the names can be substituted for the two cell references.
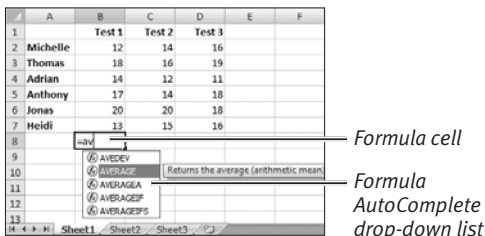

Formula cell

Formula AutoComplete drop-down list

Figure 10.15 Double-click a function name to insert it into the formula.

To create an AutoSum formula:

1. Select the cell at the bottom of a column or end of a row that will contain the formula.

   The cells that will serve as the argument to the AutoSum function must be a contiguous string within a single column or row, such as B2:B23 or H7:R7.

2. On the Formulas tab, click the AutoSum icon in the Function Library group (**Figure 10.12**). Choose a function from the drop-down menu or choose More Functions to pick from all Excel functions.

3. Excel highlights the range it thinks you want to use as the argument to the function. Adjust the range, if necessary.

4. Press ⎆Enter⎆ to complete the formula.

✔ Tips

■ When you create a formula, a cell reference can be typed or added by clicking the cell you want to reference. You can type or drag-select a range (**Figure 10.13**) as an argument to a function.

■ Typed cell references can be entered in uppercase or lowercase.

■ As explained in Chapter 8, if you've named cells or ranges, you can substitute the names for the addresses and ranges in formulas (**Figure 10.14**).

■ If required, a formula can contain multiple functions, as well as functions within functions (called *nested functions*).

■ If you can type the first few letters of a function's name when creating a formula, you can use Formula AutoComplete to insert the function (**Figure 10.15**). Double-click the function name in the drop-down list.

■ Functions do *not* ignore empty cells within the argument range(s).

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Editing Formulas

You can edit existing formulas to correct errors and to change cell or range references. Many of the techniques described below are also applicable to editing data.

To edit a formula:

1. Select the cell that contains the formula you want to edit.

2. You can edit in the cell or the formula bar, whichever is most convenient. *Do one of the following:*
   - ▲ Double-click the cell.
   - ▲ Click in the formula bar to set the text insertion mark.

3. *Do any of the following:*
   - ▲ Use normal text-editing techniques to add, delete, or change the cell contents.
   - ▲ To clear the cell, drag-select its contents and press (Backspace), or select the cell and press (Del) or (Delete).
   - ▲ To change a cell reference from relative, absolute, or mixed to another reference type, select the address within the formula and repeatedly press (F4).
   - ▲ To replace a function, select its name in the formula and begin typing the new function's name. Select the desired function from the Formula AutoComplete list by double-clicking its name (see Figure 10.15). You can also replace a selected function name by choosing a new function from the Function Library group (**Figure 10.16**).

4. Press (Enter) to complete the formula.

✔ Tip

- ■ To make an entry in a cell in multiple worksheets, (Ctrl)-select the sheet names in the Sheet tab bar, select the cell, and then enter the data or formula.
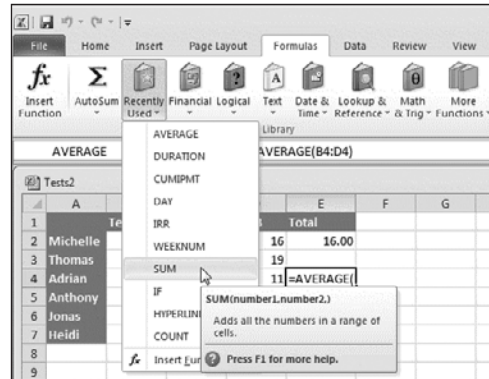
Figure 10.16 Functions can be chosen from the Function Library group's icons. If you regularly use a function, you can often choose it from the Recently Used icon's drop-down menu.
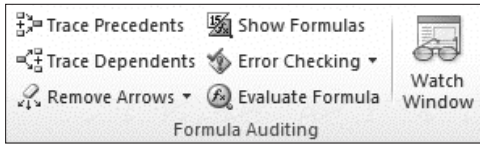
Figure 10.17 Troubleshooting tools are available in the Formula Auditing group of the Formulas tab.
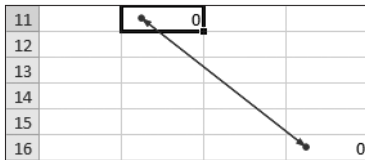
Figure 10.18 This arrow connects two cells that reference each other. The formula in B11 is =D16; the formula in D16 is =B11+8.
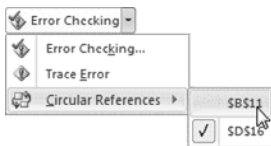
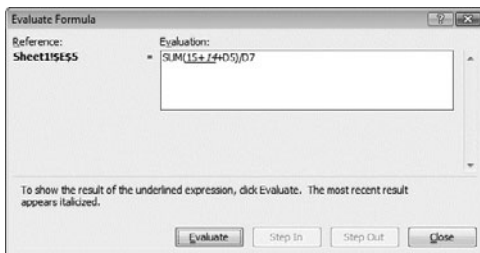**Figure 10.19** You can go directly to a circular reference cell.

Figure 10.20 Click the Evaluate button to replace the underlined formula element with its data. Click Close when you're finished.
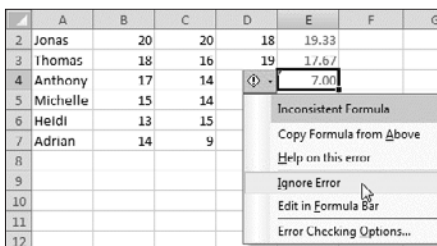

Figure 10.21 Click the icon and choose an option.

Troubleshooting Tips

Following are some techniques for finding and correcting errors in formulas. Start by switching to the Formulas tab to make the icons in the Formula Auditing group (**Figure 10.17**) accessible:

◆ **Formulas replaced by data.** To find cells in which you've accidentally replaced a formula with data, click Show Formulas. Any cell containing a formula will now display the formula, rather than the result. Click Show Formulas again to restore the worksheet to its normal state.

◆ **Circular references.** If the formulas in two cells rely on each other, Excel cannot correctly perform the calculations. This is known as a *circular reference* and is denoted on the worksheet by an arrow connecting the two cells (**Figure 10.18**). You can also find circular references by clicking the Error Checking icon and choosing any cell listed in the Circular References submenu, as shown in **Figure 10.19**. In a circular reference, only one of the two formulas can refer to the other cell.

◆ **Incorrect result.** If a formula displays an unexpected result, select the cell and click Evaluate Formula. By repeatedly clicking the Evaluate button in the Evaluate Formula dialog box (**Figure 10.20**), you can step through the elements in the formula, displaying the result for each step. Evaluating a formula often makes it easy to find incorrect cell references and identify flaws in a formula's logic.

◆ **Is it an error?** Excel notifies you immediately if it detects a possible formula error—often by displaying a tiny triangle in the cell's upper-left corner. Select the cell (**Figure 10.21**) and choose a handling option from the drop-down menu.

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WORKING WITH TABLES

Figure 11.1 Worksheets often contain lists of related data. In this harness-racing worksheet, each row is the record for a single horse. Each column is a field, such as post position or horse's name.

Although number-crunching is the purpose of the typical worksheet, many worksheets are used only to record lists of related data, such as addresses, club memberships, or a course roster. New users quickly discover that a worksheet's row-and-column grid is better for handling lengthy lists than a word processing document. Such worksheets are essentially simple databases in which each row is a *record* and each column is a *field* (**Figure 11.1**).

Because so many people use worksheets to manage lists, Microsoft added list-related features to Excel 2003. In Excel 2007, lists were renamed *tables*. Any area of a worksheet can be designated a table, and a worksheet can contain as many tables as you need. Here are some advantages of formatting data as a table rather than using normal Excel formatting and tools to manage your list:

◆ Quickly sort the table by the contents of any field

◆ Filter the data to show only certain records or those that match a criterion

◆ Display a summary statistic for selected columns in an optional *total row*

◆ Simplify the process of performing a calculation on row data using *calculated columns*

Creating a Table

You can create a table in any blank range or convert existing data to a table.

To create a table:

1. *Do one of the following:*
   - ▲ Select a blank range where you want to insert the table.
   - ▲ Select a range with data that you want to convert to a table.

2. *Do one of the following:*
   - ▲ On the Insert tab, click the Table icon in the Tables group or press Ctrl T.
   - ▲ On the Home tab, click the Format as Table icon in the Styles group and choose a table format from the gallery (**Figure 11.2**).

   The Create Table or Format As Table dialog box appears (**Figure 11.3**).

3. If the proposed table range contains a header row, check My table has headers.

4. Click OK to create the table (**Figure 11.4**).

✔ Tips

- ■ The menu icons in each cell of the header row can obscure the header labels. You may want to widen the columns, change the alignment, or apply text wrap to any lengthy headers.

- ■ To quickly select a table, click in any table cell and then move the cursor over one of the table's top corners. Click when the cursor changes to a plus (+) with arrows.

- ■ To delete a table, select the entire table and press Del or Delete.

- ■ To change a table back to a normal range, select any table cell. On the Design tab, click the Convert to Range icon in the Tools group. Click Yes in the confirmation dialog box that appears.
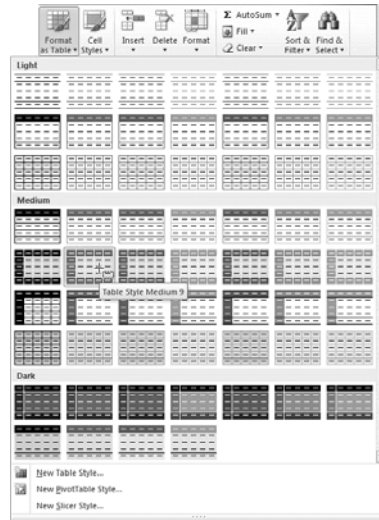
Figure 11.2 One way to create a table is to simply format a cell range as a table.

Figure 11.3 Edit the range (if necessary), indicate whether the range already contains a header row, and then click OK.
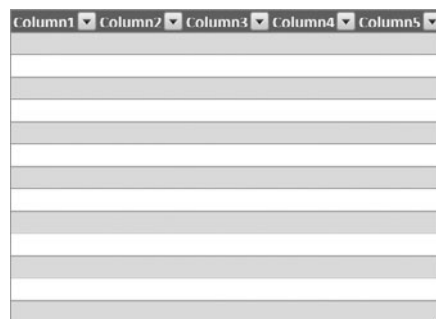
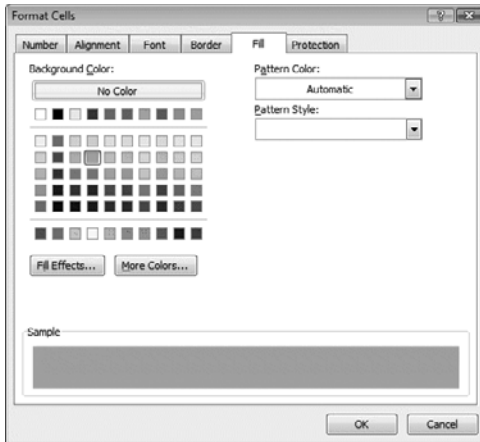**Figure 11.4** A table created from a blank range.

Figure 11.5 A color fill or gradient can be applied to selected table rows, columns, or cells. To display this dialog box, switch to the Home tab, click the Format icon in the Cells group, and choose Format Cells.
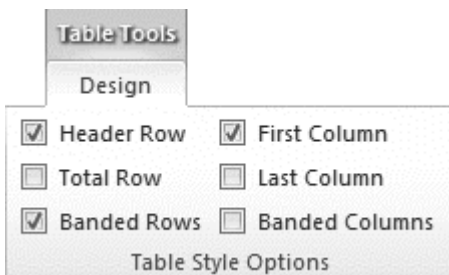

Figure 11.6 Click check boxes in the Table Style Options group to hide, show, and format table components.

Formatting a Table

A table is just another worksheet range. As such, if you aren't thrilled with the default formatting, you can format individual cells, rows, columns, or the entire table any way you like.

To format a table:

◆ **Format the entire table.** Select any cell in the table. On the Design tab, select a new style from the Table Styles gallery.

◆ **Format a row, column, or range.** Select the row, column, or range within the table. On the Home tab, select a cell format from the Cell Styles drop-down menu in the Styles group. Alternatively, you can apply a fill color, gradient, or pattern to selected cells by selecting options on the Fill tab of the Format Cells dialog box (**Figure 11.5**).

◆ **Format the first or last column.** The first column often contains record identifiers and the last column is frequently used to summarize each record's data. To apply distinctive formatting to these columns (boldface and, in some cases, a background color), switch to the Design tab and click the First Column and/or Last Column check boxes in the Table Style Options group (**Figure 11.6**).

◆ **Create alternating rows or columns.** On the Design tab, click Banded Rows or Banded Columns in the Table Style Options group (Figure 11.6).

✔ Tip

■ The effect of selecting First Column and Last Column in the Table Style Options group depends on the table's current formatting. For instance, if the entire table is formatted with a single color, only boldface will be applied to the column.

Creating Calculated Columns

Formulas in a table work differently from ones found elsewhere in the worksheet. If you insert a formula, it's automatically copied to all cells in the same column. And if you later add rows to the table, the formula is copied to the new cells in the column, too. Any table column that contains a formula is referred to as a *calculated column*.

To create a calculated column:

1. If necessary, insert a new column into the table in which to place the formula.

   To be treated as a calculated column, the column must be empty when you create the formula. If the column contains *any* data, the formula will be applied only to the current cell.

2. Select a cell in the empty column, and type or paste the formula into the cell.

   Many table formulas are automatically converted by Excel to equivalent *structured references* (**Figure 11.7**).

3. Complete the formula by pressing Enter or clicking ✔ (Enter) in the formula bar (Figure 11.7).

   The formula is automatically copied to all other cells in the column (**Figure 11.8**).

✔ Tips

- If you replace the formula with data in any cell in a calculated column, Excel marks the cell as an *exception*. You can correct an exception by clicking the indicator beside the cell (**Figure 11.9**).

- As long as a calculated column contains no exceptions, you can replace the formula with a new one. Like the original formula, it will automatically copy itself to every cell in the column.
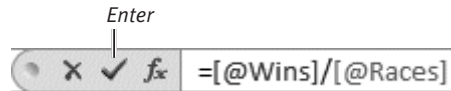
Figure 11.7 Formulas within tables are often converted into structured references.

Figure 11.8 The Win % calculated column is based on the formula =Wins/Races.

Figure 11.9 An exception cell in a calculated column is denoted by a tiny triangle in the cell's upper-left corner. When you move the cursor over the indicator beside the cell, an explanatory message appears.

Total row

Figure 11.10 When enabled, a total row appears at the bottom of the table.

Figure 11.11 Each cell in the total row has a drop-down menu from which you can choose a statistical function.

Adding a Total Row

A table can optionally have a single *total row* at its bottom, enabling you to calculate a summary statistic across all records in the table. Each column can display a different statistic or none at all. For instance, in a donations table, you could compute the total of all donations, the average of the most recent donation (across all donors), or a count of the number of donor records.

To add a total row to a table:

1. Select a cell in the table to make the table active.

2. On the Design tab, click the Total Row check box in the Table Style Options group (see Figure 11.6).

   The total row appears at the bottom of the table (**Figure 11.10**).

3. *Optional:* Edit or delete the *Total* label in the leftmost cell of the total row.

4. To display a summary statistic for a column, click the total row cell beneath the column. Click the icon that appears beside the cell and choose a statistic from the drop-down menu (**Figure 11.11**).

5. Repeat Step 4 for each additional column that you want to summarize.

6. Format the total row cells as desired.

✔ Tips

■ If the function you need isn't listed in the drop-down menu, choose More Functions.

■ To eliminate the summary statistic for a column, choose None from the drop-down menu (Figure 11.11).

■ You can disable and enable the total row as needed. When you re-enable the total row, any statistic previously specified for a column reappears.

Sorting and Filtering

Excel provides two tools that simplify viewing and analyzing table data:

◆ **Sorting.** Sort an entire table based on the contents of one or more fields (columns).

◆ **Filtering.** Restrict visible records (rows) to those that match a criterion. If desired, criteria can be chosen from multiple columns. For instance, you might filter a business table to show June absences of employees earning less than $10 per hour.

To sort a table:

1. *Do one of the following:*

▲ In the header row, click the icon in the column by which you want to sort (**Figure 11.12**).

▲ Right-click in any cell of the column by which you want to sort and open the Sort submenu (**Figure 11.13**).

▲ Select any cell in the column by which you want to sort. On the Home tab, click the Sort & Filter icon in the Editing group.

2. Choose a sort order (ascending or descending) from the menu.

The table is sorted as specified.

✔ Tip

■ You can perform a multi-field sort by choosing Custom Sort. In the Sort dialog box that appears, click the Add Level icon to add additional sort fields, such as sorting by Payee and then by Amount.
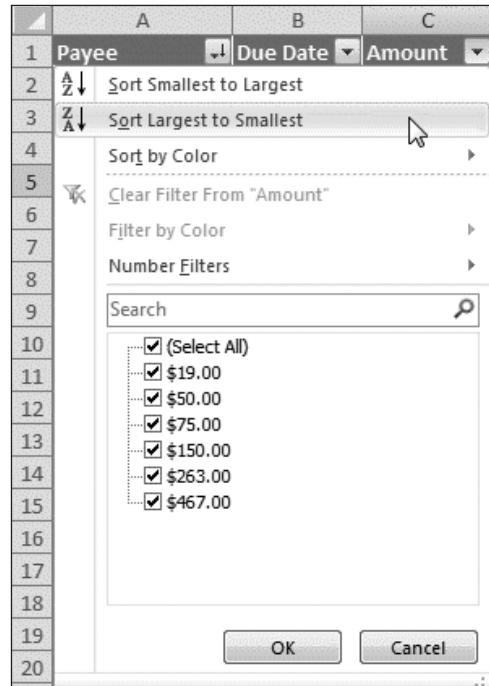
Figure 11.12 Click the icon of the header cell for the column by which you want to sort the table …
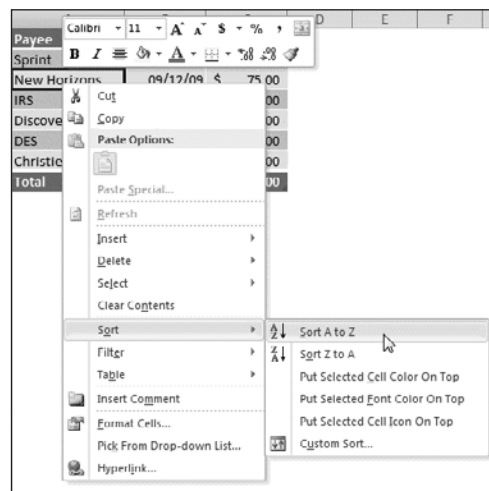
Figure 11.13 … or right-click any cell in the column by which you want to sort and choose an option from the Sort submenu.
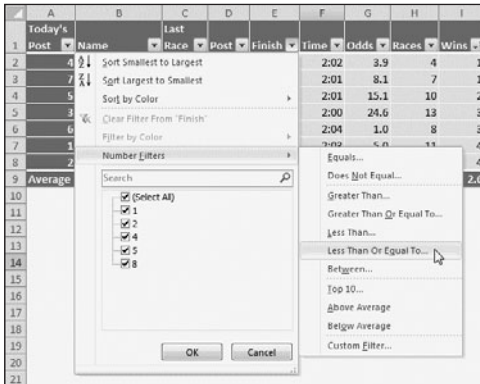
Figure 11.14 There are two ways to set a filter criterion. First, you can clear check boxes to filter out matching data. Second, you can specify a formula-based criterion by choosing a command from the pop-out menu.
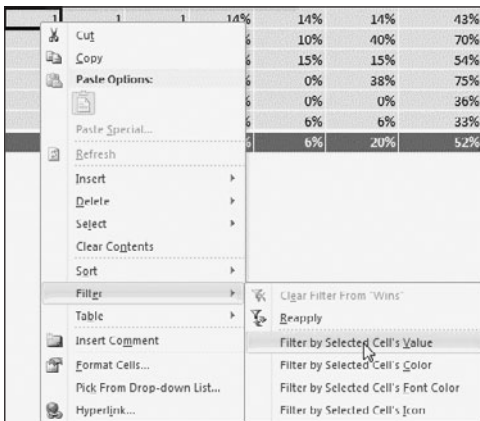

Figure 11.15 You can also filter the data based on the selected cell, but your options are limited.
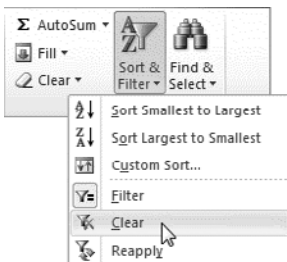

Figure 11.16 Sort & Filter icon.

To filter a table:

1. *Do either of the following:*
   ▲ In the header row, click the icon in the column by which you want to filter the table (**Figure 11.14**).
   ▲ To filter based on a cell's contents or properties, right-click the cell in the column by which you want to filter the table and open the Filter submenu (**Figure 11.15**).

2. Choose or specify a filter criterion.

   Records that do not match the filter criterion are hidden. If present, statistics in the total row are recalculated to reflect only the visible records.

✔ Tips

■ To remove all filtering effects from a table (restoring the full record set), switch to the Home tab, click the Sort & Filter icon in the Editing group, and choose Clear from the drop-down menu (**Figure 11.16**).

■ To selectively remove one table filter when one or more filters have been applied, click the icon in the column header whose filtering you want to remove and choose Clear Filter From "*field name*."

■ If you've added records to a table, you can reapply the current sort instructions and filter criteria to accommodate the new records. On the Home tab, click the Sort & Filter icon in the Editing group and choose Reapply from the drop-down menu (Figure 11.16).

Changing a Table's Size

Table contents can change over time. In addition to editing the data, you may want to add or delete fields (columns), as well as add or delete records (rows).

To change a table's size:

◆ **Insert records (rows) within a table.** Select a cell in the row beneath where you want to insert a new row. (To insert multiple rows in the same spot, begin by selecting that number of cells in adjacent rows.) On the Home tab, click the Insert icon in the Cells group and choose Insert Table Rows Above (**Figure 11.17**).

◆ **Insert fields (columns) within a table.** Select a cell in the column to the right of where you want to insert a new column. (To insert multiple columns in one spot, begin by selecting that number of cells in adjacent columns.) On the Home tab, click the Insert icon in the Cells group and choose Insert Table Columns to the Left (Figure 11.17).

◆ **Increase a table's size by dragging.** Move the cursor over the lower-right corner of the table. When the cursor changes as shown in **Figure 11.18**, drag to the right to add columns or drag down to add rows.

◆ **Delete records (rows).** Select one or more cells in the row or rows you want to delete. On the Home tab, click the Delete icon in the Cells group and choose Delete Table Rows (**Figure 11.19**).

◆ **Delete fields (columns).** Select one or more cells in the column or columns you want to delete. On the Home tab, click the Delete icon in the Cells group and choose Delete Table Columns (Figure 11.19).
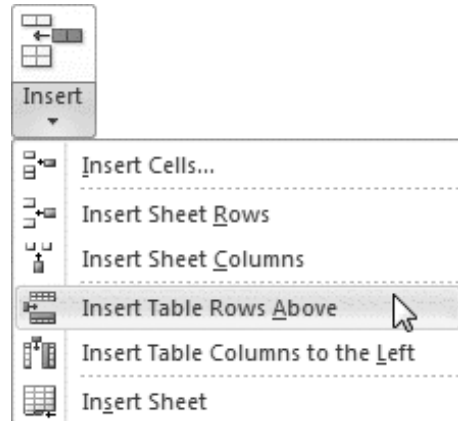

Figure 11.17 To insert or delete table rows or columns, choose a command from the Insert or Delete icon's drop-down menu.

Figure 11.18 You can append rows or columns to a table by dragging the lower-right corner.
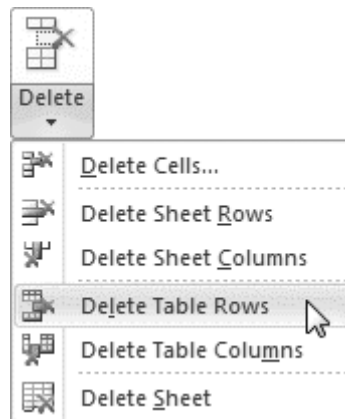

Figure 11.19 You can delete table rows or columns by choosing a command from the Delete icon's menu.
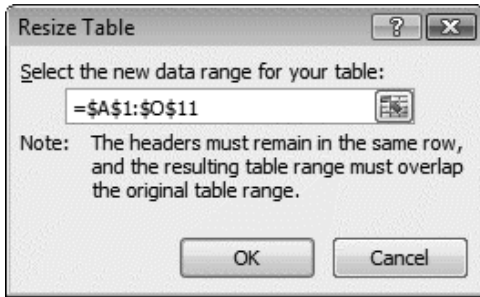
Figure 11.20 Rather than dragging to append new rows or columns to a table, you can type a new range.

Selecting Table Rows or Columns

To select a table column rather than an entire worksheet column, move the cursor over the top edge of the column header. When the cursor changes to a black down-pointing arrow, click to select the table column.

Similarly, to select a table row, move the cursor over the left edge of the row. When the cursor changes to a black right-pointing arrow, click to select the table row.

✔ Tips

■ You can also use the Delete Sheet Rows and Delete Sheet Columns commands in the Delete icon's drop-down menu to modify a table. However, unlike the equivalent Delete Table commands, the Delete Sheet commands also affect data *outside* of the table.

■ You can also resize a table by entering a new range. Select a cell in the table, switch to the Design tab, and click the Resize Table icon in the Properties group. Type a new range in the Resize Table dialog box (**Figure 11.20**) or manually select the range on the worksheet, and then click OK. Unlike resizing by dragging (see Figure 11.18), you can use the Resize Table dialog box to add new rows and columns at the same time.

■ You can move a table to a new location using cut-and-paste or drag-and-drop. Select the table, and then do one of the following:

▲ **Cut-and-paste.** Press Ctrl X or click the Cut icon in the Home tab's Clipboard group. In the destination location, click the cell that will serve as the table's new upper-left corner, and press Enter to perform the paste.

▲ **Drag-and-drop.** Move the cursor over any corner or edge of the table. When the cursor changes to a plus symbol with four arrowheads, click and drag the table to the new location.

CHANGING A TABLE'S SIZE

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Printing Tables

You can print a table as part of the current worksheet. On the other hand, there may be instances when you prefer to print *only* the table—without printing any of the surrounding worksheet cells.

To print a table:

1. Select the table or a cell within the table that you want to print.

2. Click the File tab to display the Backstage.

3. Click Print.

   The Print settings screen appears.

4. In the Settings area, choose Print Selected Table from the top drop-down menu (**Figure 11.21**).

5. Change other print settings as desired, such as the orientation and printer.

   As you select and change settings, the print preview (**Figure 11.22**) changes to reflect the new settings.

6. Click the Print button.

   The table is sent to the designated printer, the Backstage closes, and the worksheet reappears.

✔ Tip

■ You can also print a table by preselecting the entire table on the worksheet and then choosing Print Selection from the same drop-down menu.
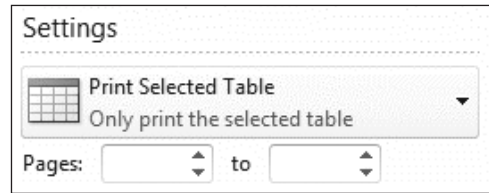
Figure 11.21 To print only a selected table, choose Print Selected Table from the drop-down menu.

Print button *Print preview*

Figure 11.22 A print preview reflects the current print settings (in this case, printing only a selected table).

PRINTING TABLES

CREATING CHARTS

In Excel, you can create charts and graphs to display your data visually. Although many kinds of charts can be made from tiny data sets, charts are especially useful for presenting and summarizing large quantities of data.

A normal Excel chart is a *floating object*. As such, you can move a chart to any convenient location on the worksheet or change its size by dragging a corner. You can customize almost any part of a chart, such as its title, axis labels, legend, chart wall, or chart floor. You can also choose which optional elements to display and which ones to hide, such as data labels, gridlines, or the data itself. Finally, if you aren't satisfied with the current chart style, you can replace it with a variation or a completely different kind of chart.

Office 2010 introduces a new chart type called *sparklines*. Rather than float as normal charts do, the tiny sparklines charts are displayed in cells just as data normally is.

Excel's charting tools are also used to create charts in PowerPoint, Word, and Outlook. Charts in these non-Excel documents can be *embedded* (static objects that are unlinked from the worksheet data) or *linked* (objects that are linked with the data and automatically reflect changes to it).

Objects and Charts

You can embellish your worksheets and charts by inserting objects, such as shapes, pictures, SmartArt, clip art, and screen shots. For instructions on inserting, resizing, moving, and rotating objects, see Chapter 3.

Chart Elements

Designing a chart is similar to creating art. You can freely add or remove elements, move them to new positions, and change their size, shape, and formatting. (Of course, you are free to accept the default elements and formatting used in a newly created chart, but you're unlikely to do so very often.)

Because you'll spend so much time working with chart elements, it's important that you be able to *identify* each element. Note that many of the ones shown below (**Figure 12.1**) are optional.
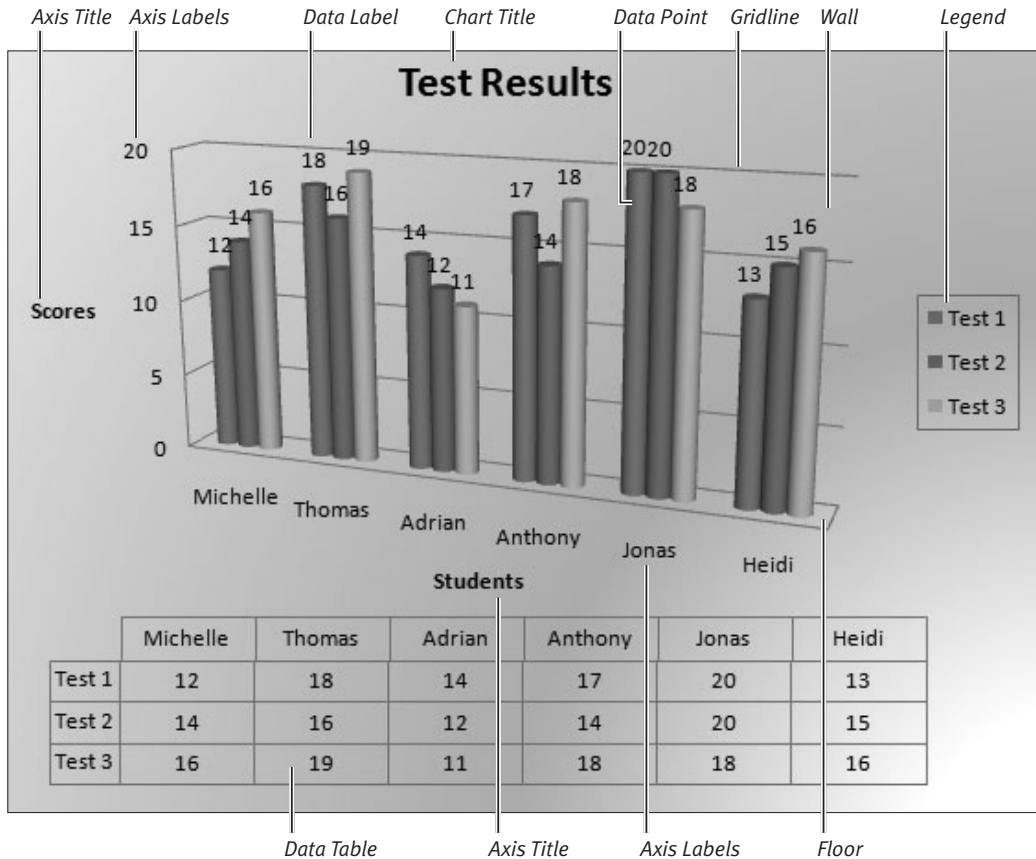
Figure 12.1 A chart and its elements.

Figure 12.2 In this example, column B (labels) and columns I, J, and K (data) have been selected.
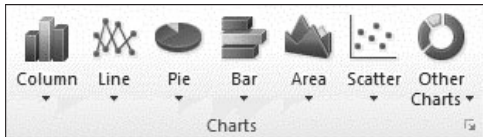
Figure 12.3 Specify the chart type by clicking an icon in the Charts group and choosing a chart style from the drop-down menu that appears.
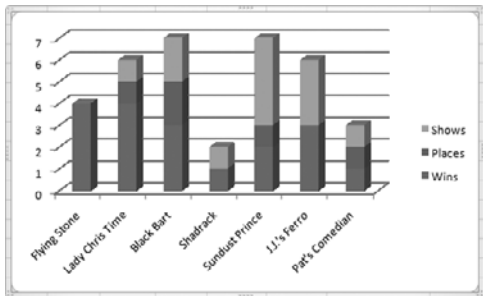
Figure 12.4 Excel adds the chart as a floating object on the worksheet.
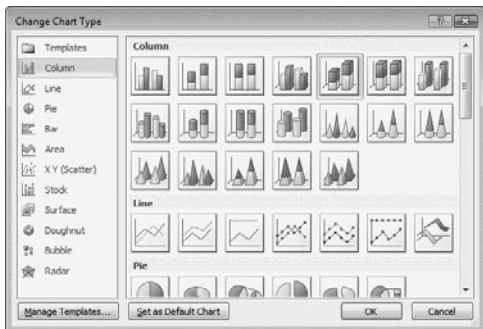
Figure 12.5 You can change an existing chart's type and/or style by clicking an icon in the Change Chart Type dialog box.

Creating a Chart

In many instances, creating a chart is as simple as selecting the labels and data on the worksheet and then picking a chart type. Your chart data can be arranged in columns or rows. However, the columns or rows must be in a specific order for some types of charts.

To create a chart:

1. If necessary, rearrange the data so it conforms to the chart's requirements.

   For example, to create one type of *stock chart*, the data must be in High, Low, Close order. For other chart requirements, see "Create a chart from start to finish" in Excel Help.

2. *Optional:* Sort the data to ensure that it will be in the desired order when charted.

3. On the worksheet, select the labels and data from which the chart will be created.

   Labels and data don't need to be contiguous. For example, in **Figure 12.2**, column B contains the labels and columns I, J, and K contain the data.

4. On the Insert tab, choose a chart type from a Charts group icon's drop-down menu (**Figure 12.3**).

   The new chart appears (**Figure 12.4**).

✔ Tips

■ If you select a chart's plot area, the labels and data used to create the chart are highlighted in the worksheet. You can also select the data by switching to the Design tab and clicking the Select Data icon in the Data group.

■ To change the chart type or style, select the chart, click the Design tab, and click Change Chart Type in the Type group (**Figure 12.5**).

■ To delete a chart, select it and press ⌫Del⌫.

Changing the Background

If you aren't satisfied with the background formatting on a generated chart, you can change it. You can apply formatting to the entire chart, the plot area, or the legend, as well as to objects you've placed on the chart, such as a title.

To change the background for the chart or a component:

1. Select the chart or component you want to format, such as the plot area, wall, floor, or legend.

2. *Do one of the following:*
   - ▲ On the Format tab, choose formatting options from the Shape Styles group (**Figure 12.6**).
   - ▲ On the Format or Layout tab, click the Format Selection icon in the Current Selection group.
   - ▲ Right-click the selected area and choose Format *item* from the context menu. In the Format *item* dialog box (**Figure 12.7**), set formatting options and click Close.

✔ Tips

- ■ To easily select a particular chart element, switch to the Format or Layout tab and choose the element from the drop-down menu at the top of the Current Selection group. Then click the Format Selection icon in the same group.

- ■ You can also modify chart formatting by choosing options from the Background group (**Figure 12.8**) on the Layout tab.
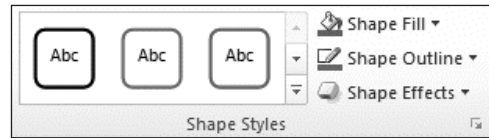

Figure 12.6 You can add an outline, fill, and effects to a selected chart component by selecting options from the Shape Styles group.

Figure 12.7 To simultaneously modify several formatting options, select settings in a Format dialog box.
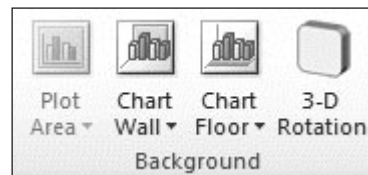

Figure 12.8 To change the wall, floor, or rotation of the plot area, choose options from the Background group.
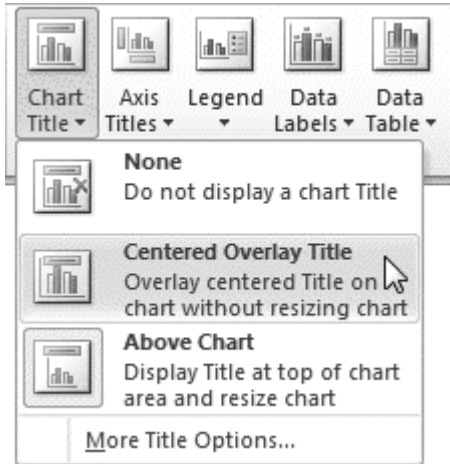
Figure 12.9 Add a title and set its initial position by choosing an option from the Chart Title drop-down menu.
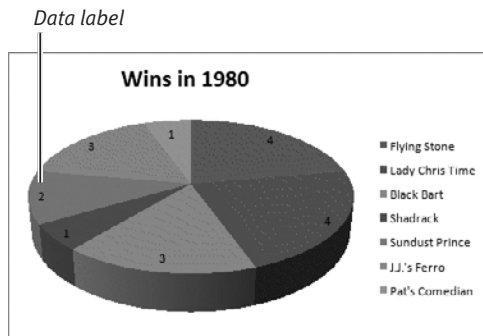
Data label

Figure 12.10 Depending on the chart type, it can be useful to display the data on chart elements.

Adding and Formatting Text

Although primarily visual, charts can also include a prodigious amount of text. You can add a title, legend, grid division labels, axis labels, data labels, and text boxes.

To add a text item to a chart:

1. Select the chart.

2. On the Chart Tools contextual tab, select the Layout tab.

3. *Do any of the following:*

   ▲ **Add a chart title.** Click Chart Title in the Labels group and choose an option from the drop-down menu (**Figure 12.9**).

   ▲ **Add an axis title.** Click Axis Titles in the Labels group and choose an option from a Horizontal Axis Title or Vertical Axis Title submenu.

   ▲ **Label the data.** Click Data Labels in the Labels group and choose an option from the drop-down menu. Labeling options vary by chart type (**Figure 12.10**).

   ▲ **Show chart data.** Click Data Table in the Labels group and choose a Show option from the drop-down menu. Doing so displays the chart data in a grid beneath the plot area.

   ▲ **Add other text.** Click Text Box in the Insert group. Click and drag to create a text box on the chart, and then type or paste the text into the box.

To format chart text:

1. *Do either of the following:*

   ▲ Select the text object. (Select an object when you want to apply the same formatting to all text within the object.)

   ▲ Within a text object, select the specific text to be formatted. (Only certain chart objects allow this, such as a title, axis label, or text box.)

2. *Do any of the following:*

   ▲ On the Home tab, choose formatting options from the Alignment group or the Font group (**Figure 12.11**).

   ▲ Right-click the selected object or text string, choose Font from the context menu (**Figure 12.12**), select formatting options from the Font dialog box (**Figure 12.13**), and click OK.

   ▲ With text selected, move the cursor up and choose formatting options from the Mini toolbar (Figure 12.12).

   ▲ On the Format tab, choose options from the WordArt Styles group.

✔ Tips

■ Another way to format a text object is to choose More *text object* Options from the element's drop-down menu in the Labels group (see Figure 12.9). A Format dialog box appears in which you can apply a background fill, specify a border style and color, add a shadow, and so on.

■ To remove most text objects, select the object and press ⌞Del⌟. You can also remove a specific label type by switching to the Layout tab, clicking the proper icon in the Labels group, and choosing None. For example, you can remove a chart title by choosing None from the Chart Title icon (see Figure 12.9).

Figure 12.11 You can apply text formatting by choosing commands from the Font group.
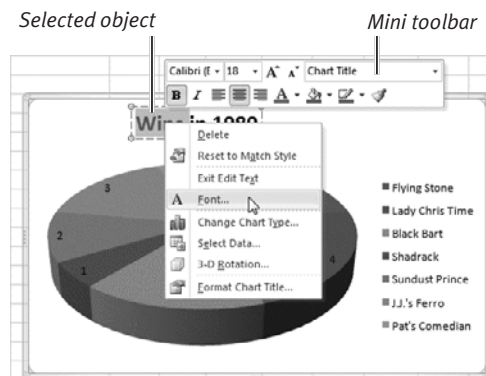
Selected object   *Mini toolbar*

Figure 12.12 You can right-click objects that contain text and choose Font from the context menu.
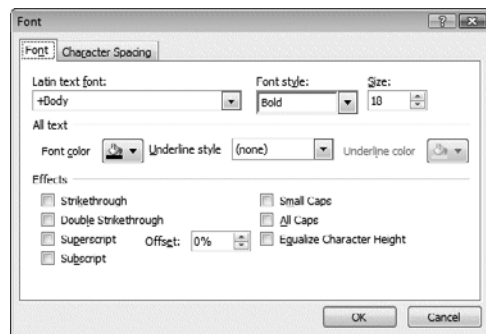

Figure 12.13 For complex text-formatting needs, you may prefer to use the Font dialog box.
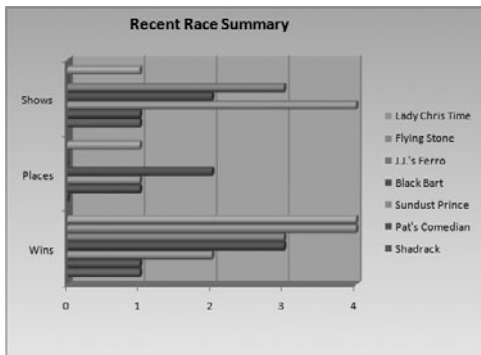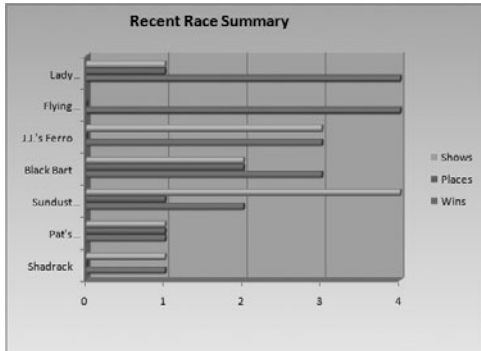
Figure 12.14 By switching rows and columns, you can view the wins, places, and shows for each horse (top) or see how the seven horses compare on number of wins, places, and shows (bottom).

Rows or Columns

Regardless of how your data is organized on the worksheet, you can plot it by rows or by columns. With many types of charts, plotting it *both* ways can give you a new perspective on the data.

To switch rows and columns:

1. Select the chart.

2. In the Data group within the Design tab, click the Switch Row/Column icon.

   The chart updates to reflect the change (**Figure 12.14**).

Changing Layout and Style

One of the simplest ways to modify a chart is to specify a new layout or style. *Layout* refers to the elements appearing on the chart and their positions. *Style* refers to the coloring of chart elements, including the data objects, plot walls, and surrounding background.

To specify a new layout:

1. Select the chart.

2. On the Design tab, click an icon in the Chart Layouts group (**Figure 12.15**).

   The chart is modified to match the selected layout (**Figure 12.16**).

3. If previously undefined text elements appear in the chart (such as a title or axis titles), you can delete them or change their text.

To change the chart style:

1. Select the chart.

2. On the Design tab, choose a different style from the Chart Styles group (**Figure 12.17**).

   The chart is modified to match the chosen chart style.

✔ Tips

■ Choosing a new chart style is a destructive process. Elements you've manually formatted, such as gridlines or the background, are replaced with the features specified in the new style.

■ When choosing a new chart layout or style, you can scroll through one line of options at a time by clicking the up and down scroll arrows. To view all options simultaneously as a gallery, click the bottom arrow (Figure 12.15).
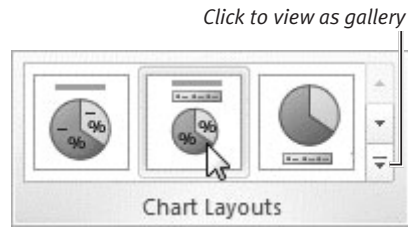
Click to view as gallery

Figure 12.15 Choose a new chart layout from the Chart Layouts group.
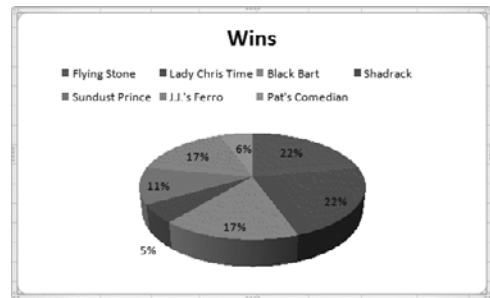

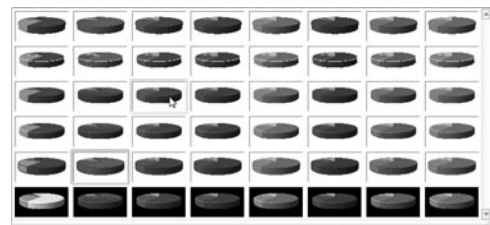**Figure 12.16** The pie chart is automatically modified to match the chosen layout.

Figure 12.17 To change the style for a selected chart, choose a new style from the Chart Styles gallery.
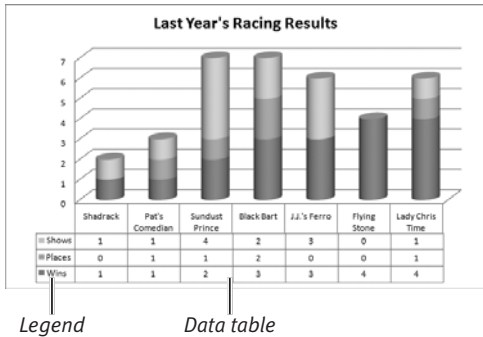
Figure 12.18 The data and legend can be combined (shown here) or displayed as separate chart items.

Displaying the Data Set

If a chart is based on a small data set, it can be informative to show the data table on the chart.

To display the data on the chart:

1. Select the chart.

2. *Do one of the following:*

▲ On the Layout tab, choose a data display option from the Data Table drop-down menu in the Labels group.

▲ On the Design tab, choose a layout from the Chart Layouts group that includes the data table.

The data table is added to the chart (**Figure 12.18**).

3. If necessary, resize the chart.

✔ Tips

■ To remove the data table, choose None from the Data Table drop-down menu or choose a layout from the Chart Layouts group that doesn't includes the data table.

■ Another way to show data is to place it directly on chart items, such as bars and pie slices. On the Layout tab, choose an option from the Data Labels drop-down menu in the Labels group.

DISPLAYING THE DATA SET

Working with Gridlines

To make it easier to estimate the size of data points, you can display horizontal and/or vertical lines called *gridlines (***Figure 12.19***)* on many kinds of charts. You can modify gridlines by removing them; displaying major, minor, or both types of gridlines for an axis; and setting a new line color or style.

To add, remove, or modify gridlines:

1. Select the chart.

2. On the Layout tab, click the Gridlines icon in the Axes group and choose one of the following options from the Primary Horizontal Gridlines, Primary Vertical Gridlines, or Depth Gridlines submenu (**Figure 12.20**):

   ▲ **None.** Remove all gridlines of the chosen type.

   ▲ **Major Gridlines.** Display major data divisions on the chosen axis, such as 1–5 or integers divisible by 5, 10, or 25 (depending on the size and spread of the data).

   ▲ **Minor Gridlines.** Display subdivisions between major gridlines (whether or not major gridlines are visible).

   ▲ **Major & Minor Gridlines.** Display both major and minor gridlines for the chosen axis.

   ▲ **More Primary Gridlines Options.** Open a Format dialog box to set color, style, shadow, glow, or soft edges for horizontal or vertical primary gridlines. Select new settings and click Close.

   The chosen option is applied to the chart.

✔ Tips

■ The Depth Gridlines submenu appears only when a true 3-D chart is selected (**Figure 12.21**).
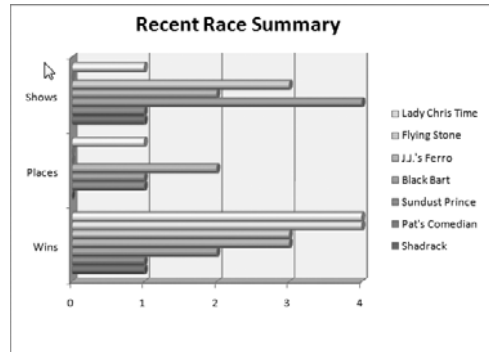

Figure 12.19 Gridlines behind the data can make it easier to see or estimate the size of data points.
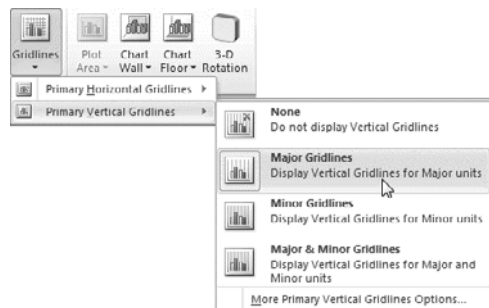
Figure 12.20 A Gridlines submenu.
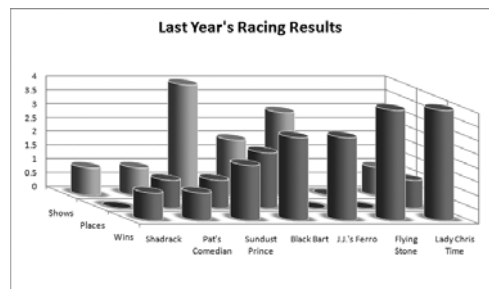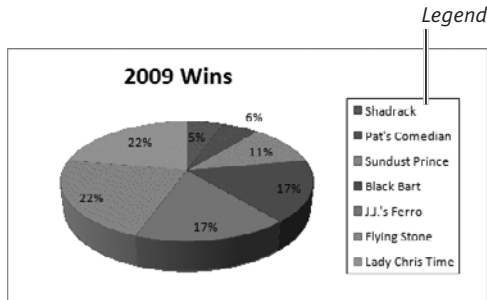

Figure 12.21 A true 3-D chart has depth.

■ You can also remove gridlines by right-clicking them on the chart and choosing Delete from the context menu.

Legend

Figure 12.22 The legend serves as a key to the chart. Each element in the legend represents a data series.
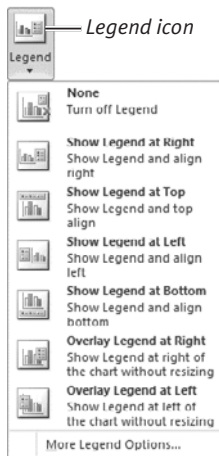
Legend icon

Figure 12.23 Add, remove, or change the placement of the legend by choosing an option from this menu.
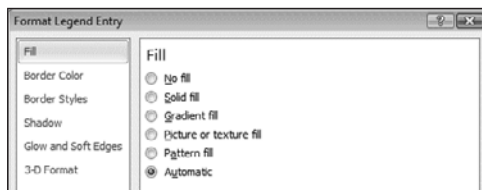

Figure 12.24 You can specify a new location or custom formatting in the Format Legend dialog box.

■ You can also open the Format Legend dialog box by double-clicking the legend.

Working with the Legend

If you select row or column labels when creating a chart, a *legend* (key to the data series) is generally added to the chart (**Figure 12.22**). You can add or remove the legend, specify its placement in relation to the chart, change its properties (such as fill color and border style), and edit its labels.

To add, remove, or modify the legend:

1. Select the chart.

2. *Do any of the following:*

▲ To add, remove, or change the position of the legend, click the Layout tab and choose an option from Legend menu in the Labels group (**Figure 12.23**).

▲ To manually change the size or position of the legend, drag an edge or the center, respectively.

▲ To format the legend, right-click it, choose Format Legend from the context menu, and make the desired changes in the Format Legend Entry dialog box (**Figure 12.24**).

▲ To change the properties of a single data series, select that element in the legend, right-click it, choose Format Data Series or Format Legend Entry, and make any desired changes in the Format Data Series or Format Legend Entry dialog box.

▲ To modify the text used for legend entries, make the edits in the worksheet cells you used as labels.

✔ Tips

■ You don't have to close a Format dialog box immediately. To format a *different* chart element, select that element on the chart. The Format dialog box changes to one appropriate for the selected element.

WORKING WITH THE LEGEND

Adding Trendlines

If data is gathered over time, you can add lines called *trendlines* to the chart that summarize the data and predict future values. Depending on the data set, different trendline types may provide a better *fit* to the data.

To add a trendline:

1. Select the chart.

2. On the Layout tab, click the Trendline icon in the Analysis group and choose an option from the drop-down menu.

   If the chart includes multiple data series, an Add Trendline dialog box appears. Select the data series to which the trendline will be applied and click OK.

   The trendline appears on the chart.

3. *Optional:* To modify a trendline's properties or type, select the trendline. Open the Format Trendline dialog box (**Figure 12.25**) by doing one of the following:

   ▲ Right-click the trendline and choose Format Trendline.

   ▲ Choose More Trendline Options from the Trendline drop-down menu.

4. Make the desired changes and click Close. The new settings are reflected on the chart (**Figure 12.26**).

✔ Tips

■ Adding trendlines is cumulative. That is, you can plot multiple types of trendlines on the same chart.

■ To remove all trendlines from a chart, choose None from the Trendline drop-down menu. To remove one trendline (when multiple trendlines are displayed), select the trendline on the chart and press ⌷Del⌷.
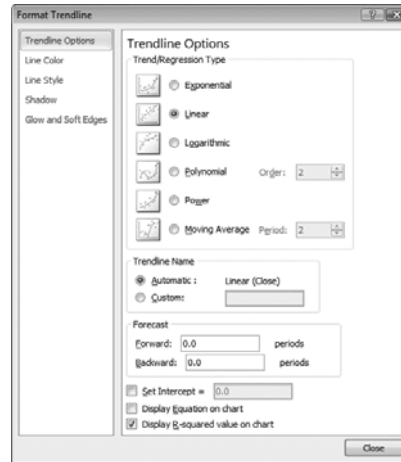

Figure 12.25 The Format Trendline dialog box offers additional options, such as other trendline types and displaying predicted values, based on the trendline.
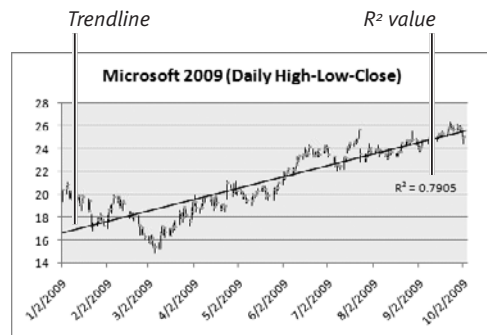

Figure 12.26 A trendline on a stock chart.

■ You may also want to explore these other options in the Analysis group:

   ▲ **Lines.** Show high-low marks (especially useful for stock charts) and/or drop lines that extend up from the X axis to each data point.

   ▲ **Error Bars.** Surround each data point with bars showing a confidence interval based on a percentage, standard deviation, or standard error.
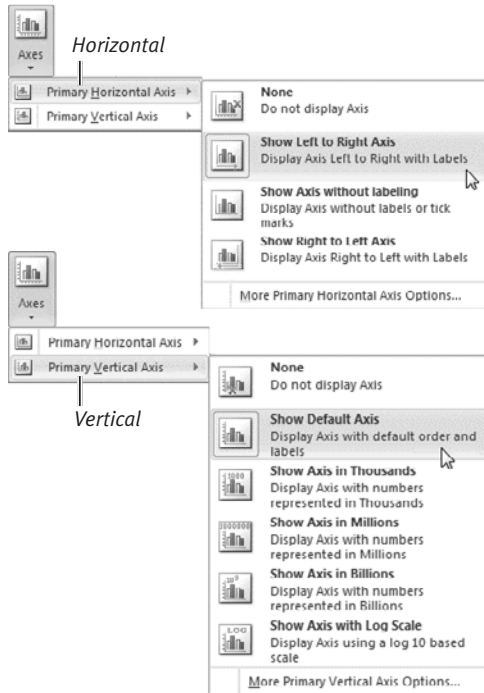
Figure 12.27 Because the horizontal and vertical axes serve different purposes, each has different options.
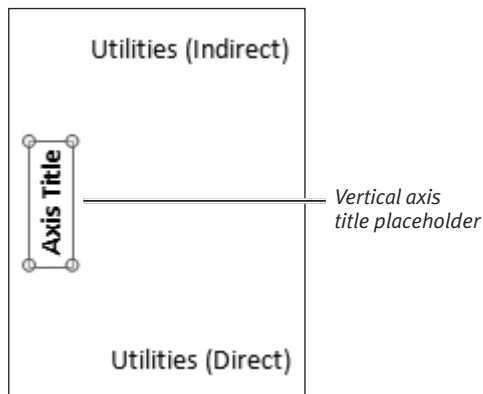

Figure 12.28 You can add a title to either or both axes.

Modifying the Axes

Most charts have a horizontal (X) and a vertical (Y) axis. You can modify either axis by changing its labels or formatting.

To modify an axis:

1. Select the chart.

2. *Do any of the following:*

   ▲ To remove an axis, set the position of the Y axis, or specify numeric units to use for the X axis, click the Layout tab and choose an option from the Axes drop-down menu in the Axes group (**Figure 12.27**).

   ▲ To change the formatting for an axis, right-click the axis labels on the chart and choose Format Axis, or choose More *axis name* Axis Options from the Axes menu (Figure 12.27). Make changes in the Format Axis dialog box and click Close.

   ▲ To change an individual axis label, edit the label's text in its worksheet cell. You can also modify axis labels in the Select Data Source dialog box. Click the Design tab, and click the Select Data icon in the Data group.

   ▲ To add a title to the horizontal or vertical axis, choose a display option from the appropriate Axis Titles submenu on the Layout tab. A title containing placeholder text appears on the chart (**Figure 12.28**). Edit the placeholder text and then change the formatting, if you wish.

Creating Sparklines

New in Office 2010, *sparklines* (**Figure 12.29**) are tiny charts that display and summarize data. Unlike normal charts that are floating, resizable objects, sparklines are presented in individual cells, visually linking them with their data.

Sparklines

Figure 12.29 In this example, column sparklines show each student's three test scores.

To add sparklines:

1. Select the data range or the range into which you want to insert the sparklines.

2. Click the Insert tab. In the Sparklines group (**Figure 12.30**), click a sparkline format icon.

   The Create Sparklines dialog box appears (**Figure 12.31**).
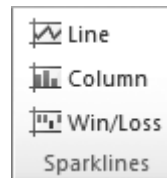
Figure 12.30 Select a sparkline format by clicking an icon.

3. Fill in the two range text boxes by typing or drag-selecting on the worksheet.

   If you preselected a range in Step 1, it will already be specified in the dialog box. Edit it, if necessary.

4. Click OK.

   The sparklines appear in the designated Location Range.

✔ Tips

- As with other Excel charts, if you edit the data on which sparklines are based, the sparklines automatically update.

- To change their style or formatting, select the sparklines and set new options on the Design tab (within the Sparkline Tools contextual tab).

- You can change the formatting of an individual sparkline by selecting only its cell, rather than all sparkline cells.

- Sparkline cells can also contain data.

- To remove all or selected sparklines, choose a Clear command from the Group group on the Design tab.

Figure 12.31 Specify the data range and location range for the sparklines.
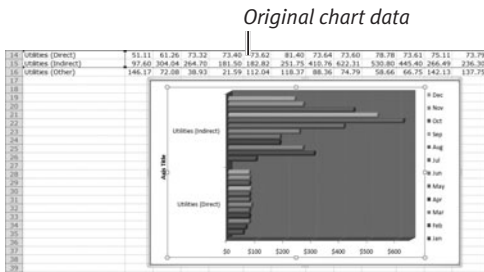
Original chart data

Figure 12.32 With the chart selected, drag a corner handle of the data selection rectangle to select the original and new data.
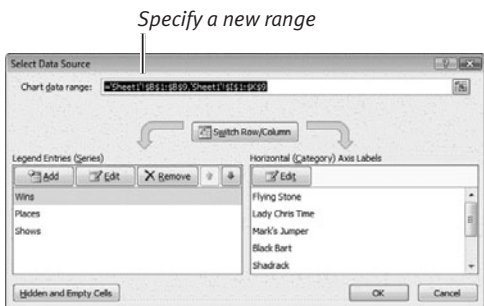
Specify a new range

Figure 12.33 To change the data on which a chart is based, edit the ranges in the Select Data Source dialog box or select new ranges on the worksheet.

Changing the Chart Data

Even if you've created a chart and carefully formatted it exactly the way you wanted, a problem sometimes occurs. The data on which the chart is based changes! A column or row in the data source may need to be deleted, data in one or more cells may need to be edited, or you may want to include additional rows or columns.

To modify chart data:

1. Select the chart.

2. *Do any of the following:*

   ▲ **Edit existing data.** If you edit data in the cells on which the chart is based, the chart automatically updates to reflect the edited data.

   ▲ **Delete rows or columns.** If you delete rows or columns within the range(s) used to create the chart, the data is automatically removed from the chart.

   ▲ **Add new rows or columns.** Adding new rows or columns within the range of the original chart data triggers an update of the chart.

   To add new rows that are immediately adjacent to the existing rows, select the chart. This causes the original chart data to be selected on the worksheet. Drag a corner of the data selection rectangle to encompass the new rows or columns (**Figure 12.32**).

✔ Tip

■ You can also add new data to a chart by switching to the Design tab and clicking the Select Data icon in the Data group. The Select Data Source dialog box appears (**Figure 12.33**). Edit the ranges in the dialog box or select new ranges on the worksheet. Click OK.