

Microsoft® Office Excel® 2007 and Spreadsheet Modeling

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Microsoft® Office Excel® 2007 is a spreadsheet program that can be used to organize and analyze data, perform complex calculations, and create a wide variety of graphical displays. We assume readers of this primer are familiar with basic Excel operations such as selecting cells, entering formulas, copying, and so on. But, we do not assume readers are familiar with Excel 2007.

The purpose of this primer is twofold. First, we provide an overview of Excel 2007 and discuss the basic operations needed to work with Excel 2007 workbooks and worksheets. Second we provide an introduction to building mathematical models using Excel, including a discussion of how to find and use a particular Excel function. A variety of tools are available when using Excel 2007 to develop mathematical models. These include Excel's Goal Seek tool, Excel's Solver, and commercially available add-ins such as Premium Solver for Education, and TreePlan. We discuss the use of these additional tools in selected chapter appendixes in *An Introduction to Management Science*.

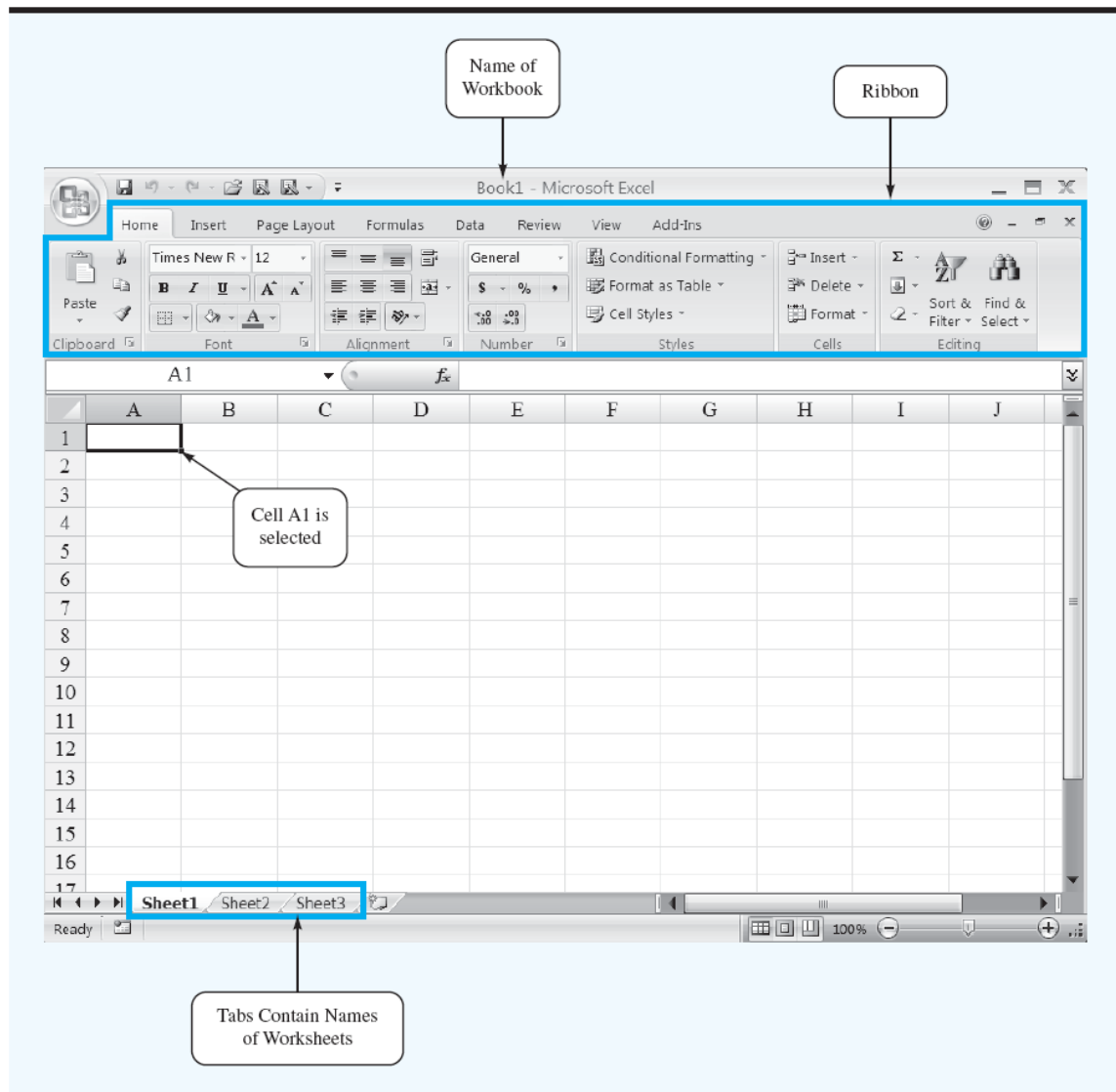
OVERVIEW OF MICROSOFT EXCEL 2007

When using Excel for modeling, the data and the model are displayed in workbooks, each of which contains a series of worksheets. Figure 1 shows the layout of a blank workbook created each time Excel is opened. The workbook is named Book1, and consists of three worksheets named Sheet1, Sheet2, and Sheet3. Excel highlights the worksheet currently displayed (Sheet1) by setting the name on the worksheet tab in bold. To select a different worksheet simply click on the corresponding tab. Note that cell A1 is initially selected.

The wide bar located across the top of the workbook is referred to as the Ribbon. Tabs, located at the top of the Ribbon, provide quick access to groups of related commands. There are eight tabs: Home, Insert, Page Layout, Formulas, Data, Review, View, and Add-Ins. Each tab contains several groups of related commands. Note that the Home tab is selected when Excel is opened. Figure 2 displays a portion of the Home tab. Under the Home tab there are seven groups of related commands: Clipboard, Font, Alignment, Number, Styles, Cells, and Editing. Commands are arranged within each group. For example, to change selected text to boldface, click the Home tab and click the Bold button in the Font group.

Figure 3 illustrates the location of the Office Button, the Quick Access Toolbar, and the Formula Bar. When you click the Office Button, Excel provides a list of workbook options such as opening, saving, and printing (worksheets). The Quick Access Toolbar allows you to quickly access these workbook options. For instance, the Quick Access Toolbar shown in Figure 3 includes an Open button that can be used to open files without having to first click the Office Button. To add or remove features on the Quick Access Toolbar click the Customize Quick Access Toolbar button on the Quick Access Toolbar.

FIGURE 1 BLANK WORKBOOK CREATED WHEN EXCEL IS OPENED



The Formula Bar contains a Name box, the Insert Function button f_x , and a Formula box. In Figure 3, "A1" appears in the Name box because cell A1 is selected. You can select any other cell in the worksheet by using the mouse to move the cursor to another cell and clicking or by typing the new cell location in the name box and pressing the enter key. The Formula box is used to display the formula in the currently selected cell. For instance, if you had entered $=A1+A2$ into cell A3, whenever you select cell A3 the formula $=A1+A2$ will be shown in the Formula box. This feature makes it very easy to see and edit a formula in a particular cell. The Insert Function button allows you to quickly access all of the functions available in Excel. Later we show how to find and use a particular function.

FIGURE 2 PORTION OF THE HOME TAB

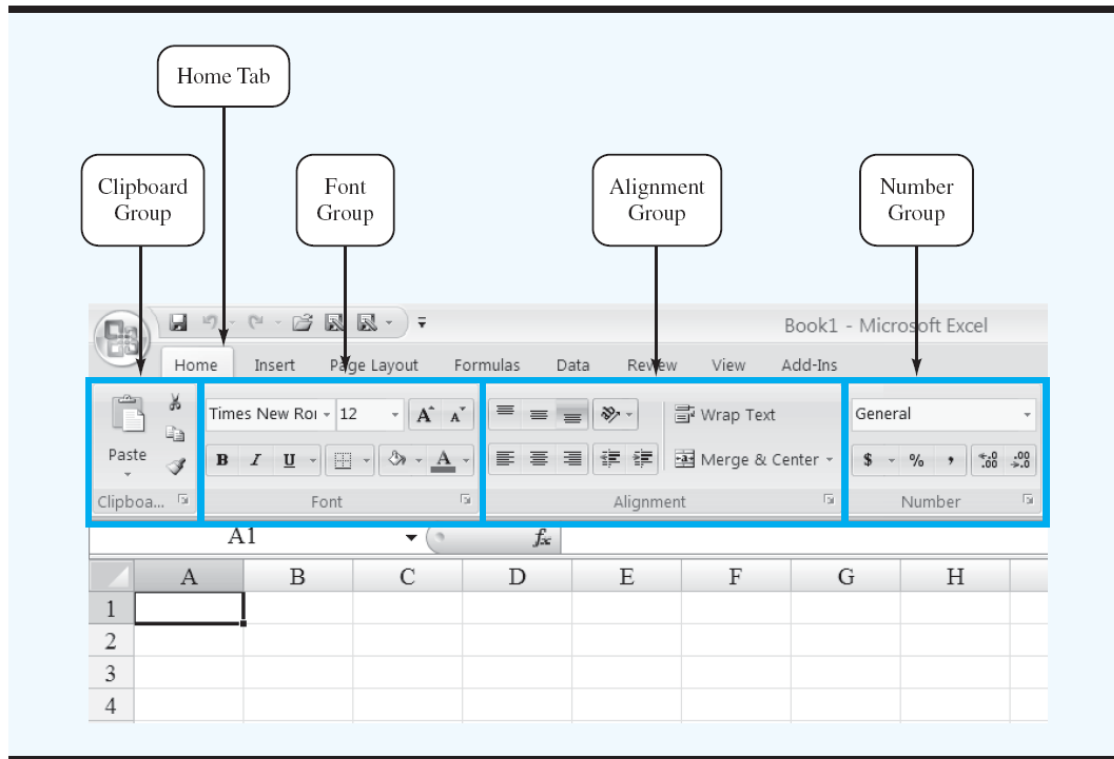


FIGURE 3 EXCEL 2007 OFFICE BUTTON, QUICK ACCESS TOOLBAR, AND FORMULA BAR

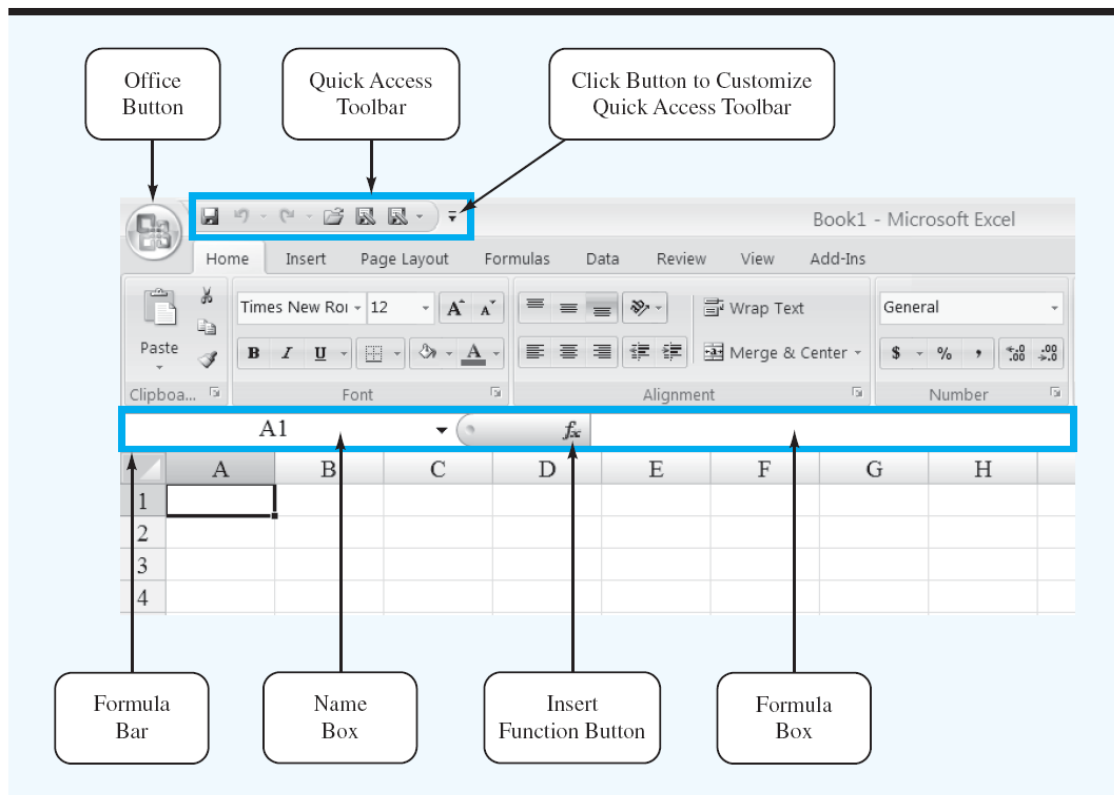
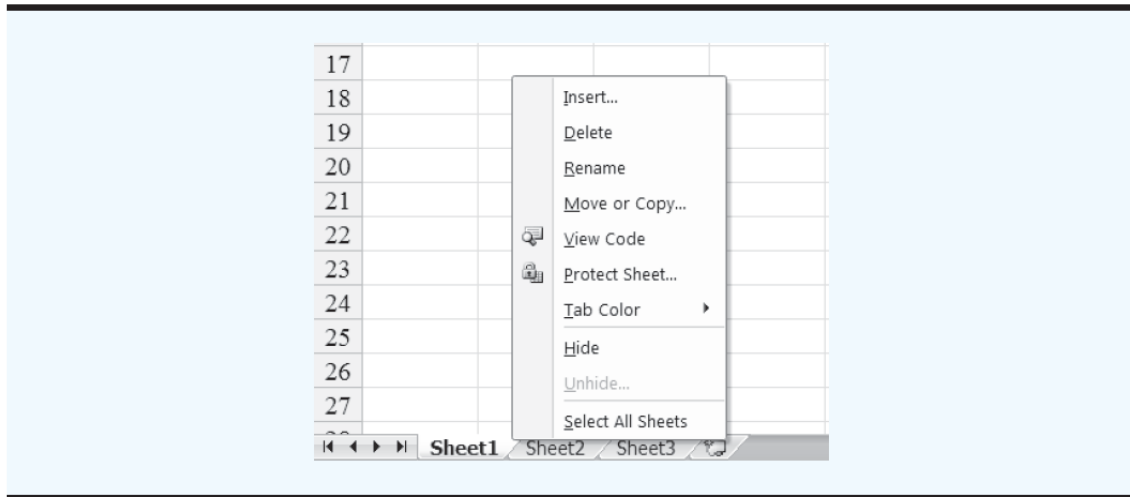



FIGURE 4 WORKSHEET OPTIONS AVAILABLE AFTER RIGHT CLICKING ON A WORKSHEET TAB



BASIC WORKBOOK OPERATIONS

Figure 4 illustrates the worksheet options that can be performed after right clicking on a worksheet tab. For instance, to change the name of the current worksheet from “Sheet1” to “NowlinModel,” right click the worksheet tab named “Sheet1” and select the Rename option. The current worksheet name (Sheet1) will be highlighted. Then, simply type the new name (NowlinModel) and press the Enter key to rename the worksheet.

Suppose that you wanted to create a copy of “Sheet 1.” After right clicking the tab named “Sheet1,” select the Move or Copy option. When the Move or Copy dialog box appears, select Create a Copy and click OK. The name of the copied worksheet will appear as “Sheet1 (2).” You can then rename it, if desired.

To add a worksheet to the workbook, right click any worksheet tab and select the Insert option; when the Insert dialog box appears, select Worksheet and click OK. An additional blank worksheet titled “Sheet 4” will appear in the workbook. You can also insert a new worksheet by clicking the Insert Worksheet button  that appears to the right of the last worksheet tab displayed. Worksheets can be deleted by right clicking the worksheet tab and choosing Delete. After clicking Delete, a window will appear warning you that any data appearing in the worksheet will be lost. Click Delete to confirm that you do want to delete the worksheet. Worksheets can also be moved to other workbooks or a different position in the current workbook by using the Move or Copy option.

Creating, Saving, and Opening Files

As an illustration of manually entering, saving, and opening a file we will use the Nowlin Plastics production example from Chapter 1 of *An Introduction to Management Science*. The objective is to compute the breakeven point for a product that has a fixed cost of €3000, a variable cost per unit of €2, and a selling price per unit of €5. We begin by creating a worksheet containing the problem data.

If you have just opened Excel, a blank workbook containing three worksheets will be displayed. The Nowlin data can now be entered manually by simply typing the fixed cost of €3000, the variable cost of €2, and the selling price of €5 into one of the worksheets.

If Excel is currently running and no blank workbook is displayed, you can create a new blank workbook using the following steps:

- Step 1: Click the **Office** button
- Step 2: Click **New** in the list of options
- Step 3: When the New Workbook dialog box appears:
 - Select **Blank and recent** under **Templates**
 - Double click **Blank Workbook**

A new workbook containing three worksheets labelled Sheet1, Sheet2, and Sheet3 will appear.

We will place the data for the Nowlin example in the top portion of Sheet1 of the new workbook. First, we enter the label “Nowlin Plastics” into cell A1. To identify each of the three data values we enter the label “Fixed Cost” into cell A3, the label “Variable Cost Per Unit” into cell A5, and the label “Selling Price Per Unit” into cell A7. Next, we enter the actual cost and price data into the corresponding cells in column B: the value of €3000 in cell B3; the value of €2 in cell B5; and the value of €5 into cell B7. Finally, we will change the name of the worksheet from “Sheet1” to “NowlinModel” using the procedure described previously. Figure 5 shows a portion of the worksheet we have just developed.

Before we begin the development of the model portion of the worksheet, we recommend that you first save the current file; this will prevent you from having to re-enter the data in case something happens that causes Excel to close. To save the workbook using the filename Nowlin we perform the following steps:

- Step 1: Click the **Office** button
- Step 2: Click **Save** in the list of option

FIGURE 5 NOWLIN PLASTICS DATA

	A	B	C
1	Nowlin Plastics		
2			
3	Fixed Cost	€3,000	
4			
5	Variable Cost Per Unit	€2	
6			
7	Selling Price Per Unit	€5	
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			

Step 3: When the **Save As** dialog box appears:
In the **Save in** box select the location where you want to save the file
Type the filename **Nowlin** in the **File name** box
Click **Save**

Excel's Save command is designed to save the file as an Excel 2007 workbook. As you work with and build models in Excel you should follow the practice of periodically saving the file so you will not lose any work. Simply follow the procedure described above using the Save command.

Sometimes you may want to create a copy of an existing file. For instance, suppose you change one or more of the data values and would like to save the modified file using the filename "NowlinMod." The following steps show how to save the modified workbook using filename NowlinMod.

Step 1: Click the **Office** button
Step 2: Position the mouse pointer over **Save As**
Step 3: Click **Excel Workbook** from the list of options
Step 4: When the **Save As** dialog box appears:
In the **Save in** box select the location where you want to save the file
Type the filename **NowlinMod** in the **File name** box
Click **Save**

Once the NowlinMod workbook has been saved, you can continue to work with the file to perform whatever type of analysis is appropriate. When you are finished working with the file simply click the close window button located at the top right-hand corner of the Ribbon. You can easily access a saved file at another point in time. For example, the following steps show how to open the previously saved Nowlin workbook.

Step 1: Click the **Office** button
Step 2: Click **Open** in the list of options
Step 3: When the Open dialog box appears:
In the **Look in** box select the location where you previously saved the file
Type the filename **Nowlin** in the **File name** box
Click **Open**

The procedures we showed for saving or opening a workbook begin by clicking on the Office Button to access the Save and Open commands. Once you have used Excel for awhile you will probably find it more convenient to add these commands to the Quick Access Toolbar.

MODEL DEVELOPMENT

Assume that the **Nowlin** workbook is open again and that we would like to develop a model that can be used to compute the profit or loss associated with a given production volume. We will use the bottom portion of the worksheet shown in Figure 5 to develop the model. First, we enter the label "Models" into cell A10 to provide a visual reminder that the bottom portion of this worksheet will contain the model. Next, we enter the labels "Production Volume" into cell A12, "Total Cost" into cell A14, "Total Revenue" into cell A16, and "Total Profit (Loss)" into cell A18. Cell B12 is used to contain a value for the production volume. We will now enter formulas into cells B14, B16, and B18 that use the production volume in cell B12 to compute the values for total cost, total revenue, and total profit or loss.

Total cost is the sum of the fixed cost (cell B3) and the total variable cost. The total variable cost—the product of the variable cost per unit (cell B5) and production volume (cell B12)—is given by $B5*B12$. Thus, to compute the value of total cost we enter the formula $=B3+B5*B12$ into cell B14. Next, total revenue is the product of the selling price per unit

FIGURE 6 NOWLIN PLASTICS DATA AND MODEL


	A	B	C
1	Nowlin Plastics		
2			
3	Fixed Cost	3000	
4			
5	Variable Cost Per Unit	2	
6			
7	Selling Price Per Unit	5	
8			
9			
10	Models		
11			
12	Production Volume		
13			
14	Total Cost	=B3+B5*B12	
15			
16	Total Revenue	=B7*B12	
17			
18	Total Profit (Loss)	=B16-B14	
19			

(cell B7) and the number of units produced (cell B12), which we enter in cell B16 as the formula =B7*B12. Finally, the total profit or loss is the difference between the total revenue (cell B16) and the total cost (cell B14). Thus, in cell B18 we enter the formula =B16-B14. Figure 6 shows a portion of the formula worksheet we have just developed. We can now compute the total profit or loss for a particular production volume by entering a value for the production volume into cell B12. Figure 7 shows the results after entering a value of 800 into cell B12. We see that a production volume of 800 units results in a total cost of €600, a total revenue of €4000, and a loss of €600.

USING EXCEL FUNCTIONS

Excel 2007 provides a wealth of functions for developing mathematical models. If we know which function is needed, and how to use it, we can simply enter the function into the appropriate worksheet cell. However, if we are not sure which functions are available to accomplish a task or are not sure how to use a particular function, Excel can provide assistance.

Finding the Right Excel Function

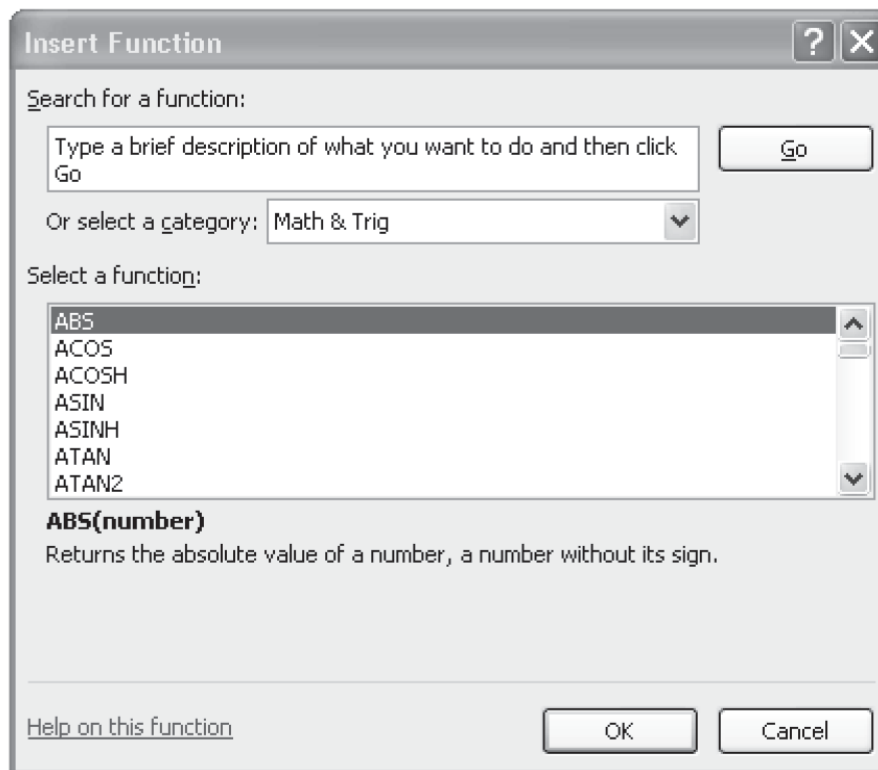
To identify the functions available in Excel, click the **Formulas** tab on the Ribbon and then click the **Insert Function** button in the **Function Library** group. Alternatively click the  button on the formula bar. Either approach provides the **Insert Function** dialog box shown in Figure 8.

The **Search for a function** box at the top of the Insert Function dialog box enables us to type a brief description for what we want to do. After doing so and clicking **Go**, Excel will search for and display, in the **Select a function** box, the functions that may accomplish our task. In many situations, however, we may want to browse through an entire category of functions to see what is available. For this task, the **Or select a category** box is helpful.

FIGURE 7 NOWLIN PLASTICS RESULTS

	A	B	C
1	Nowlin Plastics		
2			
3	Fixed Cost	€3,000	
4			
5	Variable Cost Per Unit	€2	
6			
7	Selling Price Per Unit	€5	
8			
9			
10	Models		
11			
12	Production Volume	800	
13			
14	Total Cost	€4,600	
15			
16	Total Revenue	€4,000	
17			
18	Total Profit (Loss)	- €600	

FIGURE 8 INSERT FUNCTION DIALOG BOX



It contains a drop-down list of several categories of functions provided by Excel. Figure 8 shows that we selected the **Math & Trig** category. As a result, Excel's Math & Trig functions appear in alphabetical order in the **Select a function** box. We see the ABS function listed first, followed by the ACOS function, and so on.

The ABS function is highlighted in Figure 8, indicating it is the function currently selected. The proper syntax for the function and a brief description of the function appear below the **Select a function** box. We can scroll through the list in the **Select a function** box to display the syntax and a brief description for each of the Math & Trig functions that are available. For instance, scrolling down farther, we select the SUMPRODUCT function as shown in Figure 9. The SUMPRODUCT function is used in many of the Solver examples in the textbook. Note that SUMPRODUCT is now highlighted, and that immediately below the Select a function box we see **SUMPRODUCT(array1,array2,array3,...)**, which indicates that the SUMPRODUCT function contains the array arguments array1, array2, array3, In addition, we see that the description of the SUMPRODUCT function is "Returns of the sum of the products of corresponding ranges or arrays."

If the function selected (highlighted) is the one we want to use, we click **OK**; the **Function Arguments** dialog box then appears. The Function Arguments dialog box for the SUMPRODUCT function is shown in Figure 10. This dialog box assists in creating the appropriate arguments for the function selected. When finished entering the arguments we click OK; Excel then inserts the function into a worksheet cell.

FIGURE 9 DESCRIPTION OF THE SUMPRODUCT FUNCTION IN THE INSERT FUNCTION DIALOG BOX

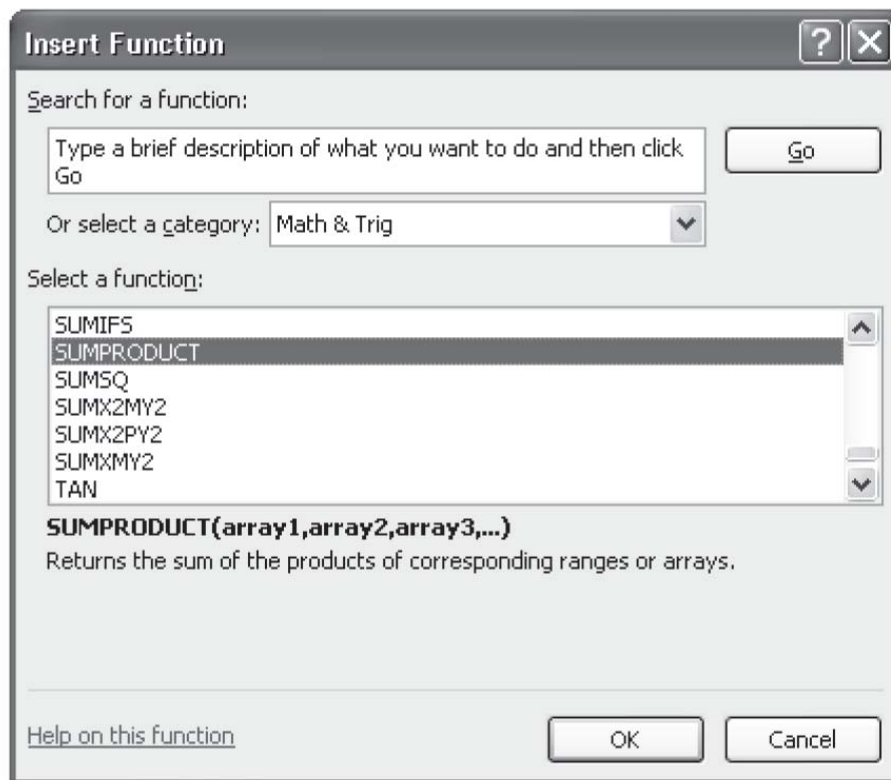
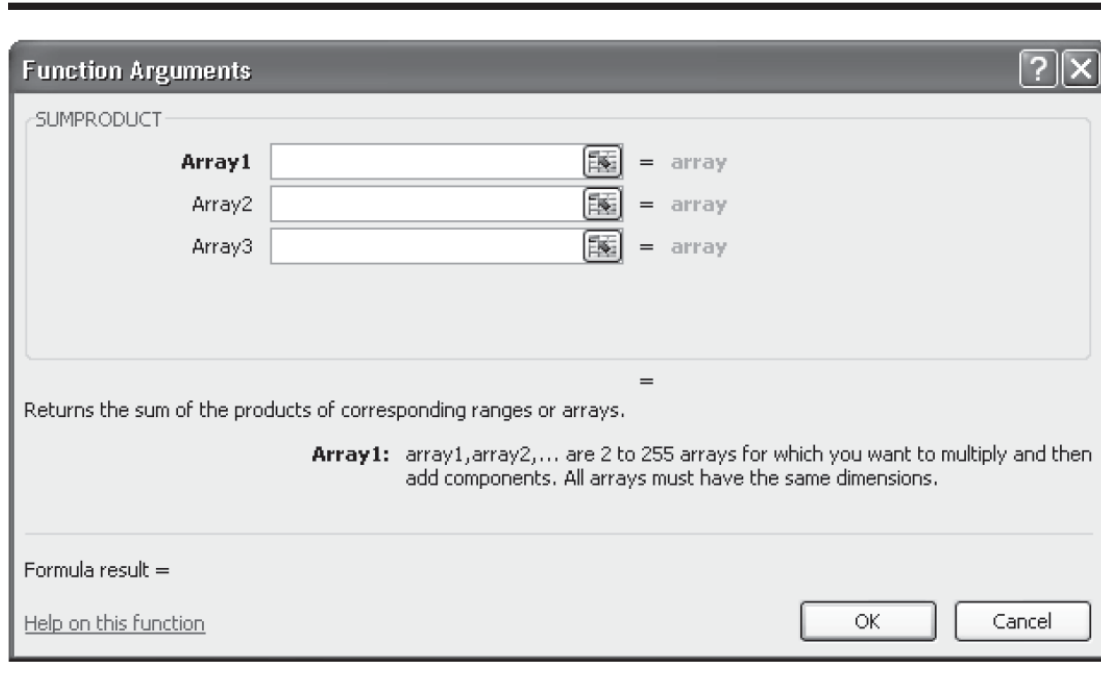


FIGURE 10 FUNCTION ARGUMENTS DIALOG BOX FOR THE SUMPRODUCT FUNCTION



Inserting a Function into a Worksheet Cell

We will now show how to use the Insert Function and Function Arguments dialog boxes to select a function, develop its arguments, and insert the function into a worksheet cell.

Figure 11 displays an Excel worksheet for the Foster Generators Problem that appears in Chapter 7 of *An Introduction to Management Science*. This problem involves the transportation of a product from three plants (Czech Rep, Brazil, and China) to four distribution centers (Boston, Dubai, Singapore, and London). The costs for each unit shipped from each plant to each distribution center are shown in cells B5:E7, and the values in cells B17:E19 are the number of units shipped from each plant to each distribution center. Cell B13 will contain the total transportation cost corresponding to the transportation cost values in cells B5:E7 and the values of the number of units shipped in cells B17:E19. The following steps show how to use the SUMPRODUCT function to compute the total transportation cost for Foster Generators. Step 1: Select cell C13

Step 2: Click  on the formula bar

Step 3: When the Insert Function dialog box appears

Select **Math&Trig** in the **Or select a category** box

Select **SUMPRODUCT** in the **Select a function** box

Click **OK**

Step 4: When the **Function Arguments** box appear (see Figure 12)

Enter B5:E7 in the **Array1** box

Enter B17:E19 in the **Array2** box

Click **OK**

FIGURE 11 EXCEL WORKSHEET USED TO CALCULATE TOTAL SHIPPING COSTS FOR THE FOSTER GENERATORS TRANSPORTATION PROBLEM

	A	B	C	D	E	F	G	H	I	
1	Foster Generators									
2										
3		Destination								
4	Origin	Boston	Dubai	Singapore	London	Supply				
5	Czech Republic	3	2	7	6	5000				
6	Brazil	7	5	2	3	6000				
7	China	2	5	4	5	2500				
8	Demand	6000	4000	2000	1500					
9										
10										
11	Model									
12										
13		Min Cost								
14										
15		Destination								
16	Origin	Boston	Dubai	Singapore	London	Total				
17	Czech Republic	3500	1500	0	0	5000	<=	5000		
18	Brazil	0	2500	2000	1500	6000	<=	6000		
19	China	2500	0	0	0	2500	<=	2500		
20	Total	6000	4000	2000	1500					
21		=	=	=	=					
22		6000	4000	2000	1500					
23										

FIGURE 12 COMPLETED FUNCTION ARGUMENTS DIALOG BOX FOR THE SUMPRODUCT FUNCTION

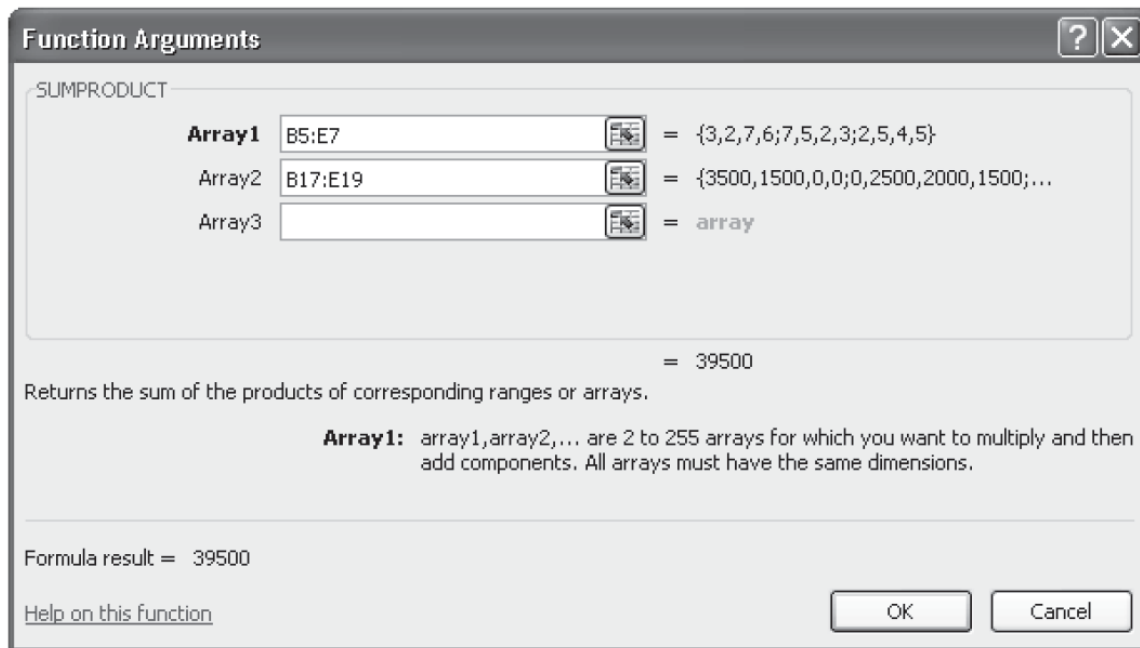


FIGURE 13 EXCEL WORKSHEET SHOWING THE USE OF EXCEL'S SUMPRODUCT FUNCTION TO CALCULATE TOTAL SHIPPING COSTS

	A	B	C	D	E	F	G	H	I
1	Foster Generators								
2									
3		Destination							
4	Origin	Boston	Dubai	Singapore	London	Supply			
5	Czech Republic	3	2	7	6	5000			
6	Brazil	7	5	2	3	6000			
7	China	2	5	4	5	2500			
8	Demand	6000	4000	2000	1500				
9									
10									
11	Model								
12									
13		Min Cost	39500						
14									
15		Destination							
16	Origin	Boston	Dubai	Singapore	London	Total			
17	Czech Republic	3500	1500	0	0	5000	<=	5000	
18	Brazil	0	2500	2000	1500	6000	<=	6000	
19	China	2500	0	0	0	2500	<=	2500	
20	Total	6000	4000	2000	1500				
21		=	=	=	=				
22		6000	4000	2000	1500				
23									

The worksheet then appears as shown in Figure 13. The value of the total transportation cost in cell C13 is 39500 or €39,500.

We illustrated the use of Excel's capability to provide assistance in using the SUMPRODUCT function. The procedure is similar for all Excel functions. This capability is especially helpful if you do not know what function to use or forget the proper name and/or syntax for a function.

ADDITIONAL TOOLS FOR MODELING

In *An Introduction to Management Science* we illustrate a variety of Excel tools that are helpful in developing mathematical models. For example, in Appendix 1.1 we show how Excel's Goal Seek tool is used to compute the breakeven point for the Nowlin Plastics example. An add-in package titled Premium Solver for Education, included on the Student CD, extends the range of problem type and size that can be handled using Excel Solver.