Notes on Excel 2007
Forecasting Tools

- ►*Data Table*
- ►*Scenario Manager*
- ►*Goal Seek*
- ►*Solver*

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Tools Introduction

Data Table

Excel's Data Table is a powerful sensitivity analysis tool that shows how changing certain values in a model's formulas might affect critical elements of the model. Data tables provide a shortcut for generating multiple views for a model in a single operation as well as a way to view and compare the results of all of the variations together on a single worksheet. There are two varieties of Data Table: one-input and two-input. To run a Data Table, establish the proper Data Table layout and data and then use the commands *Data, Table* to open the "Table" dialog. Using the prompts in the "Table" dialog, link the Data Table input values to the model and click *OK* to run.

Scenario Manager

A scenario is a set of values that Excel saves and can substitute on command in a worksheet model. You can create and save different groups of values on a worksheet and then switch to any of these new scenarios to view different model results. For example, if you create a budget worksheet but are uncertain what revenue value to include, you can define different values for the revenue and then switch between the scenarios to perform what-if analyses. To build scenarios, choose *Tools, Scenarios* to open the "Scenario Manager" dialog. Follow the prompts.

Goal Seek

When you know the result you want from a single formula but not the input value the formula needs to determine the result, use Excel's Goal Seek. When goal seeking, Excel varies the value in a worksheet cell you specify until the formula that's dependent on that cell returns the result you want.

Solver

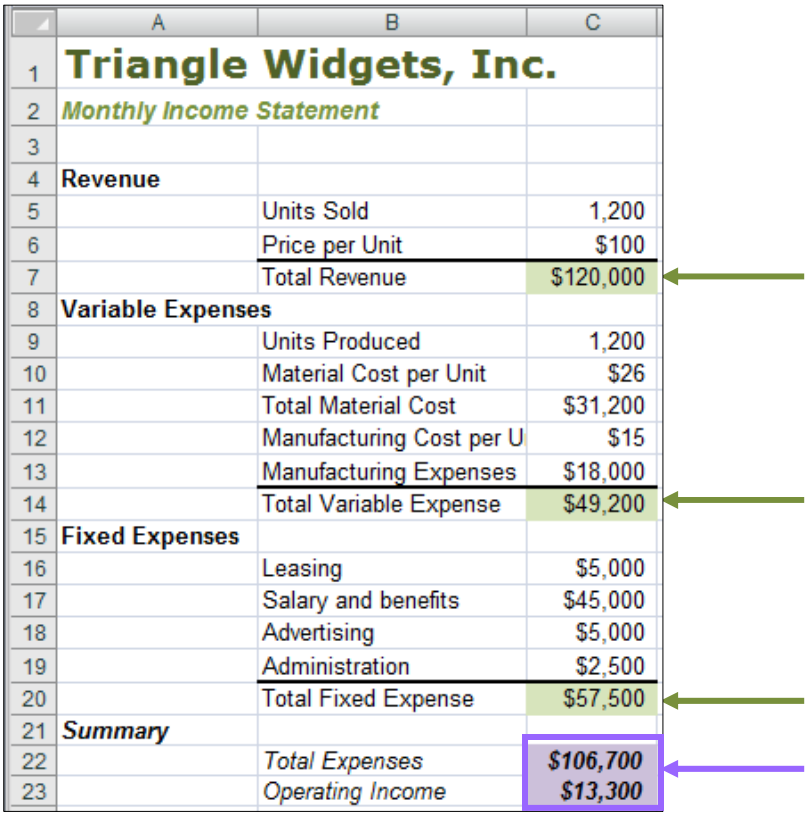
Excel's Solver is a problem-solving tool like Goal Seek; however, the Solver provides a much more powerful and flexible approach. Use Solver to determine the maximum or minimum value of one cell by changing other cells— for example, the maximum profit you can generate by changing advertising expenditures. You specify one or more "changing cells" which must be related through formulas on the worksheet. In addition, you can establish model constraints, and Solver will search for a solution without violating the constraints. Solver adjusts the values in the changing cells you specify to produce the result you want from the formula. Solver is an Excel add-in, but is part of Excel. If you don't find Solver on the ribbon, add it by opening the "Excel Options" dialog and going to the "Add-Ins" section. You may need to return to your Excel software media to add it as an option to your Excel installation.

The Sample Workbook

A multi-tabbed Excel file named ForecastingTools2007.xlsm is available for download if you want to experiment with the examples that follow and see them in context. If you don't have the sample workbook or would rather focus just on the text in this document, there are plenty of illustrations; using the workbook isn't necessary.

Tool Examples

► The Excel 2007 Data Table



	A	B	C
1	**Triangle Widgets, Inc.**		
2	*Monthly Income Statement*		
3			
4	**Revenue**		
5		Units Sold	1,200
6		Price per Unit	$100
7		Total Revenue	$120,000
8	**Variable Expenses**		
9		Units Produced	1,200
10		Material Cost per Unit	$26
11		Total Material Cost	$31,200
12		Manufacturing Cost per U	$15
13		Manufacturing Expenses	$18,000
14		Total Variable Expense	$49,200
15	**Fixed Expenses**		
16		Leasing	$5,000
17		Salary and benefits	$45,000
18		Advertising	$5,000
19		Administration	$2,500
20		Total Fixed Expense	$57,500
21	***Summary***		
22		*Total Expenses*	***$106,700***
23		*Operating Income*	***$13,300***

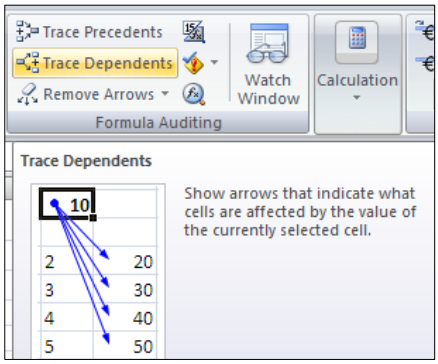
To illustrate the features of Excel 2007's Data Table we make use of a monthly income statement for a firm named Triangle Widgets, Inc. If you're following along with the ForecastingTools2007.xlsm workbook, make the "Data Table" tab current.

As you might expect, this income statement model uses formulas, not static values, for many cells. For example, the Total Revenue, Total Variable Expenses, and Total Fixed Expenses are formulas. Changing the value of one or more of cells that determine the values of these items changes the model. In particular the important Summary values (Total Expenses and Operating Income) are affected by any change in contributing values.

The view of the worksheet with formulas displayed (toggle: CTRL+`) makes the model relationships clearer.

	A	B	C
1	**Triangle W**		
2	***Monthly Income Sta***		
3			
4	**Revenue**		
5		Units Sold	1200
6		Price per Unit	100
7		Total Revenue	=Units_Sold*Price_per_Unit
8	**Variable Expenses**		
9		Units Produced	=C5
10		Material Cost per Unit	26
11		Total Material Cost	=C9*C10
12		Manufacturing Cost per Unit	15
13		Manufacturing Expenses	=C9*C12
14		Total Variable Expense	=SUM(Total_Material_Cost,Manufacturing_Expenses)
15	**Fixed Expenses**		
16		Leasing	5000
17		Salary and benefits	45000
18		Advertising	5000
19		Administration	2500
20		Total Fixed Expense	=SUM(C16:C19)
21	***Summary***		
22		*Total Expenses*	***=SUM(Total_Variable_Expense,Total_Fixed_Expense)***
23		*Operating Income*	***=Total_Revenue-Total_Expenses***
24			

An alternative to displaying formulas is to use the "Trace Dependents" tool in the "Formula Auditing" group on the "Formulas" ribbon.



	A	B	C
1	**Triangle Widgets, Inc.**		
2	***Monthly Income Statement***		
3			
4	**Revenue**		
5		Units Sold	1,200
6		Price per Unit	$100
7		Total Revenue	$120,000
8	**Variable Expenses**		
9		Units Produced	1,200
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16		Leasing	$5,000
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18		Advertising	$5,000
19		Administration	$2,500
20		Total Fixed Expense	$57,500
21	***Summary***		
22		*Total Expenses*	***$106,700***
23		*Operating Income*	***$13,300***
24			
25			
26			

Click any cell and click the "Trace Dependents" button one or more times for a graphical view of how cell values determine formula results.

As you examine the Triangle Widgets monthly income statement you might want the answers to some questions that this model can provide. For example: [1]

- What happens to Operating Income (the bottom line) if Triangle Widgets sells 2000, 2500, or 3000 units per month instead of 1,200?
- If the company sells 2000 units how do expenses change? What's the impact on expenses if 3000 units are sold? 4000?
- What happens if Triangle Widget's leasing costs go up by 20%? By 25% By 30%?
- What happens if the manufacturing cost per unit goes down by an eighth? By a quarter? By a third?

	A	B	C
4	**Revenue**		
5		Units Sold	1,200
6		Price per Unit	$100
7		Total Revenue	$120,000
8	**Variable Expenses**		
9		Units Produced	1,200
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21	***Summary***		
22		*Total Expenses*	***$106,700***
23		*Operating Income*	***$13,300***
24			

Much of the power of Excel comes from its dynamic modeling capability. If you want to know the effect on the bottom line if Units Sold is 3,000 instead of 1,200 it's easy to find out. Replace the 1,200 value in Cell C5 with 3000. The Operating Income value automatically changes from $13,300 to $119,500.

[1] As the model is currently constructed there are also some kinds of questions (that involve more complex calculations and assumptions) that you can *not* answer. For example, in this model the fixed expense value for "Advertising" is a static number. While changing the static advertising value *will* affect the bottom line, the model can't show how a change might affect "Units Sold". So you can't use this model to answer the question "How would an increase in advertising affect unit sales?"

Certainly changing the values of model cells can be a useful exercise. However, if you want to look at the results of a large number of changes, manually editing and recording the results becomes a tedious task. The Data Table can help you forecast results quickly and efficiently. The Data Table is constructed *outside* of the model, but is linked to it. When you run the Data Table, you read its analysis in the Data Table results area. The model itself doesn't change.

Some of the advantages of using a Data Table for this kind of task instead of just changing values in the model itself are:

- Any number of values can be included in the Data Table as substitutes for a model value. For example, with a Data Table it's easy how a wide range of production level values (Units Sold) affect operating income instead of viewing one at a time the effect of a change in Units Sold on the model.
- The Data Table results are displayed visible in a conveniently small matrix.

Data Tables can be a bit tricky to work with only because you must understand the Data Table layout Excel requires and how to execute the Data Table properly.

One-Input vs. Two-Input Data Tables

The Data Table is available in two "flavors": One-Input and Two-Input. Both are illustrated in these notes. The differences in brief are:

In a One-Input Data Table, the Data Table has multiple substitute values for a *single* model value. It has at least one formula from the model. The formula's results (as displayed in the Data Table results area) must depend on the chosen Data Table input value either directly or indirectly. A One-Input Data Table *may* have more than one formula from the model. If it has more than one formula, the One-Input Data Table is generally built with input values arranged down a column and formulas across the top row.

In a Two-Input Data Table, the Data Table has *two* substitute values, one set for each of two model values. It can have only a *single* formula from the model. One set of inputs is arranged down a column, the other set of inputs is arranged along a row, and the formula is in the intersecting cell above the first column input and to the left of the first row input.

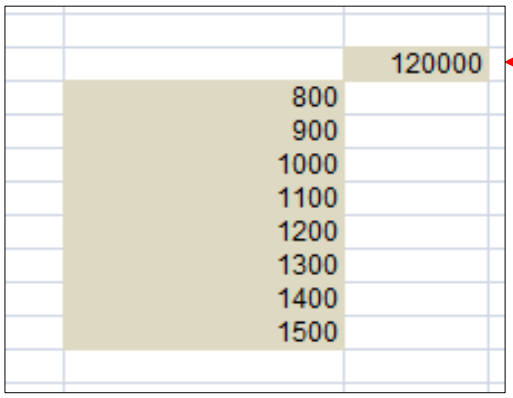
The layout of the two types and the differences between them will be more obvious in the examples that follow.

Building a One input Data Table

I locate a One-Input Data Table to the right of the income statement model on the "Data Table" worksheet. My Data Table will operate on different values for "Units Sold" (in model Cell C5) and track the effects of those different values on "Total Revenue" (in model Cell C7).

To build the Data Table I locate input values for "Units Sold" down one column. In the illustration below the values range from 800 to 1,500 in increments of 100. This column becomes the left-hand edge of the Data Table. One column to the right of the inputs and one row above the first column input I locate a reference to the model cell whose value I want to track: "Total Revenue". The structure of the One-Input Data Table with a single formula looks like this:

"Units Sold" values



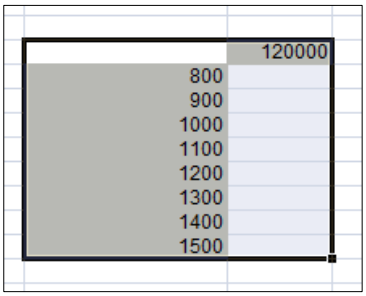
The Total Revenue formula from the model (Cell C7).

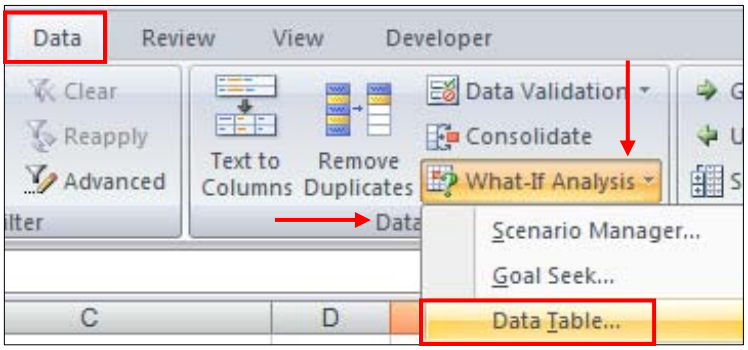
Notice that the Total Revenue formula in the model can be either a copy of the formula in the model or a reference to the model cell that holds the original formula.

Running a One-Input Data Table

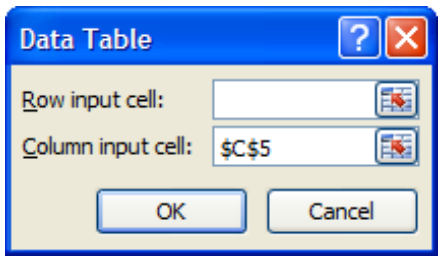
Once the Data Table is constructed it's ready to run. Follow these steps:

1) Select the Data Table range (the column of input cells, the formula, the blank cells to the right of the inputs, and the blank cell to the left of the formula).
2) From the "Data" tab choose the "Data Tools" group and the "What-If Analysis" drop-down.
3) Choose *Data Table…* from the drop-down.





4) A "Data Table" dialog displays, prompting for a row input cell and a column input cell. This dialog serves both the One-Input and the Two-Input Data Tables, but for a One-Input Data Table arranged like the one I built the "Row input cell" prompt is irrelevant. Leave that box blank.



For the "Column input cell" box, indicate *the cell in the model for which your Data Table input values will substitute*. In this model, that's Cell C5, the cell holding the number of units sold.

5) Click *OK*. Excel fills the Data Table results area with calculated values.

	120000
800	80000
900	90000
1000	100000
1100	110000
1200	120000
1300	130000
1400	140000
1500	150000

Read the results like this:

When Units Sold =	**Then Total Revenue =**
800	80,000
900	90,000
1,000	100,000
Etcetera.	

If you have a "target" value for Total Revenue, you can zero in on the number of units that must be sold in a month to reach that value.

Examples of Other Uses for the One-Input Data Table with this Model

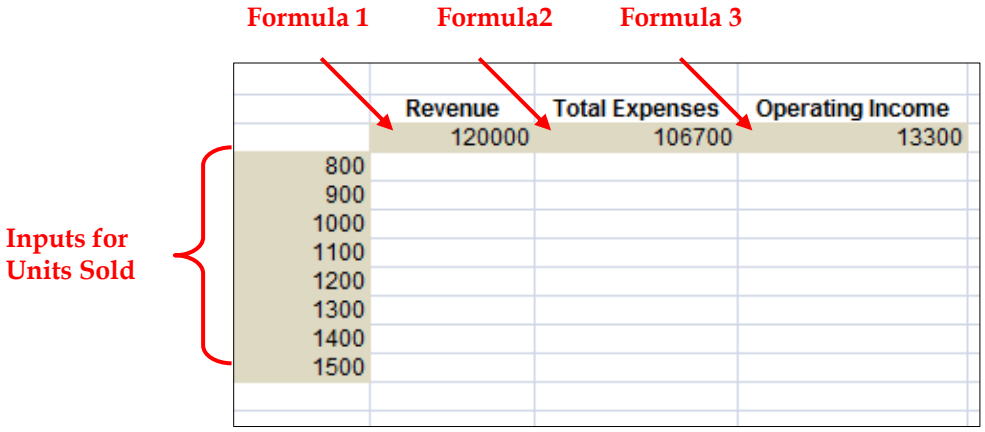
A One-Input Data Table could be constructed with this model to:

Vary	**and see the effect on**
Price per Unit	Total Revenue
Manufacturing Expenses	Total Variable Expenses
Administration	Total Fixed Expenses
Administration	Total Expenses
Units Produced	Operating Income
Etcetera	

An Example of a One-Input Data Table with Multiple Formulas

A One-Input Data Table needs at least one formula, but it *can* have more than one formula. The only rule about formulas included in a One-Input Data Table are that each one must be dependent in some way (directly or indirectly) on the input value for that Data Table.

Continuing with the Triangle Widgets, Inc. Monthly Income Statement model, the structure of a One-Input Data Table with *three* formulas might look like the illustration below.

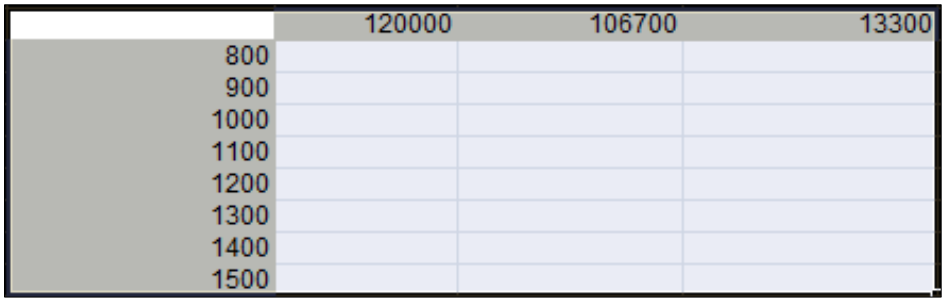


The formula for Revenue references the model Cell C7.
The formula for Total Expenses references the model Cell C22.
The formula for Operating Income references the model Cell C23.

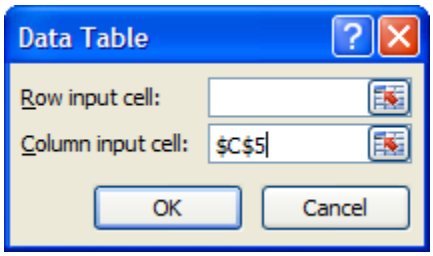
In the illustration, the cells holding the text items "Revenue", "Total Expenses" and "Operating Income" are *not* part of the Data Table. These cells hold labels for information only. They need not be included.

Run this Data Table in the same way as the simpler One-Input Data Table with a single formula. That is:

1) Highlight the Data Table range. Do *not* include the label cells in the selection. *Do* include the column of inputs, the blank upper-left-hand-corner cell, the formula cells, and all the now-blank results cells.



2) On the "Data" tab choose the "Data Tools" group and the "What-If Analysis" icon.
3) From the drop-down that displays choose "Data Table…" and complete the "Data Table" dialog, indicating Cell C5 (Units Sold) as the Data Table's column input cell.
4) Click *OK*.



Excel generates results in the Data Table. Read the results of this Data Table in the same way you read the earlier one.

	Revenue	Total Expenses	Operating Income
	120000	106700	13300
800	80000	90300	-10300
900	90000	94400	-4400
1000	100000	98500	1500
1100	110000	102600	7400
1200	120000	106700	13300
1300	130000	110800	19200
1400	140000	114900	25100
1500	150000	119000	31000

For example:

- When 800 units are sold, Total Revenue is 80,000, Total Expenses are 90,300, and Operating Income is -10,300.
- When 1,500 units are sold, Total Revenue is 150,000, Total Expenses are 119,000, and Operating Income is 31,000.

One input Data Table Summary

A One-Input Data Table varies one model value to see the effect on one or more other values in the model. The focus can be on the change to a single model value (such as Total Revenue). Or, changes to multiple model values (Total Revenue, Total Expenses, and Operating Income) can be shown, as in the example above. The One-Input Data Table can be expanded or contracted by changing the column of input values. Use the Data Table to quickly see the results of a range of changes to a model value on one or more model formulas you want to track.

Data Table Manipulations

Formatting Data Table Results

You may want to format the values in the Data Table. Use Excel's regular formatting tools.

The "results array"

The results area of the Data Table does not contain "regular" numeric values. Instead, because of the way Excel processes the data to generate the values, the results area cells are filled with array values.

	=Total_Revenue	=Total_Expenses	=Operating_Income
800	=TABLE(,C5)	=TABLE(,C5)	=TABLE(,C5)
900	=TABLE(,C5)	=TABLE(,C5)	=TABLE(,C5)
1000	=TABLE(,C5)	=TABLE(,C5)	=TABLE(,C5)
1100	=TABLE(,C5)	=TABLE(,C5)	=TABLE(,C5)
1200	=TABLE(,C5)	=TABLE(,C5)	=TABLE(,C5)
1300	=TABLE(,C5)	=TABLE(,C5)	=TABLE(,C5)
1400	=TABLE(,C5)	=TABLE(,C5)	=TABLE(,C5)
1500	=TABLE(,C5)	=TABLE(,C5)	=TABLE(,C5)

Array notation for results values.

Because of the array structure:

You can *not* change or delete any single value in the results array.
You *can* format any single value in the results array.
You *can* delete all the results array values at the same time.

Changing the Structure and Re-Running

You may very well find that you work with a Data Table in an iterative way. That is, you create an initial Data Table and after viewing the results you decide to modify the input values, change the input values, or change the model formula(s) you're tracking.

It's simple to make structural changes to the Data Table. Changing the Data Table structure automatically changes values in the Data Table results area. Example:

Initial Data Table

	Revenue
	120000
800	80000
900	90000
1000	100000
1100	110000
1200	120000
1300	130000
1400	140000
1500	150000

Input values changed.

	Revenue
	120000
100	10000
900	90000
1500	150000
2700	270000
3200	320000
8500	850000
12000	1200000
16250	1625000

Results area values automatically update.

You must re-run the Data Table manually only if:

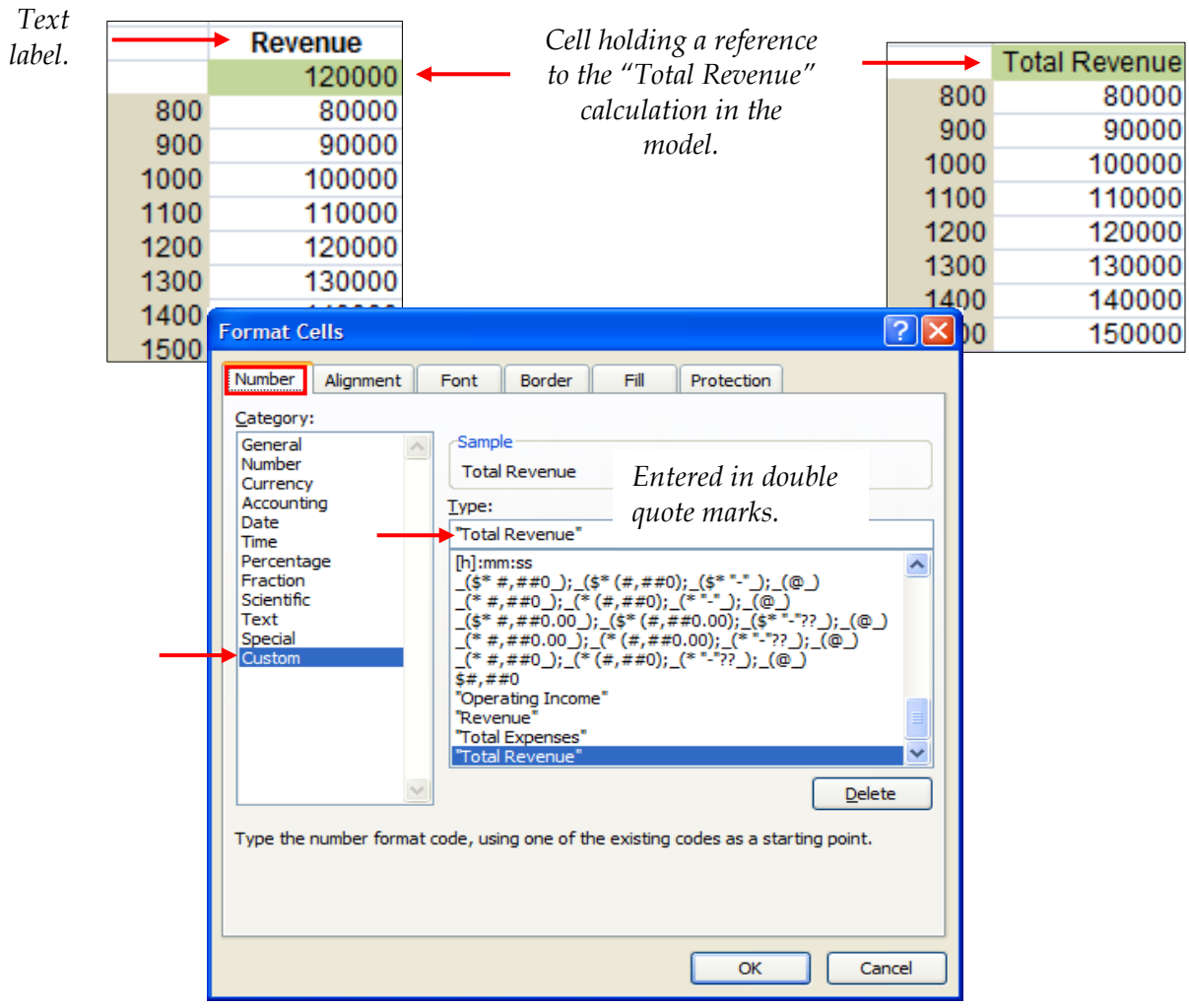
1) You erase the results area.
2) You expand the number of input values or the number of formulas.

	Revenue	Total Expenses	Operating Income
	120000	106700	13300
800	80000		
900	90000		
1000	100000		
1100	110000		
1200	120000		
1300	130000		
1400	140000		
1500	150000		
1600			
1700			

In the illustration at left, the original One-Input Data Table has been executed and results are shown. The lavender areas show new input values added and new tracking formulas added. The Data Table must be manually re-run to account for this expanded structure.

Labeling Tip

In the illustration at left below, the Data Table cell holding a reference to the model's Total Revenue formula displays the current Total Revenue value in the model; that is, 120000. The cell *above* that value holds a text label "Revenue" which is not part of the Data Table. In the illustration at right below, the Data Table cell holding a reference to the model's Total Revenue formula has been reformatted using a "Custom" format so it displays the text "Total Revenue" instead of 120000. This reformat makes a separate out-of-Data Table label cell unnecessary.



The Two input Data Table

As you might expect, a two input Data Table allows you to supply two ranges of input values. The limitation on choosing the two inputs is that they must be model variables used either directly or indirectly in the Two-Input Data Table's *single* formula.

In the Two-Input layout, one input is arranged down the left-hand column and the second input is arranged across the top row of the table. This arrangement of inputs permits only a single formula, which must be located in the upper-left-hand corner of the Table. The output is displayed just as it is for the one input Data Table. In the case of the Two-Input Data Table, that means to the right of and beneath the column and row of inputs.

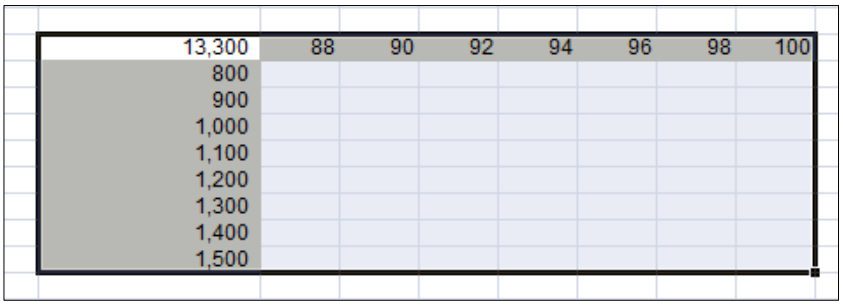
Again, the "Triangle Widgets, Inc." monthly income statement on the "Data Table" tab of the sample worksheet serves as our example. The Two-Input Data Table will show the effect of varying "Units Sold" (the column) and "Price per Unit" (the row) values on "Operating Income" (the tracked formula).

13,300	88	90	92	94	96	98	100
800							
900							
1,000							
1,100							
1,200							
1,300							
1,400							
1,500							

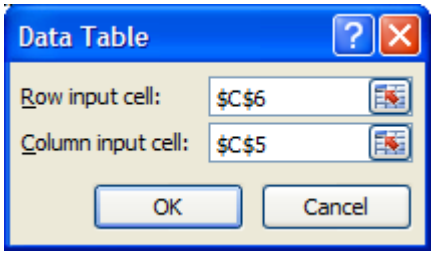
The structure of the Two-Input Data Table

Run this Data Table in almost the same way the One-Input Data Table is run. That is:

1) Select the Data Table range.



2) On the "Data" tab find the "Data Tools" group and click the "What-If Analysis" icon.
3) From the drop-down that displays choose *Data Table* and complete the "Data Table" dialog. Here, both the row input cell *and* the column input cell box must be completed.
4) Click *OK*.



Excel fills in the results matrix. Read the Two-Input Data Table results by reading across a row and down a column. For example, if 1,400 units are sold at $96/unit, Operating Income is $19,500.

13,300	$ 88	$ 90	$ 92	$ 94	$ 96	$ 98	$ 100
800	$ (19,900)	$ (18,300)	$ (16,700)	$ (15,100)	$ (13,500)	$ (11,900)	$ (10,300
900	$ (15,200)	$ (13,400)	$ (11,600)	$ (9,800)	$ (8,000)	$ (6,200)	$ (4,400
1,000	$ (10,500)	$ (8,500)	$ (6,500)	$ (4,500)	$ (2,500)	$ (500)	$ 1,500
1,100	$ (5,800)	$ (3,600)	$ (1,400)	$ 800	$ 3,000	$ 5,200	$ 7,400
1,200	$ (1,100)	$ 1,300	$ 3,700	$ 6,100	$ 8,500	$ 10,900	$ 13,300
1,300	$ 3,600	$ 6,200	$ 8,800	$ 11,400	$ 14,000	$ 16,600	$ 19,200
1,400	$ 8,300	$ 11,100	$ 13,900	$ 16,700	$ 19,500	$ 22,300	$ 25,100
1,500	$ 13,000	$ 16,000	$ 19,000	$ 22,000	$ 25,000	$ 28,000	$ 31,000

The same manipulations that apply to the One-Input Data Table also apply to the Two-Input Data Table.

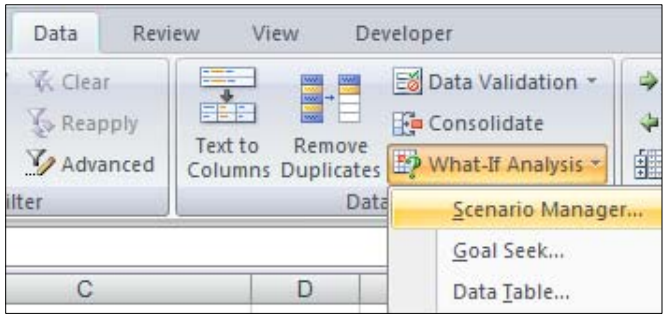
Two input Data Table Summary

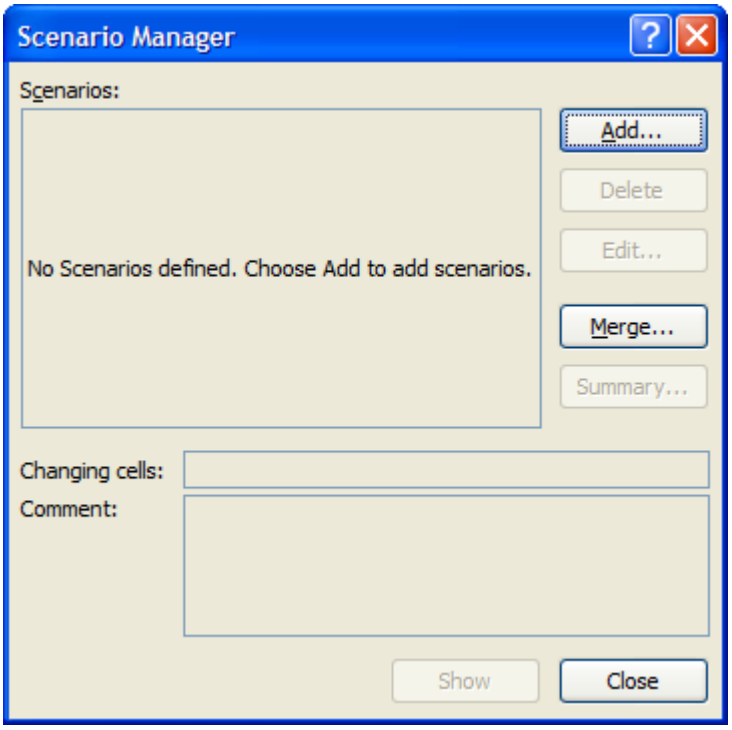
A Two-Input Data Table varies two model values to see the effect on a single calculated value in the model. Both inputs must be referenced by the calculation either directly or indirectly. The Two-Input Data Table can be extended or contracted by changing the column and row of input values. Use the Two-Input Data Table to quickly see the results of a range of changes to two model values on a single model formula you want to track.

►Scenario Manager

For an example of Excel's Scenario Manager we again return to the "Income Statement" worksheet in the ForecastingTools2007.xlsm workbook. Above, we generated two kinds of Data Tables to summarize how a change in one or two values affects other values in the model. Here, we do something similar. However, instead of showing the changed values in a table of results we show a number of possible variations individually as different worksheet scenarios. This method has the advantage of allowing the viewer to see the changes within the worksheet itself and is often useful if you have a small number of scenarios you want to work with or present.

The Scenario Manager is available from the same set of "What-If Analysis" tools that contain the Data Table. Click the "Data Tab" and choose the "Data Tools" group. Click the "What-If Analysis" drop-down and select "Scenario Manager…"





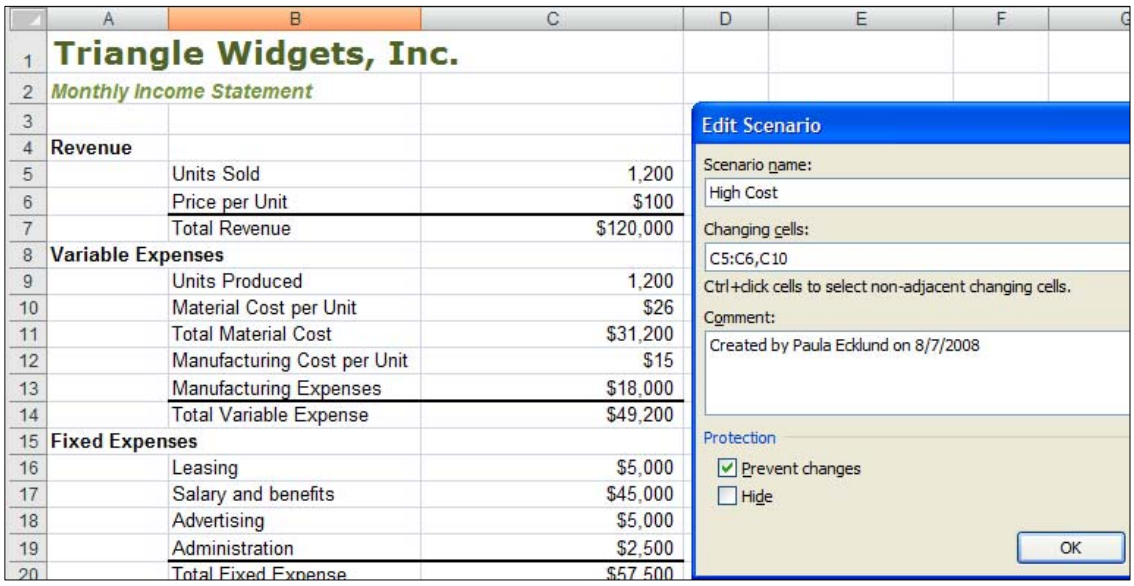
Excel opens the "Scenario Manager" dialog. The dialog initially looks like the one at left. No scenarios currently are defined.

We create three new scenarios: **Low Cost**, **Competitive**, and **High Cost**. In addition, for convenience, I'll add a scenario named **Status Quo** that shows the original model values.

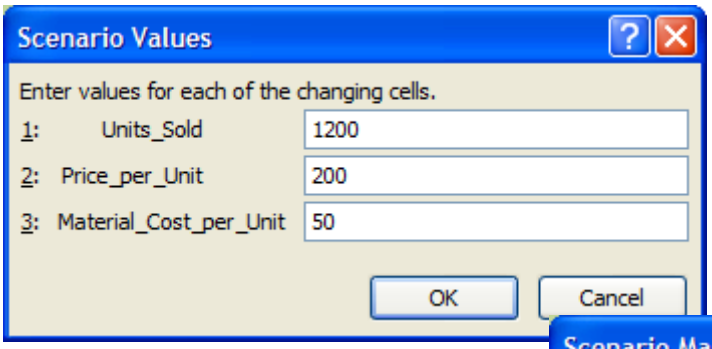
Once the scenarios are built we can use the manager to view any scenario by itself and/or generate a summary that compares the scenarios.

To create a scenario:

1) Click the *Add…* button on the "Scenario Manager" dialog. The "Edit Scenario" dialog opens.
2) Complete the "Edit Scenario" dialog. In the example below, we build a scenario named "High Cost" and elect in this scenario to change the cells C5, C6, and C10. In the model those are the "Units Sold", "Price per Unit", and "Material Cost per Unit" cells.
3) Click *OK*.

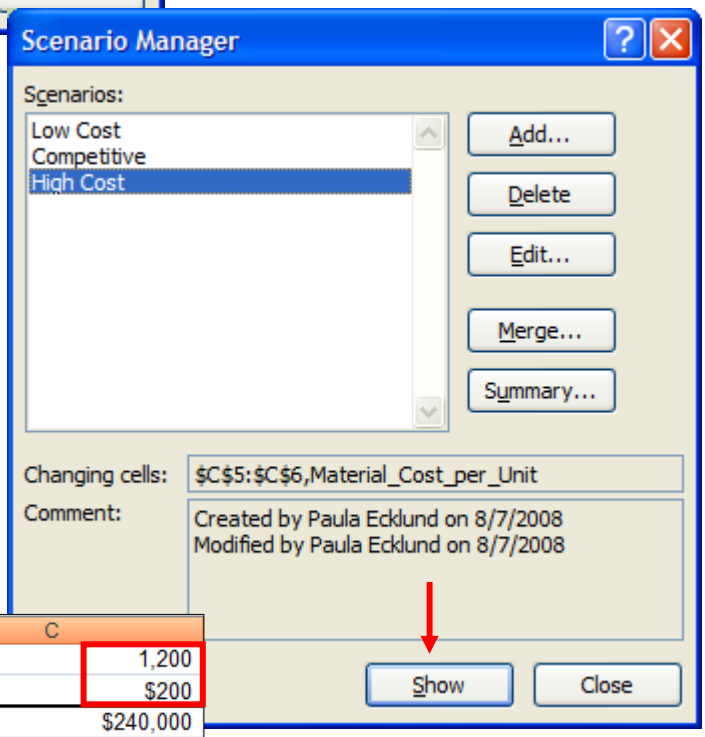


4) Excel displays a "Scenario Values" dialog and prompts for values for each of the model cells identified as changing cells. If these cells are range-named, Excel uses the names in the dialog, making it much easier to work with the scenario.



"High Cost" values are s shown in the illustration at left.

5) Click *OK* to return to the "Scenario Manager" dialog. From this dialog additional scenarios can be added by going through the same steps, beginning with clicking the *Add…* button. Add as many scenarios as you like.
6) To display a scenario, return to the "Scenario Manager" dialog, select a scenario by name, and click the *Show* button at the bottom of the dialog.



	A	B	C
5		Units Sold	1,200
6		Price per Unit	$200
7		Total Revenue	$240,000
8	**Variable Expenses**		
9		Units Produced	1,200
10		Material Cost per Unit	$50
11		Total Material Cost	$60,000
12		Manufacturing Cost per Unit	$15
13		Manufacturing Expenses	$18,000
14		Total Variable Expense	$78,000
15	**Fixed Expenses**		
16		Leasing	$5,000
17		Salary and benefits	$45,000
18		Advertising	$5,000
19		Administration	$2,500
20		Total Fixed Expense	$57,500
21	***Summary***		
22		*Total Expenses*	***$135,500***
23		*Operating Income*	***$104,500***

The cells in red at left are identified as changing cells.

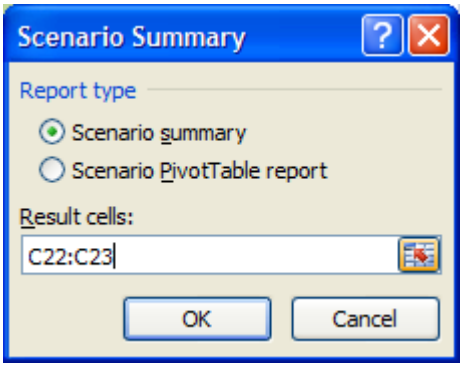
Excel substitutes into the model the values you established for the scenario you selected. You see the changes and their effects in the context of the *entire model*. This is very different from the looking at a Data Table results area, for example.

Show a different scenario by selecting its name in the "Scenario Manager" dialog. Put the "Scenario Manager" dialog away by clicking its *Close* button.

The scenarios you build are automatically saved when you save your workbook. You can call them up to view or edit at any time.

7) Generate a summary of the various scenarios you've built by clicking the *Summary…* button on the "Scenario Manager" dialog.

8) Excel opens a "Scenario Summary" dialog that prompts for the type of report (summary or PivotTable) and "result cells". Result cells are cells you want the summary report to track. In the illustration below, we track "Total Expenses" (Cell C22) and "Operating Income" (C23).



9) Click *OK*. Excel inserts a new worksheet into the workbook and gives it the name "Scenario Summary" The summary devotes one column to each of the scenarios ("Low Cost", "Competitive", and "High Cost") and one column to document the model's original values ("Current Values"). The values for cells identified as scenario changing cells are shown, as are values under each scenario for the result cells identified when building the summary. Use the outline symbols to display just the changing cells, just the result cells, or both.

The summary below shows that the "Low Cost" scenario would result in a negative value for Operating Income and, not surprisingly, the "High Cost" scenario would generate the highest profit.

Scenario Summary	Current Values:	Low Cost	Competitive	High Cost
Changing Cells:				
Units_Sold	1,200	1,200	1,200	1,200
Price_per_Unit	$200	$50	$90	$200
Material_Cost_per_Unit	$50	$20	$24	$50
Result Cells:				
Total_Expenses	$135,500	$99,500	$104,300	$135,500
Operating_Income	$104,500	($39,500)	$3,700	$104,500

Notes: Current Values column represents values of changing cells at time Scenario Summary Report was created. Changing cells for each scenario are highlighted in gray.

►Goal Seek

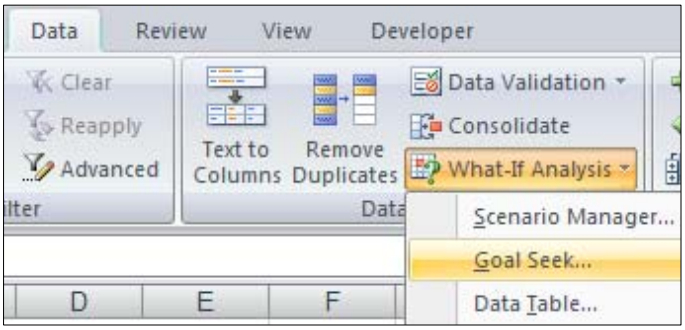
When you know the result you want from a single formula but not the input value the formula needs to determine that result, use Excel's Goal Seek. When goal seeking, Excel varies the value in the cell you specify until a formula that's dependent on that cell returns the result you want.

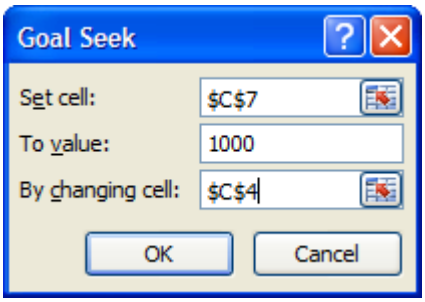
This example is from the "Goal Seek" tab in the ForecastingTools2007.xlsm workbook. In that worksheet a small model uses Excel's PMT function to calculate the monthly repayment cost for a loan of $100,000 over 15 years (180 months) at 5% interest. The monthly payment is $790.79.

	A	B	C	D	E
1	**Loan Repayment: Goal Seek Example**				
2					
3					
4		**Loan Amount**	**$100,000**		
5		**Term in Months**	**180**		
6		**Interest Rate**	**5.00%**		
7		**Payment**	**$790.79**		
8					

Suppose the borrower can afford to pay *more* per month on the loan. They want to see how much larger a loan they can afford at a repayment rate of $1,000 per month. Use Goal Seek and identify the "Loan Amount" (Cell C4) as the value that Goal Seek can change. Excel changes this value in the model until the payment value in C7 equals $1,000.

To open the "Goal Seek" dialog, click the "Data" tab and find the "Data Tools" group. Choose the "What-If Analysis" button and select *Goal Seek…* from the drop-down that displays.



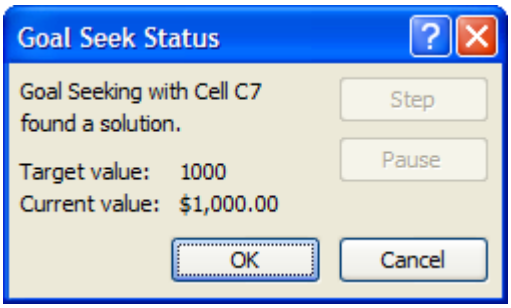


A "Goal Seek" dialog opens. Identify the "set cell", or the cell whose value you know you want to change. The "set cell" must hold a formula. In the "to value" box enter the value you want the formula to return. In the "by changing cell" identify one model cell that affects the formula you identified and that holds a value you will allow Goal Seek to change.

Click *OK*.

Goal seek goes to work and if it finds a solution it displays a "Goal Seek Status" dialog with its results.

To keep the results click *OK*. To discard the results click *Cancel*.



	A	B	C
1	**Loan Repayment: Goal Seek E**		
2			
3			
4		**Loan Amount**	**$126,455**
5		**Term in Months**	**180**
6		**Interest Rate**	**5.00%**
7		**Payment**	**$1,000.00**
8			

In this example, Goal Seek has found that the borrower can add $26,455 to the loan amount.

►Solver

Excel's Solver is a powerful tool for forecasting and what-if analysis. For an example of Solver we use the data on the "Solver" worksheet in the Forecasting Tools2007.xlsm workbook. Start by taking a look at that worksheet.

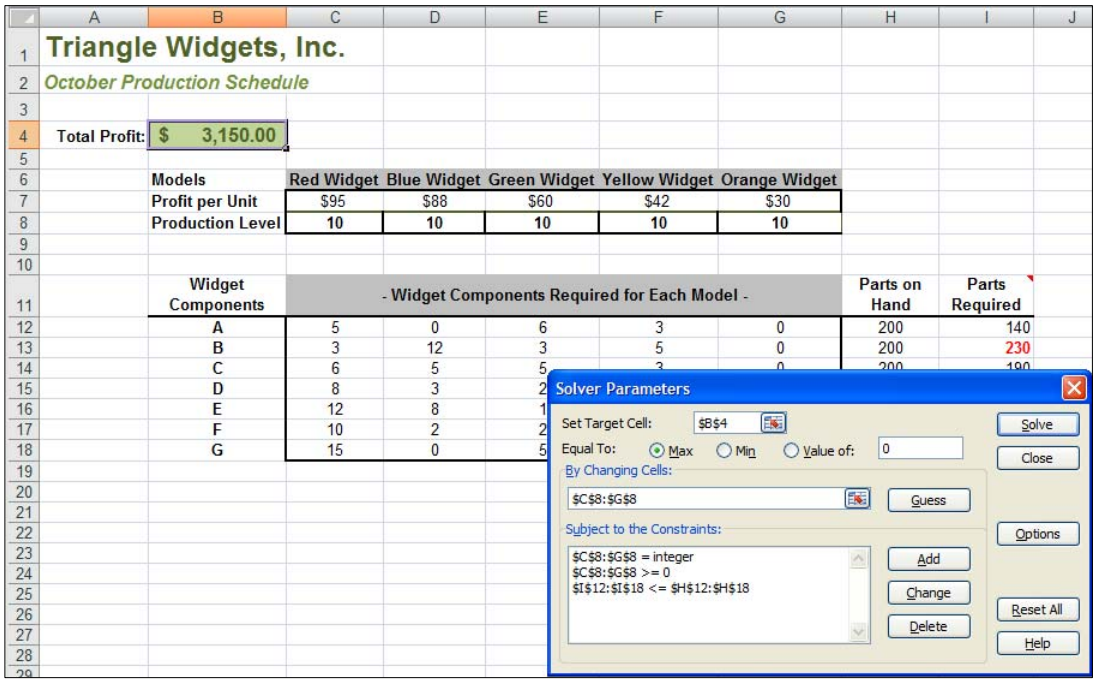
	A	B	C	D	E	F	G	H	I
1	**Triangle Widgets, Inc.**								
2	*October Production Schedule*								
3									
4	**Total Profit:**	**$ 3,150.00**							
5									
6		**Models**	**Red Widget**	**Blue Widget**	**Green Widget**	**Yellow Widget**	**Orange Widget**		
7		**Profit per Unit**	$95	$88	$60	$42	$30		
8		**Production Level**	**10**	**10**	**10**	**10**	**10**		
9									
10									
11		**Widget Components**	**- Widget Components Required for Each Model -**					**Parts on Hand**	**Parts Required**
12		**A**	5	0	6	3	0	200	140
13		**B**	3	12	3	5	0	200	230
14		**C**	6	5	5	3	0	200	190
15		**D**	8	3	2	3	1	200	170
16		**E**	12	8	1	0	3	200	240
17		**F**	10	2	2	0	2	200	160
18		**G**	15	0	5	0	0	200	200
19									

The worksheet shows the five different widget models that Triangle Widgets makes (Red, Blue, etc. in Row 6) along with the profit per unit for each model (Row 7), and the production levels for October (Row 8, 10 for each type). An Excel SUMPRODUCT formula in Cell B4 near the top of the worksheet calculates the Total Profit that will be generated by the current production levels.

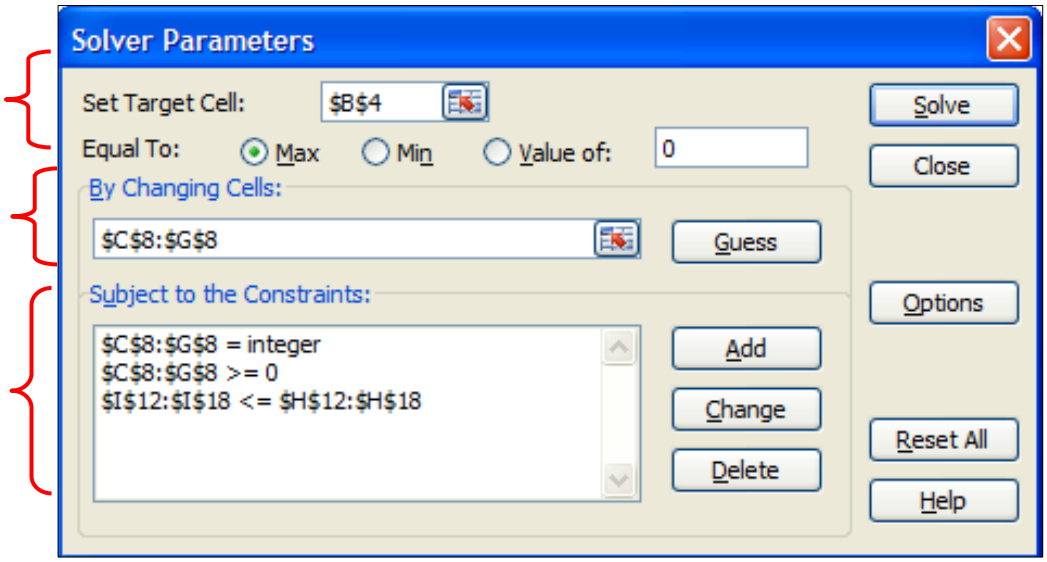
As written, however, there's a problem with the values in this model. In the section of the worksheet that details widget components are two columns that track the number of widget parts required for the current level of production: "**Parts Required**" and "**Parts on Hand**". At the production levels currently in the model -- 10 widgets of each type -- the company has exceeded parts-on-hand quantities for components B (by 30) and E (by 40). So the Production Level values in the model show an impossible scenario. Although the model shows a Total Profit of $3,150.00, it's at the expense of the reality in the factory.

To change the Production Level values to get the highest possible Total Profit without violating any of the Parts on Hand and Parts Required constraints, one could change the five Production Level values in the model manually. This would require experimenting with different combinations until a combination that maximizes profit is found, while keeping within the constraints. Unfortunately, to be *sure* to maximize profits this experimental, manual process could take quite a bit of time. In a large problem, a manual method might prove to be simply impractical.

As an alternative to a manual method, Excel's Solver tool can maximize total profit in this model, quickly finding the best solution. Solver is an Excel add-in that's part of the Excel program. That is, when you purchase Excel, you get Solver automatically (whether or not it's actually installed). If installed, Solver appears on Excel 2007's "Data" tab in the "Analysis" group. Start Solver and the "Solver Parameters" dialog opens.



The "Solver Parameters" dialog shown below has already been completed for the Triangle Widgets model. Notice that there are three main segments in this dialog box. They define the "set" cell, the changing cells, and any constraints.



The "Set" Cell or Target

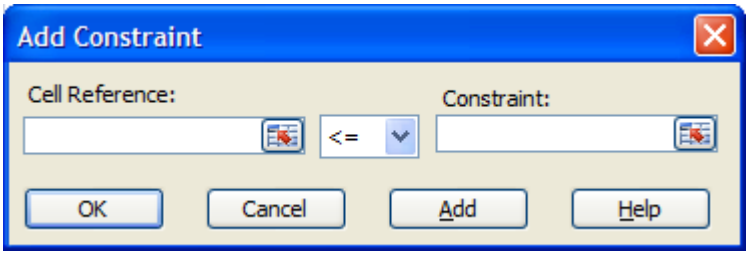
Begin with the "set" cell or target cell. In our example, the target is Total Profit, in Cell B4. To maximize total profit click the "Max" option. Solver can also minimize or find a particular value (like Goal Seek).

The Changing Cells

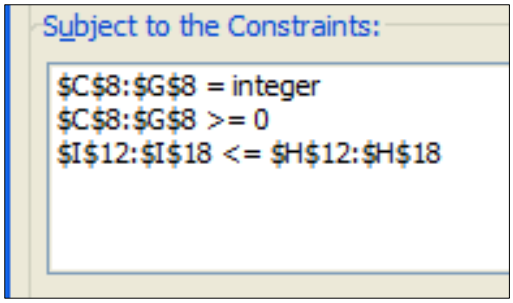
Identify the model cells that Solver can change to find its solution. The changing cells should be related to the target cell, of course. In our example, the changing cells are the number of widgets to make, or the Production Level values. The changing cells need not be contiguous in the worksheet and there can be any number of changing cells.

Constraints

Finally, identify any constraints Solver should take into account when finding a solution. Although it appears that there's a text box in which to enter constraints, that's not the case. To enter a constraint, click inside the "Subject to the Constraints" box and click the *Add* button. Solver then displays a special mini-dialog in which to enter the constraint in the correct format.



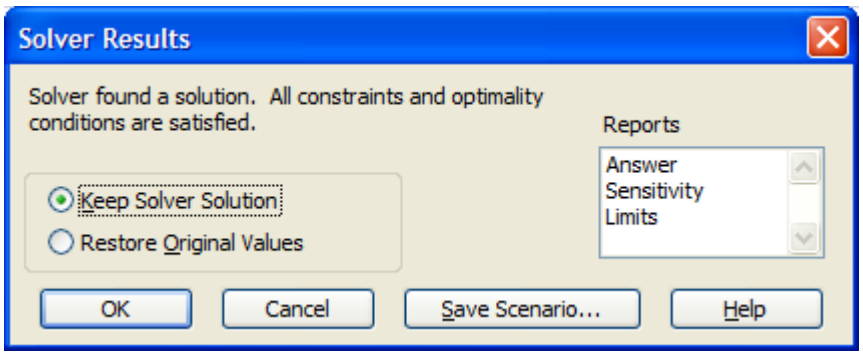
This problem has three constraints identified:



1) The Production Level values must be greater than or equal to zero. E.g., not negative production.
2) The Parts Required range values are less than or equal to the Parts on Hand range.
3) The Production Level values must be integers. No fractional widgets.

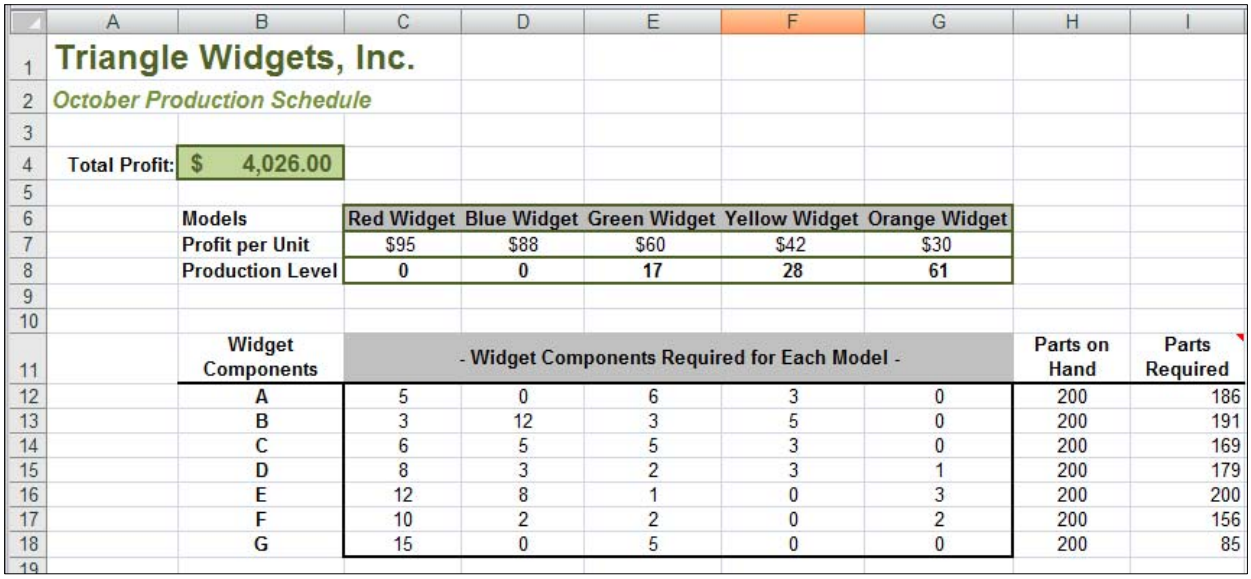
Click the *Solve* button to start the solving process.

While Solver may not be able to find a solution for *every* problem, in most cases, Solver finds a solution and returns with a dialog that looks like the below:



Solver's solution (changed values in the "changing cells") appears in the model. Choose *Keep Solver Solution* and click *OK* here to keep the Solver solution in the worksheet, or choose *Restore Original Values* and click *OK* to discard the Solver solution. Note that you can choose to generate one or more of Solver's reports (Answer, Sensitivity, Limits) and/or to apply the Scenario Manager to record the Solver's solution.

The model with Solver's solution in place looks like this:



Triangle Widgets, Inc.

October Production Schedule

Total Profit:	$ 4,026.00

Models	Red Widget	Blue Widget	Green Widget	Yellow Widget	Orange Widget
Profit per Unit	$95	$88	$60	$42	$30
Production Level	0	0	17	28	61

Widget Components	- Widget Components Required for Each Model -					Parts on Hand	Parts Required
A	5	0	6	3	0	200	186
B	3	12	3	5	0	200	191
C	6	5	5	3	0	200	169
D	8	3	2	3	1	200	179
E	12	8	1	0	3	200	200
F	10	2	2	0	2	200	156
G	15	0	5	0	0	200	85

Solver found a reasonable maximum total profit by eliminating the red and blue widgets from the production schedule and adjusting the production levels of the three other widget types considerably.

Note that Solver respected the constraints we defined:

No production level is less than zero.

The values in the Parts Required column are less than or equal to the Parts on Hand values.

All the production level recommendations are for integer quantities.

End