K2's Road to Excellence Power Excel – Session 1 Analysis

This session will introduce you to tools for organizing, managing, and manipulating data. All too often, end-users rely on manual processes and techniques for these activities, notwithstanding the fact that Excel provides a terrific toolbox to assist in these efforts. With the Watch Window, *Scenario Manager*, *Goal Seek Forecast*, Break Analysis and *Solver at* your disposal, you have tremendous opportunities to improve your productivity when working with datasets of any size in Excel.

Table of Contents

Watch Window

Have you ever changed assumptions in a workbook and then rearranged the workbook or worksheets to view the impact of the change on some calculation of interest, only to change the assumptions again and again, each time rearranging the workbook to view the results? The **Watch Window** allows users to view in the current window the changes in other cells resulting from changes in assumptions. In fact, the Watch Window allows users to track cell properties of every type (workbook, worksheet, defined name, cell, value, and formula), while the cells are out of view. Essentially, the Watch Window is a cell-management tool, providing users with information regarding selected cells in the current or other workbooks.

Click **Watch Window** on the **Formulas** tab of the Ribbon to open the Watch Window. In default, the Watch Window floats on the face of the worksheet, but it can be docked on any edge of the worksheet by dragging it to the desired location. Cells or ranges of cells can be added to the Watch Window by highlighting the cells of interest and clicking **Add Watch** as shown in **Figure 1**.

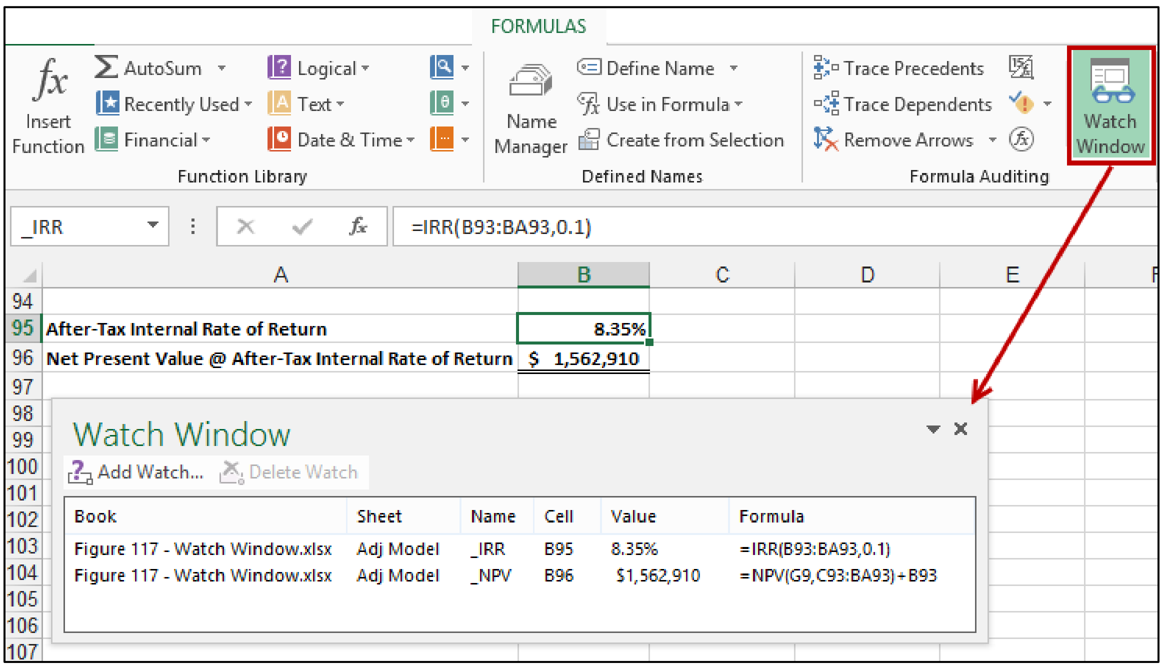


Figure 1 - Using the Watch Window to Observe Changes to Cells

Defined watches are saved when a workbook is saved so that they will be available the next time the workbook containing them is opened, even if the Watch Window has been closed prior to saving the workbook.

Working with Excel's Goal Seek Function

Excel's **Goal Seek** function is a tool that allows users to "back-in" to the value needed in a variable to produce a specific result. In other words, use Goal Seek when you already know what the answer is – or should be – and just need identify the value in a specific variable that will produce the intended result.

In the following example, suppose Greg Adams, a budget analyst at GTM Manufacturing, has the responsibility of determining what level of sales revenue is needed to provide gross profit of $6 million for the upcoming fiscal year. Greg knows that GTM's gross profit percentage averages 29%, so he could simply divide $6 million by 29% to arrive at the necessary sales revenue of $20,689,655. Greg could also use Goal Seek to solve this problem.

Using Goal Seek, Greg might construct a model similar to that shown in **Figure 2**.

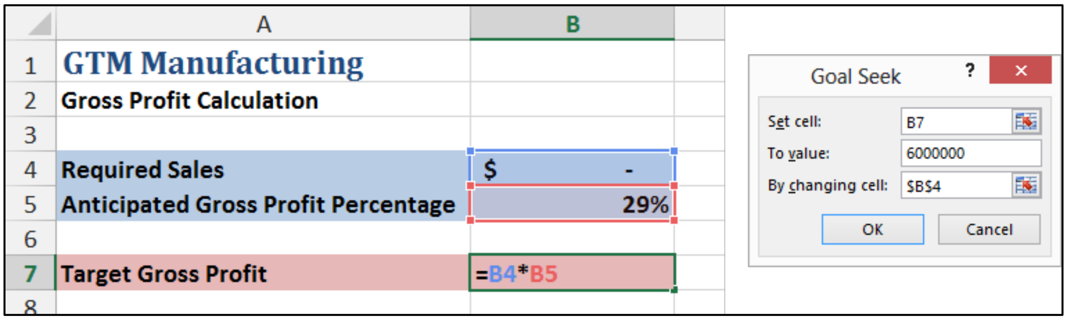


Figure 2 - Goal Seek Model

When Greg constructs this model, he would access the **Goal Seek** dialog box by choosing **What-If Analysis** from the **Data** tab and selecting **Goal Seek**. Upon entering the information shown in **Figure 2,** Greg clicks **OK** in Goal Seek dialog box. Upon doing so, Goal Seek calculates the result and displays it as shown in **Figure 3**.

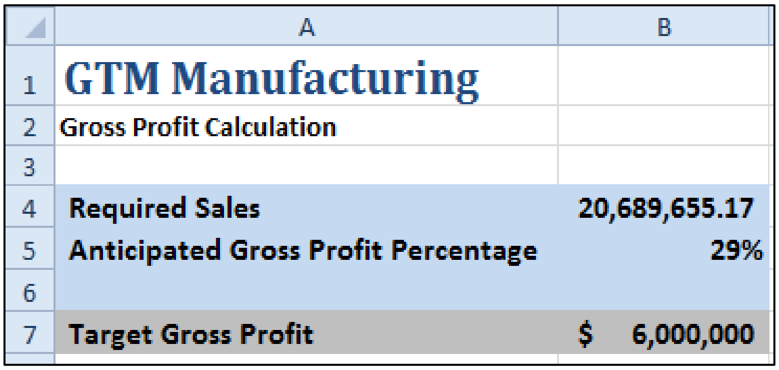


Figure 3 - Completed Goal Seek Calculation

Of course, rarely are the calculations required in preparing budgeting and forecasting models as simple as the one required by Greg in the previous example. Consequently, a more complex example is in order. In the next example, John Adams, the Chair of the School of Accountancy at State University, proposes to establish an endowed professorship at the school to teach Applied Technology to Accounting majors at the school. In considering the expected rate of return on the endowment, a professor's initial annual salary, and annual cost of living and merit raises, Adams is attempting to determine the level of fundraising required to endow the professorship for a term of thirty years.

After performing due diligence, Adams makes the following initial estimates regarding variables affecting the endowment.

Expected Annual Investment Earnings Rate	*7.5%*
Expected Annual Cost of Living and Merit Raises	*4.5%*
Expected Initial Salary	*$160,000*

To begin the process, Adams creates a schedule, a portion of which is shown in **Figure 4**. As shown there, if the professorship were endowed at $1 million, it would run out of money by year 8.

State University
Endowed Professorship Calculation

Endowment Necessary	$ 1,000,000		**Year**	**Beginning Balance**	**Annual Salary**	**Investment Earnings**	**Ending Balance**
Expected Annual Investment Earnings Rate	7.50%		1	$ 1,000,000	$160,000	$ 75,000	$ 915,000
Expected Annual Cost of Living and Merit Raises	4.50%		2	$ 915,000	$167,200	$ 68,625	$ 816,425
Expected Initial Salary	$ 160,000		3	$ 816,425	$174,724	$ 61,232	$ 702,933
			4	$ 702,933	$182,587	$ 52,720	$ 573,066
			5	$ 573,066	$190,803	$ 42,980	$ 425,243
			6	$ 425,243	$199,389	$ 31,893	$ 257,747
			7	$ 257,747	$208,362	$ 19,331	$ 68,717
			8	$ 68,717	$217,738	$ 5,154	$ (143,867)

Figure 4 - Proposed Endowment Schedule for State University

Adams returns to the model and opens the Goal Seek dialog box. There, he uses Goal Seek to solve the equation by setting cell H34 (the ending balance for year 30) to **0** by changing the value in cell B4 (the beginning balance in the endowment) as shown in **Figure 5**. Once Adams establishes these parameters and clicks OK, Goal Seek approximates the amount required in the endowment at $3,051,764[1]. Note that the answer is approximate because, by default, Excel only runs 100 iterations in an attempt to find the correct answer. If Adams required a greater degree of precision, he could adjust the number of iterations for the workbook in Excel's **Formula Options**. Additionally, rounding functions in the workbook also cause the calculation to be less accurate than is otherwise possible.

[1] Those familiar with Excel's financial functions could also solve this problem by using Excel's PV function.

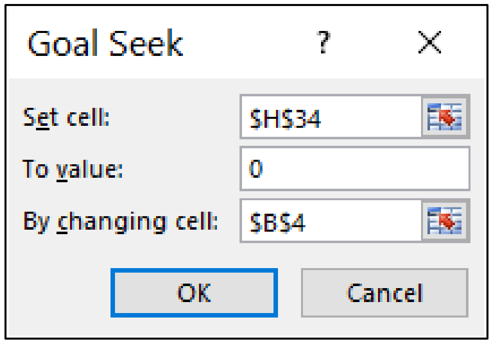


Figure 5 - Establishing Goal Seek Parameters for Calculating Required Initial Endowment

While some avoid using Goal Seek because it is capable of solving equations with one variable only, as demonstrated above, the usefulness of Goal Seek is not limited to only simple "what-if" problems. Nonetheless, when requiring functionality in Excel to assist in solving multivariable problems, Excel's **Solver** function is a better tool.

Managing Different Sets of Assumptions with Scenario Manager

Scenario Manager is a feature in Excel that provides users with the ability to see results under different sets of assumptions without needing to create multiple versions of worksheets or workbooks. In Scenario Manager, users specify the variable(s) to be changed and what the changes are. Then, whenever results are to be displayed based on a particular set of assumptions, Scenario Manager automatically recalls the assumptions and inserts them into the spreadsheet.

To illustrate how Scenario Manager works, consider the budget assumptions shown in **Table 1** for three different sets of circumstances.

	Best Case	Most Likely Case	Worst Case
A/R Collection Period	34	37	43
Days Sales In Inventory	18	24	36
Days Purchases In A/P	27	34	45
Gross Profit Percentage	49%	47%	43%
Interest Rate On Line Of Credit	5%	6%	8%
Total Sales	$900,000	$800,000	$700,000
Wages	$195,000	$200,000	$225,000

Table 1 - Scenario Manager Assumptions

Each of the assumptions associated with each set of circumstances can be loaded and saved under Scenario Manager by selecting **Data**, **What If Analysis,** and **Scenario Manager** from the Ribbon and clicking the **Add** button. In the **Add Scenario** dialog box shown in **Figure 6**, enter a name for the scenario, the cells to be changed, and any desired comments. Clicking the **OK** button advances users to the **Scenario Values** dialog box shown in **Figure 7**.

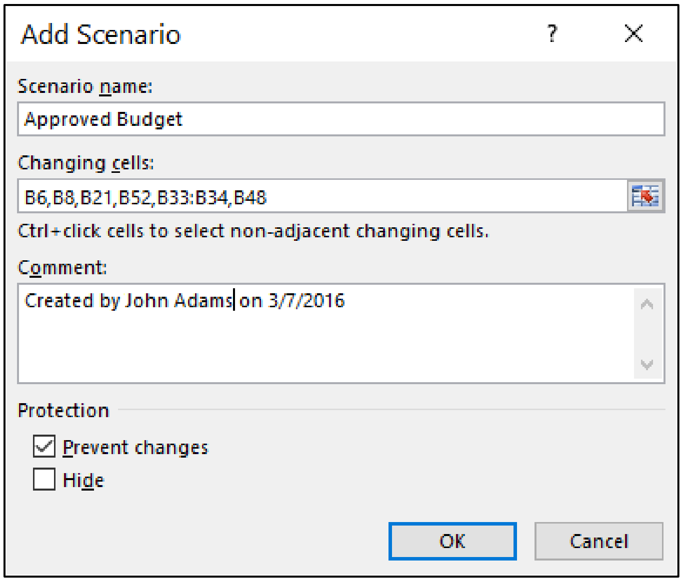


Figure 6 – Adding Scenario Dialog Box

In the **Scenario Values** dialog box, the values to be associated with each variable being changed under the scenario are entered. Once all values have been entered, click **OK** to save the data.

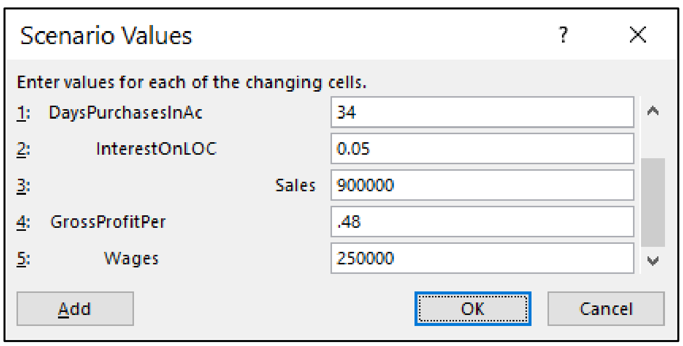


Figure 7 - Scenario Values Dialog Box

To see the results of a particular scenario, simply double-click the desired scenario in the Scenario Manger dialog box. At that point, the cell values associated with each variable identified in Scenario Manager are changed to reflect the values for that scenario. This effectively allows users to track multiple versions of the same budget. Further, Scenario Manager allows users to generate a Scenario Summary report showing the impact of changing the variables under each Scenario on selected “Result Cells.” **Figure 8** displays an example of one such report.

Scenario Summary	Current Values:	Most Likely Case	Worst Case	Best Case	Approved Budget
Changing Cells:					
ARCollectionPeriod	37	37	43	34	42
DaysSalesInInventory	24	24	36	18	24
DaysPurchasesInAccountsPayable	34	34	45	27	34
InterestOnLOC	0%	0%	0%	0%	0%
Sales	800,000	800,000	700,000	900,000	900,000
GrossProfitPerCent	0%	0%	0%	0%	0%
Wages	200,000	200,000	225,000	195,000	250,000
Result Cells:					
JanuaryNetIncome	42,846	42,846	(52,122)	90,346	43,408
JanuaryEndingCash	(97,222)	(97,222)	(94,491)	(82,203)	(309,433)

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.

Figure 8 - Scenario Summary Report

Using Solver to Maximize Resources

One of the key considerations for anyone involved in preparing revenue forecasts is to maximize profits, given available resources and operational and financial constraints. Constraints on profitability may take the form of distribution restrictions, production capacity limits, scarce inventory, or shortages of working capital caused by growth in accounts receivable or inventory. Whatever the nature of the constraints, it is the goal of every financial manager to find solutions that maximize the value of the organization. Excel's Solver add-in can assist in that process.

Solver is used to find optimal solutions to *linear programming models*. For example, Solver can be used to maximize gross profits by calculating the optimal mix of products sold, to minimize interest expense by finding an optimal capital structure for the company, or to maximize production output by calculating the most efficient production runs. Solver optimizes a value in one cell of a workbook by adjusting various input cells, subject to user-specified constraints placed on the input cells.

In this example, the CFO of a medical technology lab seeks to maximize the gross profit generated by a piece of testing equipment. The equipment can perform three different tasks, each with different billing rates, marginal costs, and gross profits. Further, the maximum number of units that can be sold of each procedure varies. **Table 2** displays the relevant data.

	Task A	Task B	Task C
Billing Rate	$350	$250	**$200**
Marginal Cost	$175	$50	**$100**
Gross Profit Per Unit Sold	$175	$200	**$100**
Max Number Of Sales Per Year	**500 minus 1/2 of the instances of Tasks B and C sold for the year**	**500 minus 1/2 of the instances of Task C sold for the year**	**500**

Table 2 - Relevant Data for a Solver Equation

In addition to the data presented in Table 5, no more than 750 procedures in total can be sold during the year, and a minimum of 50 units of each procedure must be sold. Given these constraints, the CFO must calculate the optimal mix of sales units of each task in order to maximize overall gross profit. Using Solver, a solution for this complex revenue maximization model can be calculated in short order.

First, build the basic structure of the worksheet as shown in **Figure 8**. The second panel in the figure displays the underlying formulas.

	A	B	C	D	E	F
1		Task A	Task B	Task C		
2	Maximum Number Available	450	475	500	Total Sold Cannot Exceed	750
3	Billing Rate	$ 350.00	$ 250.00	$ 200.00		
4	Marginal Cost	$ 175.00	$ 50.00	$ 100.00		
5	Gross Profit Per Unit	$ 175.00	$ 200.00	$ 100.00		
6	Number Sold	50	50	50	Total Sold	150
7	Total Gross Profit	$ 8,750	$ 10,000	$ 5,000	Total Gross Profit	$ 23,750

	A	B	C	D	E	F
1		Task A	Task B	Task C		
2	Maximum Number Available	=500-(0.5*(D6+C6))	=500-(0.5*D6)	500	Total Sold Cannot Exceed	750
3	Billing Rate	350	250	200		
4	Marginal Cost	175	50	100		
5	Gross Profit Per Unit	=B3-B4	=C3-C4	=D3-D4		
6	Number Sold	50	50	50	Total Sold	=SUM(B6:D6)
7	Total Gross Profit	=B5*B6	=C5*C6	=D5*D6	Total Gross Profit	=SUM(B7:D7)

Figure 9 - Constructing a Worksheet with the Appropriate Structure and Formulas

To begin the process of finding a solution, click **Solver** on the **Data** tab to open the **Solver Parameters** dialog box as shown in **Figure 10**. In the **Solver Parameters** dialog box, specify the target cell to be optimized, in this case cell F7. The variable cells to be adjusted include the range of cells B6:D6. The relevant constraints are described in the table above. Click the **Solve** button, and **Solver** will attempt to find a solution based on the input cells and constraints identified. When the results are calculated, select **Keep Solver Solution** in the **Solver Results** dialog box and click **OK**.

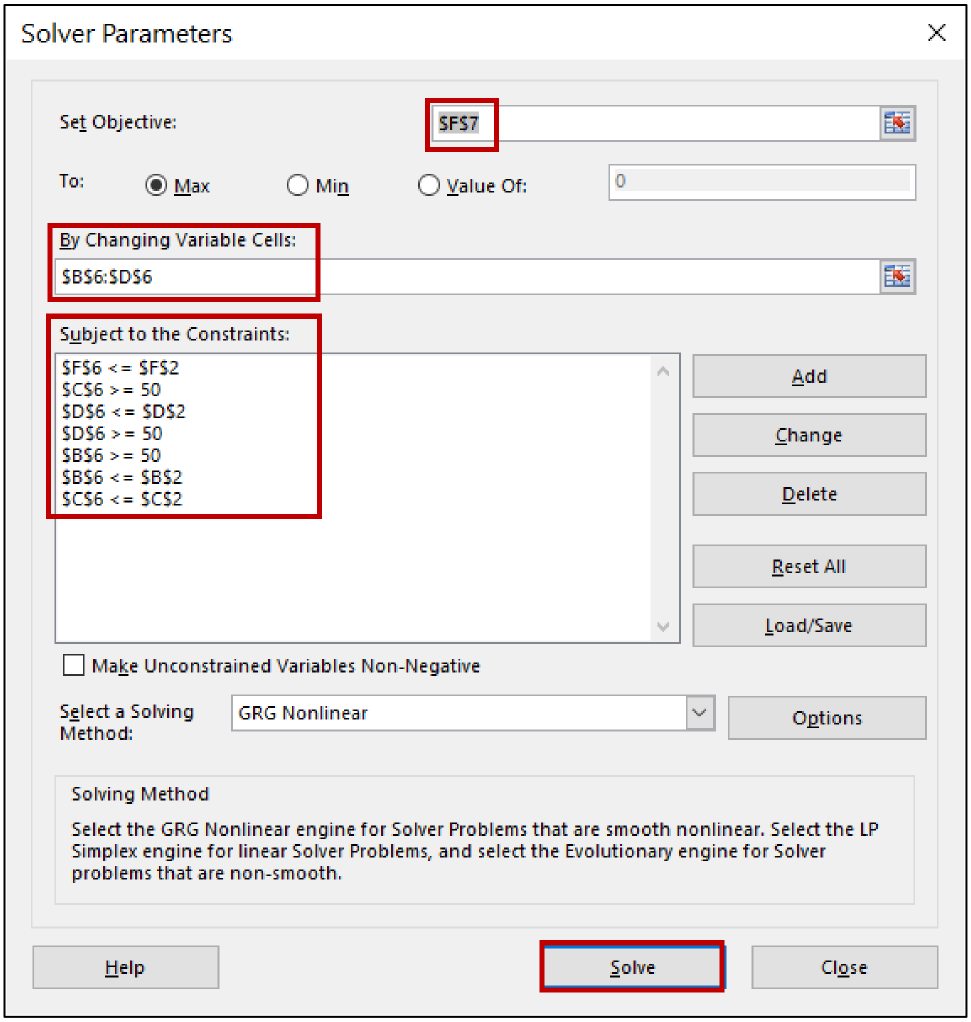


Figure 10 - Specifying the Parameters for a Solver Optimization

The solution suggested by Solver is presented in **Figure 11**. Maximum profits are generated when 225 units of Task A, 475 units of Task B, and 50 units of Task C are sold. Closer inspection reveals that at least 50 units of each task are sold, that the total number of all tasks being sold is less than or equal to 750 units, and that the number of units of each task sold is less than or equal to the maximum number available.

	A	B	C	D	E	F
1		Task A	Task B	Task C		
2	Maximum Number Available	238	475	500	Total Sold Cannot Exceed	750
3	Billing Rate	$ 350.00	$ 250.00	$ 200.00		
4	Marginal Cost	$ 175.00	$ 50.00	$ 100.00		
5	Gross Profit Per Unit	$ 175.00	$ 200.00	$ 100.00		
6	Number Sold	225	475	50	Total Sold	750
7	Total Gross Profit	$ 39,375	$ 95,000	$ 5,000	Total Gross Profit	$ 139,375

Figure 11 - Results of Solver Produced Profit Maximization

In addition to the computational efficiency of Solver, users can benefit from its documentation features in the form of several reports. The **Solver Answer Report** is shown in **Figure 12**.

Microsoft Excel 15.0 Answer Report
Worksheet: [Figure 074 Through Figure 077 - Solver.xlsx]GP Maximization
Report Created: 3/10/2013 5:43:57 PM
Result: Solver found a solution. All Constraints and optimality conditions are satisfied.
Solver Engine
Engine: GRG Nonlinear
Solution Time: 0.016 Seconds.
Iterations: 0 Subproblems: 0
Solver Options
Max Time 100 sec, Iterations 100, Precision 0.000001
Convergence 0.0001, Population Size 100, Random Seed 0, Derivatives Forward, Require Bounds
Max Subproblems Unlimited, Max Integer Sols Unlimited, Integer Tolerance 5%, Solve Without Integer Constraints

Objective Cell (Max)

Cell	Name	Original Value	Final Value
$F$7	Total Gross Profit	$ 139,375	$ 139,375

Variable Cells

Cell	Name	Original Value	Final Value	Integer
$B$6	Number Sold Task A	225	225	Contin
$C$6	Number Sold Task B	475	475	Contin
$D$6	Number Sold Task C	50	50	Contin

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
$F$6	Total Sold	750	$F$6<=$F$2	Binding	0
$B$6	Number Sold Task A	225	$B$6<=$B$2	Not Binding	12.5
$C$6	Number Sold Task B	475	$C$6<=$C$2	Binding	0
$D$6	Number Sold Task C	50	$D$6>=50	Binding	-
$D$6	Number Sold Task C	50	$D$6<=$D$2	Not Binding	450
$C$6	Number Sold Task B	475	$C$6>=50	Not Binding	425
$B$6	Number Sold Task A	225	$B$6>=50	Not Binding	175

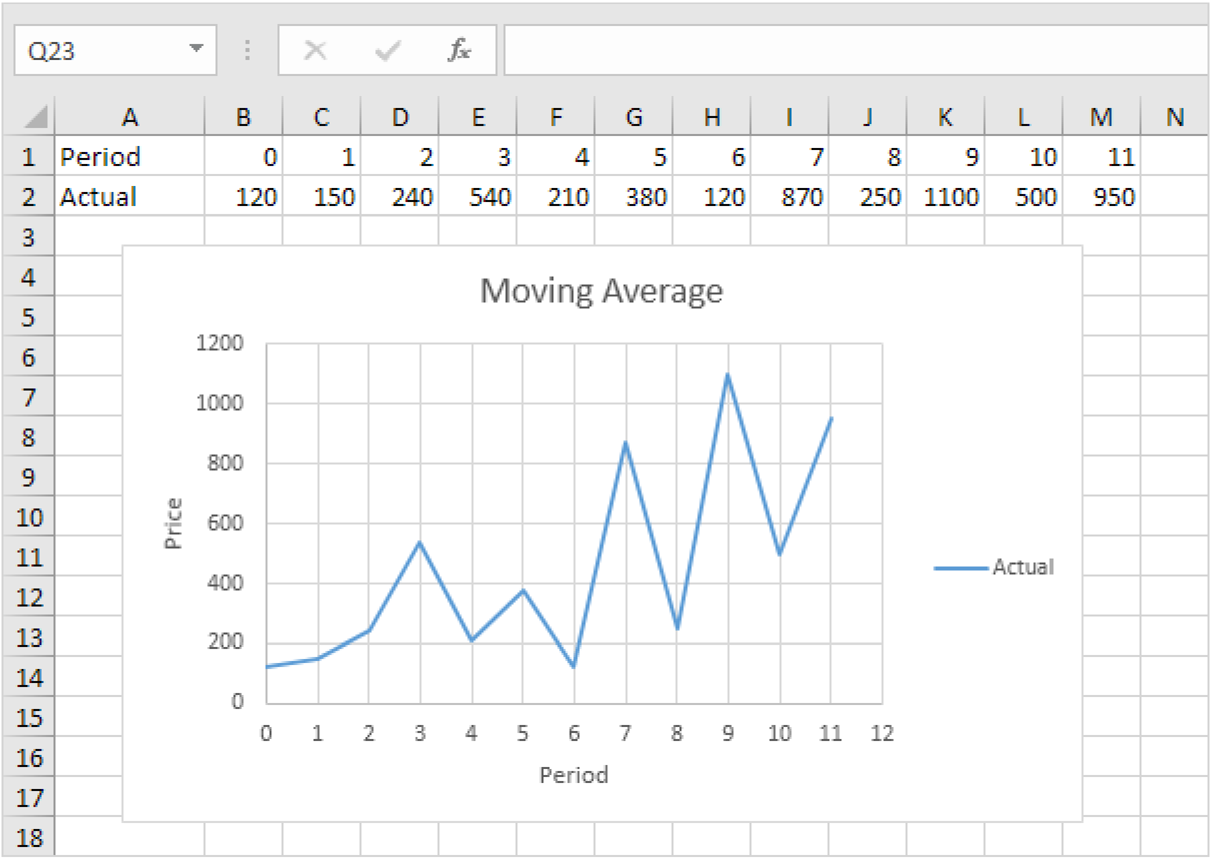
Figure12 - Answer Report Generated with a Solver Solution

In addition to Answer reports, Solver can also generate **Sensitivity Analysis** and **Limits** reports. Further, you can save Solver solutions as **Scenarios** to be recalled later in **Scenario Manager**.

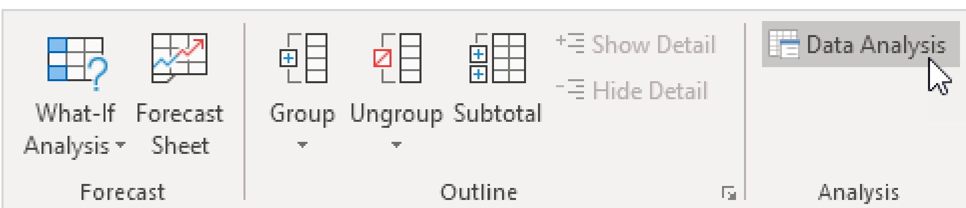
Moving Averages

This example teaches you how to calculate the moving average of a time series in Excel. A moving average is used to smooth out irregularities (peaks and valleys) to easily recognize trends.

1. First, let's take a look at our time series.

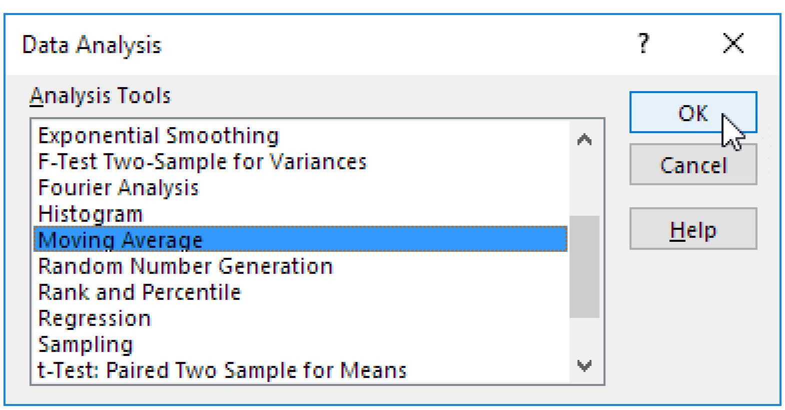


2. On the Data tab, in the Analysis group, click Data Analysis.



Note: can't find the Data Analysis button? Click here to load the [Analysis ToolPak add-in](#).

3. Select Moving Average and click OK.

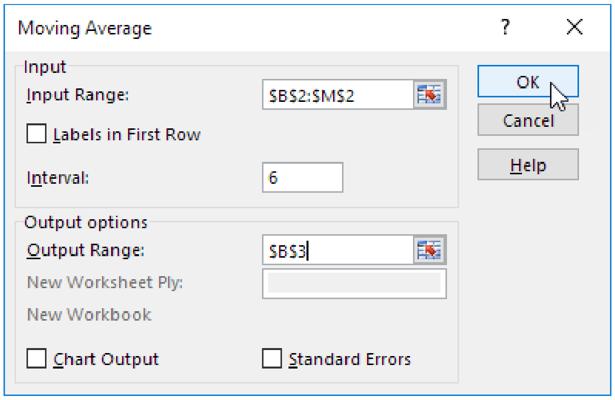


4. Click in the Input Range box and select the range B2:M2.

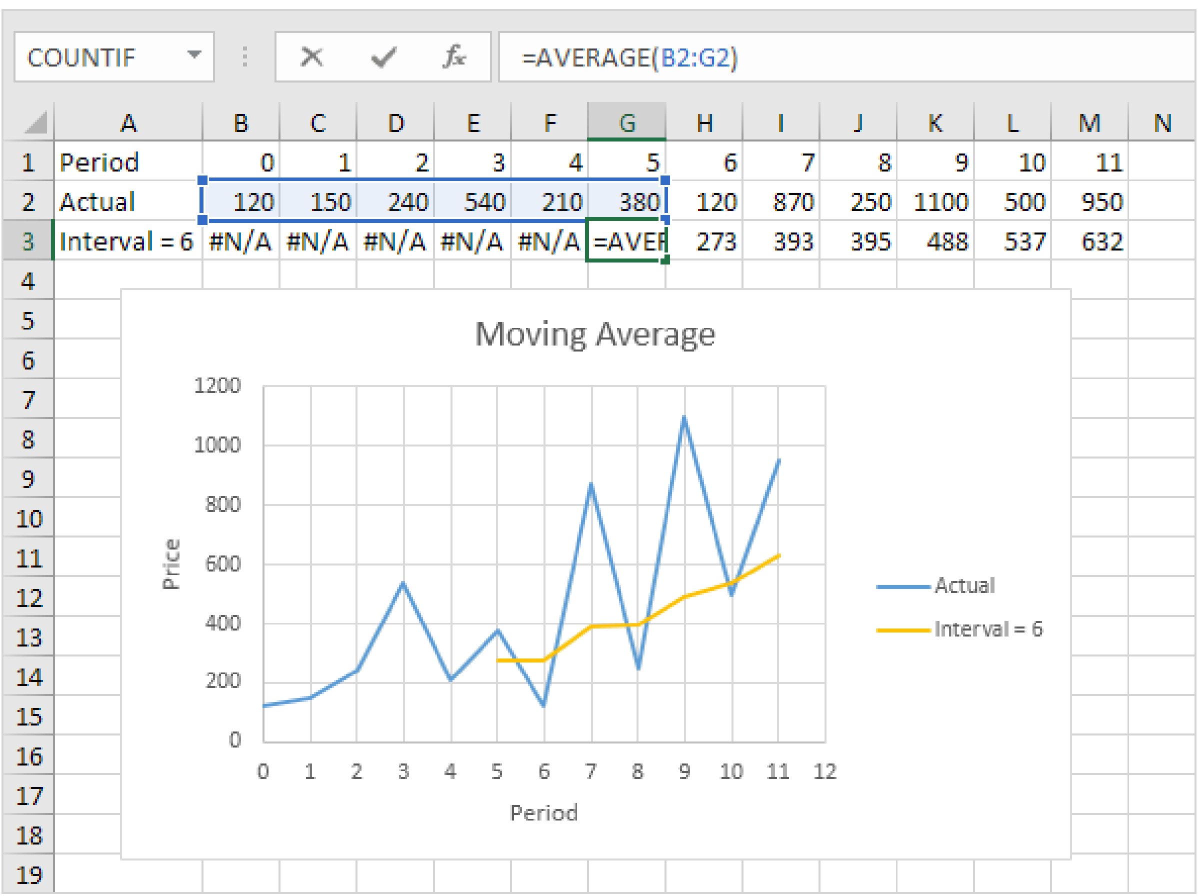
5. Click in the Interval box and type 6.

6. Click in the Output Range box and select cell B3.

7. Click OK.



8. Plot a graph of these values.

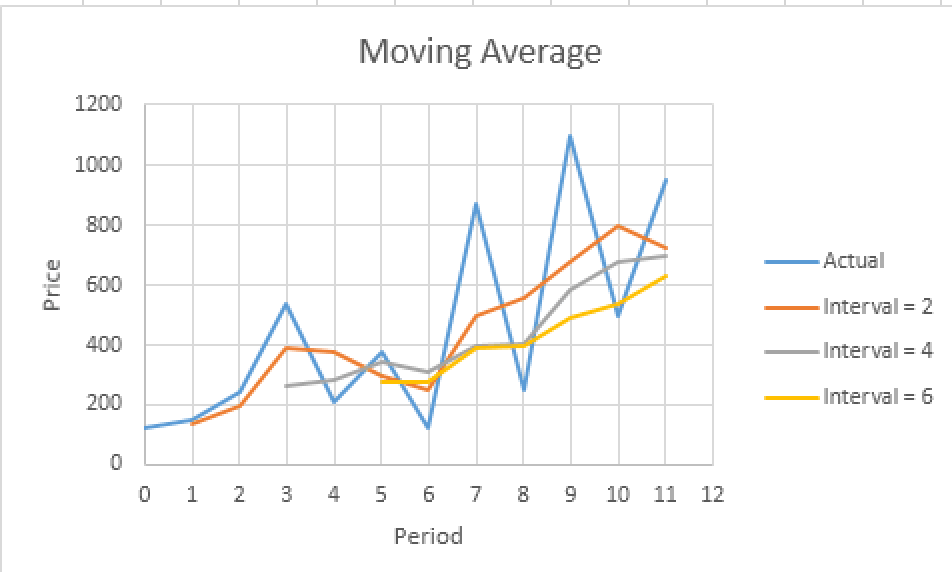


Explanation: because we set the interval to 6, the moving average is the average of the previous 5 data points and the current data point. As a result, peaks and valleys are smoothed out. The graph shows an increasing trend. Excel cannot calculate the moving average for the first 5 data points because there are not enough previous data points.

9. Repeat steps 2 to 8 for interval = 2 and interval = 4.

COUNTIF | =AVERAGE(B2:C2)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Period	0	1	2	3	4	5	6	7	8	9	10	11	
2	Actual	120	150	240	540	210	380	120	870	250	1100	500	950	
3	Interval = 2	#N/A	=AVEF	195	390	375	295	250	495	560	675	800	725	
4	Interval = 4	#N/A	#N/A	#N/A	263	285	343	313	395	405	585	680	700	
5	Interval = 6	#N/A	#N/A	#N/A	#N/A	#N/A	273	273	393	395	488	537	632	



Conclusion: The larger the interval, the more the peaks and valleys are smoothed out. The smaller the interval, the closer the moving averages are to the actual data points.