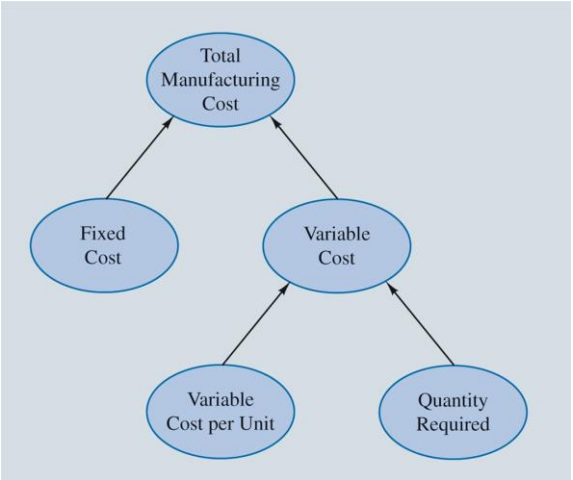
Building Good Spreadsheet models

Spreadsheet models are **mathematical** and **logic-based** models.

- Total cost of manufacturing a product is the sum of two costs:
  - Fixed cost
  - Variable cost
- **Make-versus-buy decision**: comparing the costs of manufacturing in-house to the costs of outsourcing production to another firm.
- An **influence diagram** is a visual representation that shows which entities influence others in a model.
- Parts of the model are represented by circular or oval symbols called *nodes*, and arrows connecting the nodes show influence.



Building Good Spreadsheet models

q = quantity (number of units) required.

FC = the fixed cost of manufacturing.

VC = the per-unit variable cost of manufacturing.

TMC(q) = total cost to manufacture 'q' units.

TPC (q) = total purchase cost for 'q' units.

S (q) = savings due to outsourcing

$$TMC(q) = FC + (VC \times q) \longrightarrow TMC(q) = \$234{,}000 + \$2q$$

$$TPC(q) = Pq \longrightarrow TPC(q) = \$3.5q$$

$$S(q) = TMC(q) - TPC(q)$$

Building Good Spreadsheet models

- *TMC*, *TPC*, and *S* are the functions of other components, whereas *q*, *FC*, *VC*, and *P* are not.
- *TMC*, *TPC*, and *S* will be formulas involving other cells in the spreadsheet model, whereas *q*, *FC*, *VC*, and *P* will just be entries in the spreadsheet.
- The number of Vipers to make or buy for next year is really a decision Nowlin gets to make, hence we refer to quantity *q* as a **decision variable.**
- *FC*, *VC*, and *P* are measurable factors that define characteristics of the process we are modelling; hence, we refer to *FC*, *VC*, and *P* as **parameters.**

	A	B	C
1	**Nowlin Plastics**		
2			
3	**Parameters**		
4	Manufacturing Fixed Cost	234000	
5	Manufacturing Variable Cost per Unit	2	
6			
7	Outsourcing Cost per Unit	3.5	
8			
9			
10	**Model**		
11	Quantity	10000	
12			
13	Total Cost to Produce	=B4+B11*B5	
14			
15	Total Cost to Outsource	=B7*B11	
16			
17	Savings due to Outsourcing	=B13–B15	
18			
19			

MODEL *file*
Nowlin

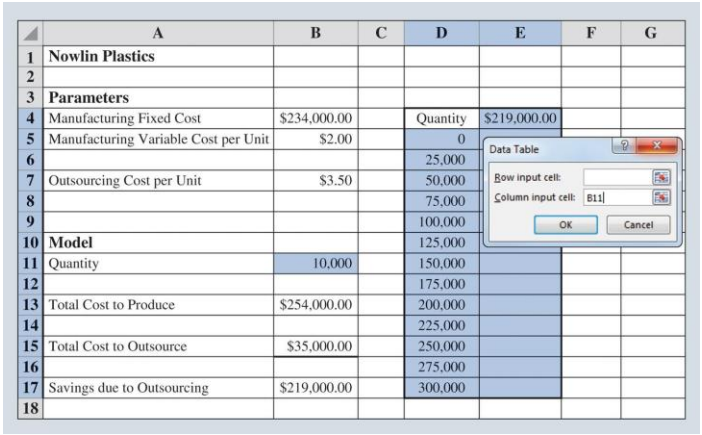
	A	B
1	**Nowlin Plastics**	
2		
3	**Parameters**	
4	Manufacturing Fixed Cost	$234,000.00
5	Manufacturing Variable Cost per Unit	$2.00
6		
7	Outsourcing Cost per Unit	$3.50
8		
9		
10	**Model**	
11	Quantity	10,000
12		
13	Total Cost to Produce	$254,000.00
14		
15	Total Cost to Outsource	$35,000.00
16		
17	Savings due to Outsourcing	$219,000.00
18		
19		

Building Good Spreadsheet models

- The general principles of spreadsheet model design and construction are:
  - **Separate the parameters from the model**: This enables the user to update the model parameters without the risk of mistakenly creating an error in a formula.
  - Document the model and use **proper formatting and color** as needed: A good spreadsheet model is well documented. Clear labels and proper formatting and alignment facilitate navigation and understanding.
  - Use **simple formulas**: Clear, simple formulas can reduce errors and make maintaining the spreadsheet easier. Long and complex calculations should be divided into several cells.

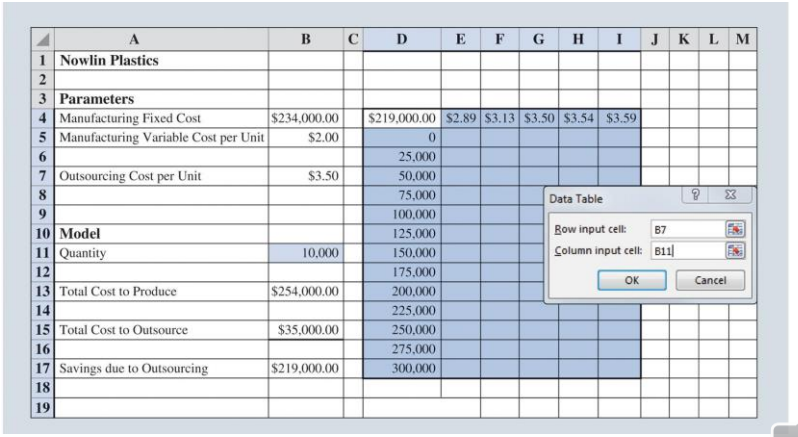
What-If Analysis

- **Data Table**: Excel tool which quantifies the impact of changing the value of a specific input on an output of interest.
- **One-way data table**: Summarizes a single input's impact on the output.
- **Two-way data table**: Summarizes two inputs' impact on the output.



	A	B	C	D	E	F	G
1	**Nowlin Plastics**						
2							
3	**Parameters**						
4	Manufacturing Fixed Cost	$234,000.00		Quantity	$219,000.00		
5	Manufacturing Variable Cost per Unit	$2.00		0			
6				25,000			
7	Outsourcing Cost per Unit	$3.50		50,000			
8				75,000			
9				100,000			
10	**Model**			125,000			
11	Quantity	10,000		150,000			
12				175,000			
13	Total Cost to Produce	$254,000.00		200,000			
14				225,000			
15	Total Cost to Outsource	$35,000.00		250,000			
16				275,000			
17	Savings due to Outsourcing	$219,000.00		300,000			
18							

Data Table
Row input cell:
Column input cell: B11
OK Cancel

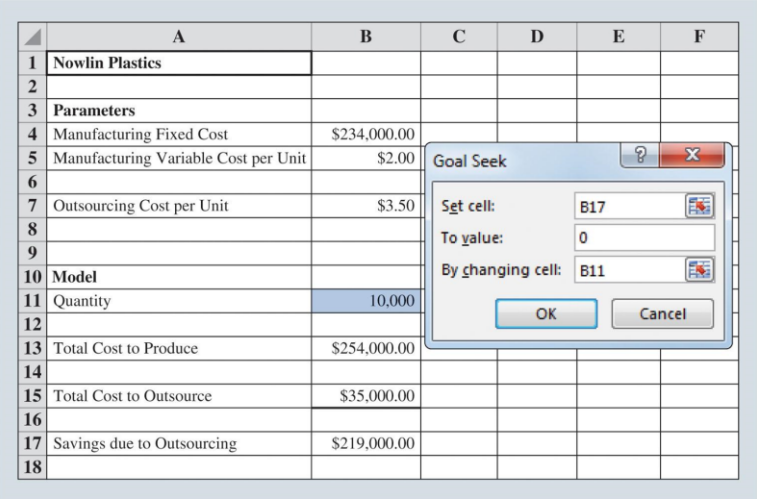


	A	B	C	D	E	F	G	H	I	J	K	L	M
1	**Nowlin Plastics**												
2													
3	**Parameters**												
4	Manufacturing Fixed Cost	$234,000.00		$219,000.00	$2.89	$3.13	$3.50	$3.54	$3.59				
5	Manufacturing Variable Cost per Unit	$2.00		0									
6				25,000									
7	Outsourcing Cost per Unit	$3.50		50,000									
8				75,000									
9				100,000									
10	**Model**			125,000									
11	Quantity	10,000		150,000									
12				175,000									
13	Total Cost to Produce	$254,000.00		200,000									
14				225,000									
15	Total Cost to Outsource	$35,000.00		250,000									
16				275,000									
17	Savings due to Outsourcing	$219,000.00		300,000									
18													
19													

Data Table
Row input cell: B7
Column input cell: B11
OK Cancel

What-if Analysis

- **Goal Seek**: Excel tool that allows the user to determine the value of an input cell that will cause the value of a related output cell to equal some specified value (the *goal*).
- In the case of Nowlin Plastics, suppose we want to know the value of the quantity of Vipers where it becomes more cost effective to manufacture rather than outsource.



	A	B	C	D	E	F
1	**Nowlin Plastics**					
2						
3	**Parameters**					
4	Manufacturing Fixed Cost	$234,000.00				
5	Manufacturing Variable Cost per Unit	$2.00				
6						
7	Outsourcing Cost per Unit	$3.50				
8						
9						
10	**Model**					
11	Quantity	10,000				
12						
13	Total Cost to Produce	$254,000.00				
14						
15	Total Cost to Outsource	$35,000.00				
16						
17	Savings due to Outsourcing	$219,000.00				
18						

What-if Analysis

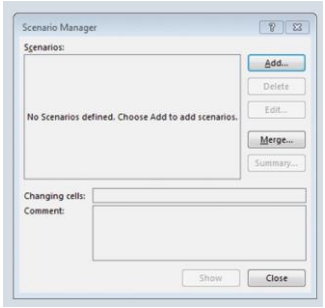
- **Scenario Manager**: Excel tool that quantifies the impact of changing multiple inputs (a setting of these multiple inputs is called a scenario) on one or more outputs of interest.
- Scenario Manager extends the data table concept to cases when you are interested in changing more than two inputs and want to quantify the changes these inputs have on one or more outputs of interest.

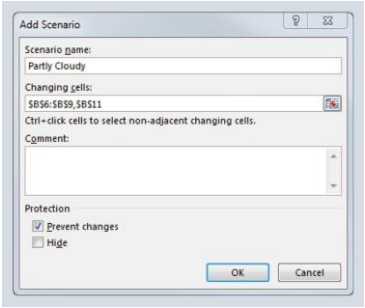
	Scenarios		
	Partly Cloudy	**Rain**	**Sunny**
Season-pass Holders	3000	1200	8000
Admissions	1600	250	2400
Average Expenditure – Season-Pass Holders	$15	$10	$18
Average Expenditure – Admissions	$45	$20	$57
Cost of Operations	$33,000	$27,000	$37,000

What-if Analysis

- **Scenario Manager**: Excel tool that quantifies the impact of changing multiple inputs (a setting of these multiple inputs is called a scenario) on one or more outputs of interest.
- Scenario Manager extends the data table concept to cases when you are interested in changing more than two inputs and want to quantify the changes these inputs have on one or more outputs of interest.

	Scenarios		
	Partly Cloudy	**Rain**	**Sunny**
Season-pass Holders	3000	1200	8000
Admissions	1600	250	2400
Average Expenditure – Season-Pass Holders	$15	$10	$18
Average Expenditure – Admissions	$45	$20	$57
Cost of Operations	$33,000	$27,000	$37,000





Useful Excel functions

- SUM: Function that adds up all of the numbers in a range of cells.
- SUMPRODUCT: Function that returns the sum of the products of elements in a set of arrays.
- IF(*condition*, *result if condition is true*, *result if condition is false*).
- COUNTIF(*range*, *condition*) - Counts the number of components having a positive order quantity.
- General form =VLOOKUP(*value*, *table*, *index*, *range*).

Auditing Spreadsheet models