

IIT KHARAGPUR



NPTEL ONLINE
CERTIFICATION COURSES

Business Analytics for Management Decision

Analytics on Spreadsheets

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Analytics on Spreadsheets

Basic Excel Skills
Excel Functions
Spreadsheet Add-ins for Business Analytics
Spreadsheet Modeling and Spreadsheet Engineering

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Basic Excel Skills

- Many commercial software packages can be used for Business Analytics.
- Spreadsheet software, such as Microsoft Excel, is widely used across all areas of business.
- Spreadsheets provide a flexible modeling environment for manipulating data and developing and solving models.
- This chapter provides a summary of the basic features in Microsoft Excel for solving problems in Business Analytics.

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Basic Excel Skills

- Opening, saving, and printing files
- Navigation
- Selecting ranges
- Inserting/deleting rows and columns
- Entering and editing text, data, and formulas
- Formatting data (number, currency, decimal)
- Working with text strings
- Performing basic arithmetic calculations
- Formatting text
- Modifying the appearance of a spreadsheet

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Basic Excel Skills

Ribbon in Excel 2010 for Windows

- Tabs - Home, Insert, Page Layout, Formulas, …
- Groups - Font, Alignment, Number, Styles, …
- Buttons and Menus

  - Buttons appear as small icons.
  - Menus of additional choices are indicated by small triangles.

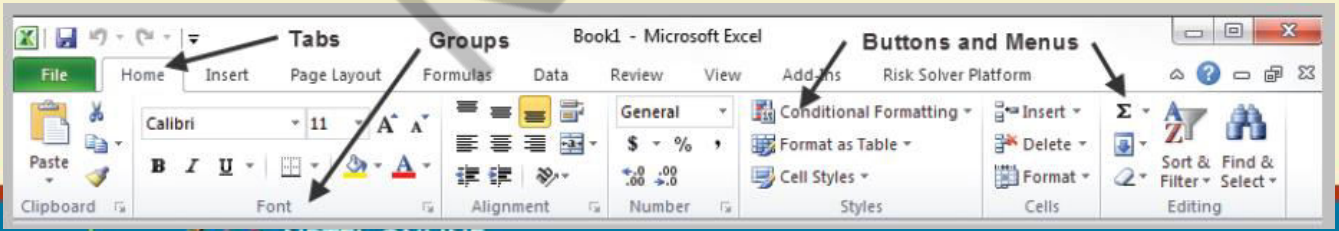


Figure 2.1

Basic Excel Skills

Excel Formulas

- Common mathematical operators are used
  $a - bP^5 + \frac{c}{d}$ would be entered into Excel as:
  =a– b*P^5 + c/d
- Cell references can be relative or absolute.
- Using a dollar sign before a row or column label creates an absolute reference.
- Relative references: A2, C5, D10
- Absolute references: $A$2, $C5, D$10

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Basic Excel Skills

Example 2.1

Implementing Price-Demand Models in Excel

Two models for predicting price using demand

Linear

$D = a - bP$

=B4 – B5*A8

(in cell B8)

Nonlinear

$D = cP^{-d}$

=E4*D8^-E5

(in cell E8)

	A	B	C	D	E
1	**Demand Prediction Models**				
2					
3	**Linear Model**			**Nonlinear Model**	
4	**a**	20,000		**c**	20,000
5	**b**	10		**d**	0.03
6					
7	**Price**	**Demand**		**Price**	**Demand**
8	$80.00	19200		$70.00	$17,606.66
9	$90.00	19100		$80.00	$17,536.27
10	$100.00	19000		$90.00	$17,474.42
11	$110.00	18900		$100.00	$17,419.27
12	$120.00	18800		$110.00	$17,369.54
13				$120.00	$17,324.25
14				$130.00	$17,282.70

Figure 2.2

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Basic Excel Skills

Example 2.1 (continued) Implementing Price-Demand Models in Excel

	A	B	C	D	E
1	**Demand Prediction Models**				
2					
3	**Linear Model**			**Nonlinear Model**	
4	**a**	20000		**c**	20000
5	**b**	10		**d**	0.03
6					
7	**Price**	**Demand**		**Price**	**Demand**
8	80	=$B$4 - $B$5*$A8		70	=$E$4*D8^-$E$5
9	90	=$B$4 - $B$5*$A9		80	=$E$4*D9^-$E$5
10	100	=$B$4 - $B$5*$A10		90	=$E$4*D10^-$E$5
11	110	=$B$4 - $B$5*$A11		100	=$E$4*D11^-$E$5
12	120	=$B$4 - $B$5*$A12		110	=$E$4*D12^-$E$5
13				120	=$E$4*D13^-$E$5
14				130	=$E$4*D14^-$E$5

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$D = a - bP$ *(linear)*

$D = cP^{-d}$ *(nonlinear)*

Figure 2.5

Basic Excel Skills

Copying Excel Formulas

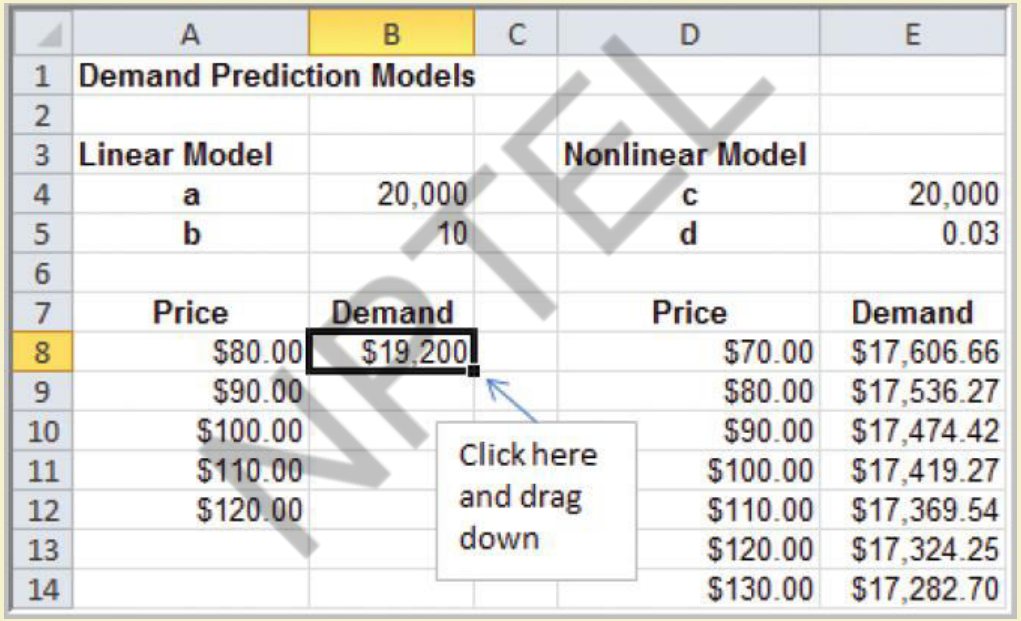
Cells can be copied in many ways.

- Use the Copy button in the Home tab, then Paste
- Use Ctrl-C, then Ctrl-V
- Drag the bottom right corner of a cell (the fill handle) across a row or column
- Double click on the fill handle of a cell and its value (or formula) is copied to the cells below if there is data in an adjacent column

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Basic Excel Skills

Example 2.2 Copying Excel Formulas by Dragging



	A	B	C	D	E
1	Demand Prediction Models				
2					
3	Linear Model			Nonlinear Model	
4	a	20,000		c	20,000
5	b	10		d	0.03
6					
7	Price	Demand		Price	Demand
8	$80.00	$19,200		$70.00	$17,606.66
9	$90.00			$80.00	$17,536.27
10	$100.00			$90.00	$17,474.42
11	$110.00			$100.00	$17,419.27
12	$120.00			$110.00	$17,369.54
13				$120.00	$17,324.25
14				$130.00	$17,282.70

Figure 2.3

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Basic Excel Skills

Example 2.2 (continued)

Copying Excel Formulas by Dragging

	A	B	C	D	E
1	Demand Prediction Models				
2					
3	Linear Model			Nonlinear Model	
4	a	20,000		c	20,000
5	b	10		d	0.03
6					
7	Price	Demand		Price	Demand
8	$80.00	$19,200		$70.00	$17,606.66
9	$90.00	$19,100		$80.00	$17,536.27
10	$100.00	$19,000		$90.00	$17,474.42
11	$110.00	$18,900		$100.00	$17,419.27
12	$120.00	$18,800		$110.00	$17,369.54
13				$120.00	$17,324.25
14				$130.00	$17,282.70

Figure 2.4

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Basic Excel Skills

Example 2.2 (continued)

Copying Excel Formulas by Dragging

	A	B	C	D	E
1	**Demand Prediction Models**				
2					
3	**Linear Model**			**Nonlinear Model**	
4	**a**	20000		**c**	20000
5	**b**	10		**d**	0.03
6					
7	**Price**	**Demand**		**Price**	**Demand**
8	80	=$B$4 - $B$5*$A8		70	=$E$4*D8^-$E$5
9	90	=$B$4 - $B$5*$A9		80	=$E$4*D9^-$E$5
10	100	=$B$4 - $B$5*$A10		90	=$E$4*D10^-$E$5
11	110	=$B$4 - $B$5*$A11		100	=$E$4*D11^-$E$5
12	120	=$B$4 - $B$5*$A12		110	=$E$4*D12^-$E$5
13				120	=$E$4*D13^-$E$5
14				130	=$E$4*D14^-$E$5

Figure 2.5

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Basic Excel Skills

Other Useful Excel Tips

- Split Screen
- Paste Special
- Column and Row Widths
- Displaying Grid Lines and Column Headers for Printing
- Filling a Range with a Series of Numbers

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Excel Functions

Basic Excel Functions

- =MIN(*range*)
- =MAX(*range*)
- =SUM(*range*)
- =AVERAGE(*range*)
- =COUNT(*range*)
- =COUNTIF(*range,criteria*)

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Excel Functions

Example 2.3 Using Basic Excel Functions

	A	B	C	D	E	F	G	H
1	**Purchase Orders**							
2								
3	**Supplier**	**Order No.**	**Item No.**	**Item Description**	**Item Cost**	**Quantity**	**Cost per order**	**A/P Terms (Months)**
4	Spacetime Technologies	A0111	6489	O-Ring	$ 3.00	900	$ 2,700.00	25
5	Steelpin Inc.	A0115	5319	Shielded Cable/ft.	$ 1.10	17,500	$ 19,250.00	30
6	Steelpin Inc.	A0123	4312	Bolt-nut package	$ 3.75	4,250	$ 15,937.50	30
7	Steelpin Inc.	A0204	5319	Shielded Cable/ft.	$ 1.10	16,500	$ 18,150.00	30
94	Hulkey Fasteners	D1212	5066	Shielded Cable/ft.	$ 0.95	17,500	$ 16,625.00	30
95	Hulkey Fasteners	D2121	1122	Airframe fasteners	$ 4.25	17,500	$ 74,375.00	30
96	Hulkey Fasteners	D3232	1122	Airframe fasteners	$ 4.25	17,000	$ 72,250.00	30
97	Pylon Accessories	D3333	9764	Gasket	$ 3.75	1,750	$ 6,562.50	15
98								
99	Minimum Quantity	90						
100	Maximum Quantity	25,000						
101	Total Order Costs	$ 2,471,760.00						
102	Average Number of A/P Months	30.64						
103	Number of Purchase Orders	94						
104	Number of O-ring Orders	12						
105	Number of A/P Terms < 30	17						

=MIN(F4:F97)
=MAX(F4:F97)
=SUM(G4:G97)
=AVERAGE(H4:H97)
=COUNT(B4:B97)
=COUNTIF(D4:D97,"=O-Ring")
=COUNTIF(H4:H97,"<30")

Figure 2.6

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Excel Functions

Functions for Specific Applications:

- =NPV(*rate,value1,value2,…*)
- Net present value (or discounted cash flow) measures the worth of a stream of cash flows, taking into account the time value of money.

F is the cash flow ($)

i is the discount rate

t is the number of time periods into the future, where *t* = 0, 1, …, *n*

$$\text{NPV} = \sum_{t=0}^{n} \frac{F_t}{(1+i)^t}$$

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Excel Functions

Example 2.4 Using the NPV Function

=NPV(*rate,value1,value2,…*)

Cell B8:

=NPV(B6, C4:H4) – B5

$$\text{NPV} = \sum_{t=0}^{n} \frac{F_t}{(1+i)^t}$$

	A	B	C	D	E	F	G	H
1	Net Present Value							
2								
3		Month	January	February	March	April	May	June
4		Sales Revenue Forecast	$2,500	$4,000	$5,000	$8,000	$10,000	$12,500
5	Fixed Cost	$25,000.00						
6	Discount rate	3%						
7								
8	NPV	$11,975.81						

Figure 2.7

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Excel Functions

Insert Function:

- Click the f_x button or choose Insert Function.
- You may type in a description or search.

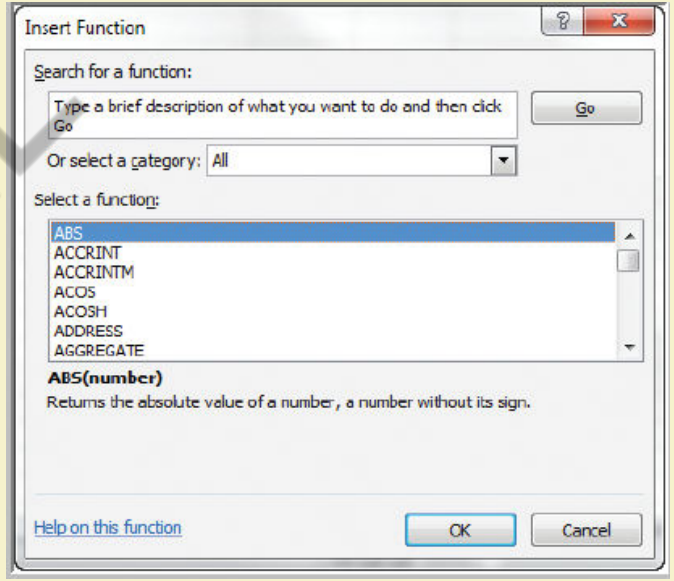


Figure 2.8

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Excel Functions

Logical Functions:

- =AND(*condition1, condition2, …*)
- =OR(*condition1, condition2, …*)
- =IF(*condition, value if true, value if false*)
- You may nest up to 7 IF functions, replacing the *value if false* with another IF function.
- Conditions may include the following:

= equal	<> not equal to
> greater than	>= greater than or equal to
< less than	<= less than or equal to

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Excel Functions

Basic Excel Functions:

- =COUNTIF(*range,criteria*)

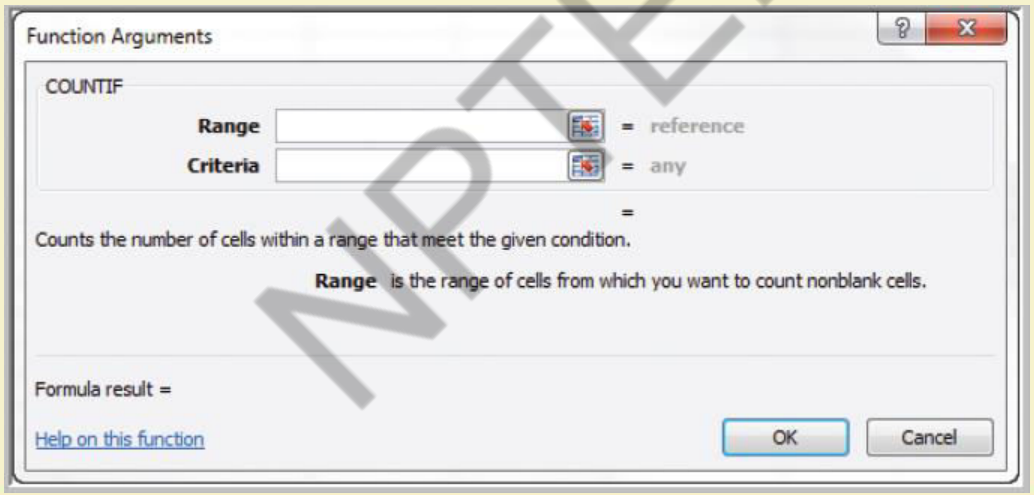


Figure 2.9

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Excel Functions

Example 2.5 Using the IF statement

=IF(*condition, value if true, value if false*)

Cell K4: =IF(F4 >= 10000, “Large”, “Small”)

	A	F	G	H	I	J	K
1	**Purchase Orders**						
2							
3	**Supplier**	**Quantity**	**Cost per order**	**A/P Terms (Months)**	**Order Date**	**Arrival Date**	**Order Size**
4	Spacetime Technologies	900	$ 2,700.00	25	10/10/11	10/18/11	Small
5	Steelpin Inc.	17,500	$ 19,250.00	30	08/20/11	08/31/11	Large
6	Steelpin Inc.	4,250	$ 15,937.50	30	08/25/11	09/01/11	Small
7	Steelpin Inc.	16,500	$ 18,150.00	30	09/15/11	10/05/11	Large
94	Hulkey Fasteners	17,500	$ 16,625.00	30	09/15/11	09/22/11	Large
95	Hulkey Fasteners	17,500	$ 74,375.00	30	10/25/11	11/03/11	Large
96	Hulkey Fasteners	17,000	$ 72,250.00	30	10/11/11	10/19/11	Large
97	Pylon Accessories	1,750	$ 6,562.50	15	09/20/11	09/25/11	Small

Figure 2.10

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Excel Functions

Lookup Functions:

- These functions are useful for finding specific data in a spreadsheet.

=VLOOKUP(*lookup_value, table_array, col_index_num*)

=HLOOKUP(*lookup_value, table_array, row_index_num*)

=INDEX(*array, row_num, col_num*)

=MATCH(*lookup_value, lookup_array, match_type*)

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Excel Functions

Example 2.6 Using the VLOOKUP Function

	A	B	C	D	E	F	G	H
1	Sales Transactions: July 14							
2								
3	Cust ID	Region	Payment	Transaction Code	Source	Amount	Product	Time Of Day
4	10001	East	Paypal	93816545	Web	$20.19	DVD	22:19
5	10002	West	Credit	74083490	Web	$17.85	DVD	13:27
6	10003	North	Credit	64942368	Web	$23.98	DVD	14:27
7	10004	West	Paypal	70560957	Email	$23.51	Book	15:38
8	10005	South	Credit	35208817	Web	$15.33	Book	15:21
9	10006	West	Paypal	20978903	Email	$17.30	DVD	13:11
10	10007	East	Credit	80103311	Web	$177.72	Book	21:59
11	10008	West	Credit	14132683	Web	$21.76	Book	4:04
12	10009	West	Paypal	40128225	Web	$15.92	DVD	19:35
13	10010	South	Paypal	49073721	Web	$23.39	DVD	13:26

Figure 2.11

=**VLOOKUP**(10007, $A$4:$H$475,3)
returns the payment type of Credit.

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Excel Functions

Example 2.7 Using the INDEX and MATCH Functions

	A	B	C	D	E	F	G	H	I	J
1	**Purchase Orders**									
2										
3	**Supplier**	**Order No**	**Item No.**	**Item Description**	**Item Cost**	**Quantity**	**Cost per order**	**A/P Terms (Months**	**Order Date**	**Arrival Date**
4	Hulkey Fasteners	C1212	1122	Airframe fasteners	$ 4.25	19,500	$ 82,875.00	30	08/05/11	08/13/11
5	Hulkey Fasteners	C2323	1122	Airframe fasteners	$ 4.25	15,500	$ 65,875.00	30	09/04/11	09/12/11
6	Hulkey Fasteners	C3232	1122	Airframe fasteners	$ 4.25	18,000	$ 76,500.00	30	10/01/11	10/08/11
7	Hulkey Fasteners	C3434	1122	Airframe fasteners	$ 4.25	12,500	$ 53,125.00	30	09/05/11	09/11/11
8	Hulkey Fasteners	C4545	1122	Airframe fasteners	$ 4.25	15,000	$ 63,750.00	30	09/08/11	09/15/11
9	Hulkey Fasteners	C5656	1122	Airframe fasteners	$ 4.25	14,500	$ 61,625.00	30	09/28/11	10/03/11
10	Hulkey Fasteners	D2121	1122	Airframe fasteners	$ 4.25	17,500	$ 74,375.00	30	10/25/11	11/03/11
11	Hulkey Fasteners	D3232	1122	Airframe fasteners	$ 4.25	17,000	$ 72,250.00	30	10/11/11	10/19/11
12	Alum Sheeting	A0443	1243	Airframe fasteners	$ 4.25	10,000	$ 42,500.00	30	08/08/11	08/14/11
13	Alum Sheeting	B0247	1243	Airframe fasteners	$ 4.25	9,000	$ 38,250.00	30	09/05/11	09/12/11
14	Alum Sheeting	B0567	1243	Airframe fasteners	$ 4.25	10,500	$ 44,625.00	30	10/10/11	10/17/11
15	Durrable Products	A1567	1369	Airframe fasteners	$ 4.20	15,000	$ 63,000.00	45	09/25/11	09/30/11
16	Durrable Products	B1468	1369	Airframe fasteners	$ 4.20	14,000	$ 58,800.00	45	09/27/11	10/03/11
17	Durrable Products	B1666	1369	Airframe fasteners	$ 4.20	10,000	$ 42,000.00	45	09/29/11	10/04/11
18	Hulkey Fasteners	C1313	3100	Electrical Connector	$ 1.25	5,600	$ 7,000.00	30	08/25/11	08/29/11

Figure 2.12

=**MATCH**(1369,$C$4:$C$475,**0**)

returns 12 (the **first** instance of 1369 is the 12th item)

=**MATCH**(1369,$C$4:$C$475,**1**)

returns 14 (the **last** instance of 1369 is the 14th item)

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Excel Functions

Example 2.7 (continued) Using INDEX and MATCH

	A	B	C	D	E	F	G	H	I	J
1	**Purchase Orders**									
2										
3	**Supplier**	**Order No**	**Item No.**	**Item Description**	**Item Cost**	**Quantity**	**Cost per order**	**A/P Terms (Months**	**Order Date**	**Arrival Date**
4	Hulkey Fasteners	C1212	1122	Airframe fasteners	$ 4.25	19,500	$ 82,875.00	30	08/05/11	08/13/11
5	Hulkey Fasteners	C2323	1122	Airframe fasteners	$ 4.25	15,500	$ 65,875.00	30	09/04/11	09/12/11
6	Hulkey Fasteners	C3232	1122	Airframe fasteners	$ 4.25	18,000	$ 76,500.00	30	10/01/11	10/08/11
7	Hulkey Fasteners	C3434	1122	Airframe fasteners	$ 4.25	12,500	$ 53,125.00	30	09/05/11	09/11/11
8	Hulkey Fasteners	C4545	1122	Airframe fasteners	$ 4.25	15,000	$ 63,750.00	30	09/08/11	09/15/11
9	Hulkey Fasteners	C5656	1122	Airframe fasteners	$ 4.25	14,500	$ 61,625.00	30	09/28/11	10/03/11
10	Hulkey Fasteners	D2121	1122	Airframe fasteners	$ 4.25	17,500	$ 74,375.00	30	10/25/11	11/03/11
11	Hulkey Fasteners	D3232	1122	Airframe fasteners	$ 4.25	17,000	$ 72,250.00	30	10/11/11	10/19/11
12	Alum Sheeting	A0443	1243	Airframe fasteners	$ 4.25	10,000	$ 42,500.00	30	08/08/11	08/14/11
13	Alum Sheeting	B0247	1243	Airframe fasteners	$ 4.25	9,000	$ 38,250.00	30	09/05/11	09/12/11
14	Alum Sheeting	B0567	1243	Airframe fasteners	$ 4.25	10,500	$ 44,625.00	30	10/10/11	10/17/11
15	Durrable Products	A1567	1369	Airframe fasteners	$ 4.20	15,000	$ 63,000.00	45	09/25/11	09/30/11
16	Durrable Products	B1468	1369	Airframe fasteners	$ 4.20	14,000	$ 58,800.00	45	09/27/11	10/03/11
17	Durrable Products	B1666	1369	Airframe fasteners	$ 4.20	10,000	$ 42,000.00	45	09/29/11	10/04/11
18	Hulkey Fasteners	C1313	3166	Electrical Connector	$ 1.25	5,600	$ 7,000.00	30	08/25/11	08/29/11

- =**INDEX**($A$4:$J$475, MATCH(1369,$C$4:$C$475,0),**7**)
  returns 63,000 (the **12th** value in the **7th** column)
- =**SUM**(INDEX($A$4:$G$475,MATCH(1369,$C$4:$C$475,**0**),7):INDEX($A$4:$G$475,MATCH(1369,$C$4:$C$475,1),**7**))
  returns 163,800 (the sum of the 3 costs for item 1369)

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Spreadsheet Add-Ins for Business Analytics

- Microsoft Excel (Windows only) provides a number of add-ins for Business Analytics:
  - Analysis *Toolpak*
  - Analysis *Toolpak* VBA
  - Solver

- Frontline Systems provides:
  - *Risk Solver* Platform
  - Premium *Risk Solver* Platform
  - *XLMiner* add-in

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Spreadsheet Modeling and Engineering

- Spreadsheet Engineering is the process of developing good, useful, and correct spreadsheet models.
- Spreadsheet models characterize the relationship between inputs and outputs.
- It is important not to use input data in model formulas, but to instead reference the spreadsheet cells that contain the data.

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Spreadsheet Modeling and Engineering

Example 2.8
Spreadsheet Model for the Outsourcing Decision

	A	B
1	Outsourcing Decision Model	
2		
3	Data	
4		
5	Manufactured in-house	
6	Fixed cost	$50,000
7	Unit variable cost	$125
8		
9	Purchased from supplier	
10	Unit cost	$175
11		
12	Production volume	1500
13		
14	Model	
15		
16	Total manufacturing cost	$237,500
17	Total purchased cost	$262,500
18		
19	Cost difference	-$25,000
20	Decision	Manufacture

	A	B
1	Outsourcing Decision Model	
2		
3	Data	
4		
5	Manufactured in-house	
6	Fixed cost	50000
7	Unit variable cost	125
8		
9	Purchased from supplier	
10	Unit cost	175
11		
12	Production volume	1500
13		
14	Model	
15		
16	Total manufacturing cost	=B6+B7*B12
17	Total purchased cost	=B12*B10
18		
19	Cost difference	=B16-B17
20	Decision	=IF(B19<=0, "Manufacture", "Outsource")

Figure 2.13

Total manufacturing cost = $50,000 + $125 x Q

Total outsourcing cost = $175 x Q

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Spreadsheet Modeling and Engineering

Example 2.9 Pricing Decision Spreadsheet Model

	A	B
1	Pricing Decision Model	
2		
3	Data	
4		
5	Price	$500.00
6		
7	Model	
8		
9	Sales	$1,766.65
10		
11	Total Revenue	$883,325.00

	A	B
1	Pricing Decision Model	
2		
3	Data	
4		
5	Price	500
6		
7	Model	
8		
9	Sales	=-2.9485*B5+3240.9
10		
11	Total Revenue	=B5*B9

Figure 2.14

Sales = -2.9485 x price + 3,240.9

Total Revenue = price x sales

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Spreadsheet Modeling and Engineering

Spreadsheet Quality

- Verification is the process of ensuring that a model is accurate and free from logical errors.
- Below are three approaches to spreadsheet engineering that can improve spreadsheet quality:

1. Improve the design and format of the spreadsheet itself.
2. Improve the process used to develop a spreadsheet.
3. Inspect your results carefully and use appropriate tools available in Excel.

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Spreadsheet Modeling and Engineering

Example 2.10 Modeling Net Income on a Spreadsheet

- Gross profit = sales – cost of goods sold
- Operating expenses = administrative expenses
  + selling expenses
  + depreciation expenses
- Net operating income = gross profit
  – operating expenses
- Earnings before taxes = net operating income
  – interest expense
- Net income = earnings before taxes – taxes

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Simple Spreadsheet Model for Computing Net Income

	A	B	C
1	Net Income Model		
2			
3	Data		
4			
5	Sales	$ 5,000,000	
6	Cost of Goods Sold	$ 3,200,000	
7	Administrative Expenses	$ 250,000	
8	Selling Expenses	$ 450,000	
9	Depreciation Expenses	$ 325,000	
10	Interest Expense	$ 35,000	
11	Taxes	$ 296,000	
12			
13	Model		
14			
15	Net Income	$ 444,000	=B5-SUM(B6:B11)

Figure 2.15

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Data-Model Format for Computing Net Income

	A	B	C
1	Net Income Model		
2			
3	Data		
4			
5	Sales	$ 5,000,000	
6	Cost of Goods Sold	$ 3,200,000	
7	Administrative Expenses	$ 250,000	
8	Selling Expenses	$ 450,000	
9	Depreciation Expenses	$ 325,000	
10	Interest Expense	$ 35,000	
11	Taxes	$ 296,000	
12			
13	Model		
14			
15	Gross Profit	$ 1,800,000	=B5-B6
16	Operating Expenses	$ 1,025,000	=SUM(B7:B9)
17	Net Operating Income	$ 775,000	=B15-B16
18	Earnings Before Taxes	$ 740,000	=B17-B10
19			
20	Net Income	$ 444,000	=B18-B11

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Figure 2.16

Spreadsheet Modeling and Engineering

Pro Forma Income Statement Format for Computing Net Income

	A	B	C	D
1	Pro Forma Income Statement			
2				
3	Sales		$ 5,000,000	
4	Cost of Goods Sold		$ (3,200,000)	
5	Gross Profit		$ 1,800,000	=C3+C4
6	Operating Expenses			
7	Administrative Expenses	$ 250,000		
8	Selling Expenses	$ 450,000		
9	Depreciation Expenses	$ 325,000	$ (1,025,000)	=-(SUM(B7:B9))
10	Net Operating Income		$ 775,000	=C5+C9
11	Interest Expense		$ (35,000)	
12	Earnings Before Taxes		$ 740,000	=C10+C11
13	Taxes		$ (296,000)	
14	Net Income		$ 444,000	=C12+C13

Figure 2.17

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Spreadsheet Modeling and Engineering



Analytics in Practice:
Spreadsheet Engineering at Proctor & Gamble

Problem: How to manage safety stock inventory.

Solution: The Western European BA group created a spreadsheet model that eventually grew into a suite of global inventory models.

- It displayed all important data on one screen.
- Allowed users constant access to current data.
- Helped supply chain managers make better decisions regarding safety stocks.

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Key Terms

- Absolute address
- Discount rate
- Net present value (discounted cash flow)
- Pro forma income statement
- Relative address
- Spreadsheet engineering
- Verification

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