

■ RICK HESSE, Feature Editor, Pepperdine University

Transportation Model Reports for Excel

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The standard transportation problem formulated as a spreadsheet model to be optimized by the Solver add-in has many advantages in terms of setup and solution for teaching. However, I have always been frustrated trying to get some form of report for the standard Transportation model that would be informative to a manager instead of a mathematician. The standard assignment model is a very simple model to have the report written automatically because there is only one assignment per row and the value of the assignments are 0s and 1s. But the transportation model will have more than one shipment for one or more rows and the values aren't 0 and 1.

optimal solution, using the Solver included with Excel from Frontline Systems is also shown.

A surprise is that the extra production is stored in New York, even though the cost (\$0.80) is over twice as much as keeping the extra production in Denver (\$0.30) or Atlanta (\$0.20). But because the cost of shipping out of New York to all the other locations is so high, it is better to keep the extra production in New York than the other two plants.

The key cell formulas and range names are given below.

Cell Formulas:

F10: =SUM(B10:E10) copy to F11:F12

B13: =SUM(B10:B12) copy to C13:E13

F13: =SUMPRODUCT(COST,SHIP)

Range Names:

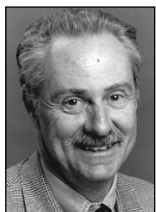
FROM: A4:A6; TO: B3:E3

COST: B4:E6; SHIP: B10:E12

Figure 2 gives the Solver setup showing that all seven constraints are equalities, with 12 variables and the total cost to be minimized.

Excel Transportation Model

The data for the standard transportation model for three plants (Denver, Atlanta and New York) shipping to three warehouses (Tucson, Miami and San Diego) as well as the inventory (Storage) is given in rows 3-7 in Figure 1. It is a balanced problem (Supply = Demand) and a total of 300 units must be left at one or more of the plants. The



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	A	B	C	D	E	F	G	
1	TRANSPORTATION PROBLEM							
2	Shipping							
3		\$/UNIT						
4		Tucson	Miami	San Diego	Storage	Supply		
5	Denver	\$0.80	\$3.10	\$1.00	\$0.30	1,800		
6	Atlanta	\$1.60	\$0.50	\$2.80	\$0.20	1,900		
7	New York	\$2.30	\$1.20	\$4.20	\$0.80	1,300		
8	Demand	2,000	1,500	1,200	300	5,000		
9		Shipping Allocations						
10		Tucson	Miami	San Diego	Storage	Used	Supply	
11	Denver	600		1,200		1,800	1,800	
12	Atlanta	1,400	500			1,900	1,900	
13	New York		1,000		300	1,300	1,300	
14	Used	2,000	1,500	1,200	300	\$5,610.00	<= Min Cost	
15	Demand	2,000	1,500	1,200	300			

Figure 1: Transportation spreadsheet model.

Transportation Report

For those of us who are used to matrices, it is a fairly simple matter to read off the solution—but it is not very user-friendly. What is more desirable is a report like the one shown in Figure 3. Such a report can certainly be created “manually”—that is, each entry needs to either be typed in or just “point and click” to the labels and values. The last column is a simple formula multiplying the number of cases times the cost per case. The Total formulas are also simple sums.

But the challenge has always been to find a way to at least set up a semi-automatic report. To do this, I have used the INDEX and MATCH functions in Excel in conjunction with the defined range names.

C18: =INDEX(SHIP,MATCH(A18, FROM,0),MATCH(B18,TO,0)) copy to C19:C23

D18: =INDEX(COST,MATCH(A18, FROM,0),MATCH(B18,TO,0)) copy to D19:D23

E18: =C18*D18 copy to E19:E23

The INDEX(range,row,column) function returns the value in range found in the specified row and column. Thus INDEX(SHIP,1,1) returns the value 600. To determine which row and column is desired, the MATCH(value,range,0) function searches the specified range for an exact (the 0 is the code for that) match of the specified value. In this case, the value is the name of the plant or wholesaler. The use of the 0 code in the MATCH function allows the list in the range not to have be ordered alphabetically. By using these two functions, then for any size model the report can be written fairly quickly and painlessly. All that is needed is to “point and click” to the names for the supply and demand to put into columns A and B of the report. Incidentally, to show what range names have been defined in your current workbook, click on the arrow on the box with the cell reference (upper left of the screen) and the drop-down list will show all the range names. Highlight any one of them and Excel will automatically highlight that range (taking you to another worksheet if necessary).

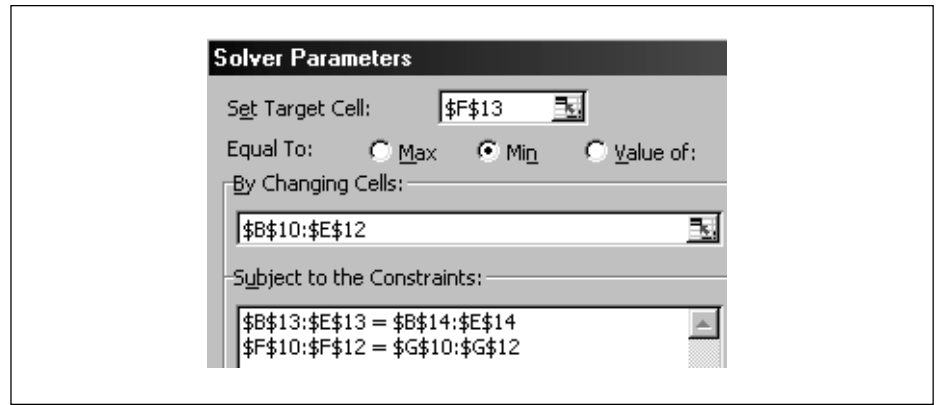


Figure 2: Solver setup for transportation model.

	A	B	C	D	E
16	REPORT				SHIPPING
17	FROM	TO	UNITS	\$/UNIT	COST
18	Denver	Tucson	600	\$0.80	\$480.00
19	Denver	San Diego	1,200	\$1.00	\$1,200.00
20	Atlanta	Tucson	1,400	\$1.60	\$2,240.00
21	Atlanta	Miami	500	\$0.50	\$250.00
22	New York	Miami	1,000	\$1.20	\$1,200.00
23	New York	Storage	300	\$0.80	\$240.00
24			5,000	Totals	\$5,610.00

Figure 3: Transportation model report.

SUMIF X ✓ ✖ =INDEX(\$B\$10:\$E\$12,MATCH(A18,\$A\$4:\$A\$6,0),MATCH(B18,\$B\$3:\$D\$7,0))

	A	B	C	D	E	F	G	H	I	J	
1	CBBS: Supply > Demand										
2	CBBS2		Cost/unit								
3		Tucson	Miami	San Diego	Chicago	Seattle	Storage	Supply			
4	Denver	\$0.23	\$0.24	\$0.31	\$0.32	\$0.21	\$0.05	1,900			
5	Atlanta	\$0.26	\$0.26	\$0.22	\$0.24	\$0.23	\$0.06	1,900			
6	New York	\$0.30	\$0.32	\$0.23	\$0.26	\$0.26	\$0.07	1,300			
7	Demand	1,000	1,500	1,000	800	700	100	5,100			
8		Shipping Allocations									
9		Tucson	Miami	San Diego	Chicago	Seattle	Storage	Used	Supply		
10	Denver		600	1,000	300			1,900	1,900		
11	Atlanta	1,000	500					1,900	1,900		
12	New York			500	700	100		1,300	1,300		
13	Used	1,000	1,500	1,000	800	700	100	\$1,363.00	<= Min Cost		
14	Demand	1,000	1,500	1,000	800	700	100				
15											
16	REPORT				SHIPPING						
17	FROM	TO	UNITS	\$/CASE	COST						
18	Denver	Miami	=3:\$E\$3,0))	\$0.24	\$144.00						
19											
20											

Figure 4: Edit function in Excel.