An Excel Modeling Practice Problem: Oak Products

Introduction

Excel Skills You'll Practice

In terms of Excel model-building and data-analysis skills,
the Oak Products problem gives you practice with:

- analyzing a problem from scratch

- retrieving data from a non-Excel format

- devising a suitable spreadsheet model layout

- building formulas to express data relationships

- making use of time-saving Excel functions such as SUMPRODUCT

- using Excel's Solver utility to quickly zero in on the best solution

- illustrating model results with a graph

- printing

Fuqua students preparing to take Fuqua's core Decision Models
class may find practice with these skills particularly useful.
For additional Excel materials and practice problems see this URL:
http://faculty.fuqua.duke.edu/~pecklund/excelreview/ExcelReview.htm

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Problem Overview

Imagine that you're a new employee at a small, family-owned North Carolina furniture manufacturing company named Oak Products, Inc. (OP). OP produces a line of high-quality solid oak chairs. The chairs have been designed to use a variety of components: Long and short dowels, heavy and light seats, heavy and light rungs, and a rail that caps the back.

OP manufactures six types of chairs: Captain, Mate, American High, American Low, Spanish King, and Spanish Queen. Each type of chair requires a certain number of different parts. At OP, finishing activity for a chair requires one month. For this reason only chair components that are on hand when a month's production starts can be used in chairs that will be produced during that month.

As a new employee you're rotated through the different areas of the company's operations and you now have the chance to review the company's production plans. In August, OP has always had as its target the production of forty chairs of each type. However, as you look over the factory data it appears that a different product mix might be more profitable. To help OP maximize its total August profits you do the following:

Obtain the Raw Data

You request a list of resource requirements for each chair type, current chair profit levels, and the parts inventory expected to be on hand for August. This information is made available to you in MS Word table format. By importing some of the Word data into Excel, you can save data entry time in Excel.

Analyze the Data

You build a model in Excel to analyze the current data. Your objective is to adjust production levels to achieve the most profitable product mix for the month of August, subject to manufacturing production constraints.

Obtain the Word Data

The Word document you receive holds:
- resource requirements for each chair type (for each chair, a column shows how many dowels, rungs, rails, etc. are required)
- current chair profit levels (in a row with the label "Unit Profit")
- the parts inventory expected to be on hand for August (in a column with the label "On Hand")

The contents of the Word file appears below. The data is arranged in tabular format.

Oak Products   **Manufacturing Data for August 2001**

Parts:		Captain	Mate	AmHi	AmLo	SpanK	SpanQ		On Hand
Long dowel		8	0	12	0	8	4		1280
Short dowel		4	12	0	12	4	8		1900
Leg		4	4	4	4	4	4		1090
Heavy seat		1	0	0	0	1	1		190
Light seat		0	1	1	1	0	0		170
Heavy rung		6	0	4	0	5	0		1000
Light rung		0	4	0	5	0	6		1000
Captain rail		1	0	0	0	0	0		110
Mate rail		0	1	0	0	0	0		72
American rail		0	0	1	1	0	0		93
Spanish rail		0	0	0	0	1	1		85
Unit Profit		$36	$40	$45	$38	$35	$25		

To obtain an electronic copy of this file, download it from this URL:

http://faculty.fuqua.duke.edu/~pecklund/excelreview/ExcelReview.htm

If you don't have access to the web to download this file but you want to work through the problem yourself in Excel, enter the data above as a table in Word.

Analyze the Data

Build a spreadsheet model in Excel to help you determine August's most profitable product mix. Although you could start your worksheet from scratch, you can save data entry time by importing into Excel some of the data from the Word document.

A.   Import Word Data Into Excel

Setup: Open both Excel and Word as full-screen sessions. (You can shift between them by holding down the Alt key and pressing the Tab key.)

Select the Data to Copy:
- In Word, open the document that holds the data.
- Position the insertion point in the table of data.
- Choose the *Table* command in Word's menu.
- Choose *Select Table*. Word highlights the entire table (but not the separate document header).

Copy the Data to the Windows Clipboard:
From Word's menus choose *Edit* and then *Copy*. (Alternatively, click the *Copy* button on Word's *Standard* toolbar or hit CTRL+C.)

Copy the Data to Excel:
- Switch to Excel by hitting Ctrl+Tab until your Excel session is active.
- Click Cell A3 to make it the current cell.
- From Excel's menus, select *Edit, Paste Special.*
- In the *Paste Special* dialog box, select *Paste* and As *Text* and click *OK*.
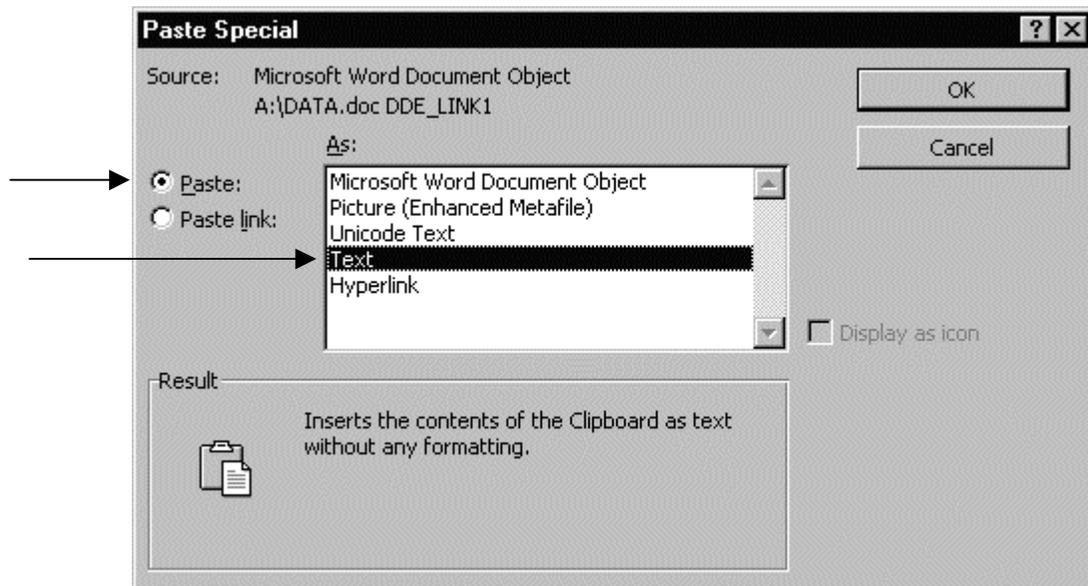
Each cell in the Word table becomes a cell in the Excel worksheet. Now you're ready to build the model around this core set of data.

B.   Conceptualize the Problem

Objective
Your objective for OP's August production is to find the mix of chair types to manufacture that results in the highest possible profit.

On Hand
1280
1900
1090
190
170
1000
1000
110
72
93
85

Constraints
- OP has only the current numbers of parts-on-hand (as described in the Word table) to work with.
- Each of the six chair types requires a different mix of parts.

Assumptions
- OP can sell every chair they make.
- The number of parts on hand cannot be increased.
- It's not possible to make substitutions for chair parts.

Data
You've already identified and obtained the raw data you need to determine the best product mix. To review, the raw data includes:
- A description of the manufacturing line with the parts required for each chair
- The parts on hand
- The profit OP earns from each chair type

We also know that OP plans to make 40 of each chair type.

Note

The next section guides you through creating the Oak Products Excel model. *Building the model yourself is the best way to learn about Excel.*

There are many ways to build a good Excel model for this problem. If you'd like to compare your model with the one in this document, review the spreadsheet printouts that appear at the end of this handout.

C. Begin Constructing the Spreadsheet Model

Arrange the data in your Excel worksheet to suit yourself. You might use a format similar to that used in the sample worksheet printouts at the end of this section. Notice that in the first sample worksheet, I've moved unit profit from its location at the bottom of the Word table to a row directly beneath chair type. Unit profit values are key in this model and so I've put them in a more central, easily visible location. I've also added documentation and have slightly changed a couple of labels to make them more clear.

D. Add Decision Variables

The next step is to add the *decision variables* to the model. I added a row for the decision variables and gave it the label *Qty Produced* (or Quantity Produced)*.* In this problem, the decision variables are the numbers of each chair to manufacture. I've arranged these variables so they're aligned in the same columns as the data on which they'll operate.
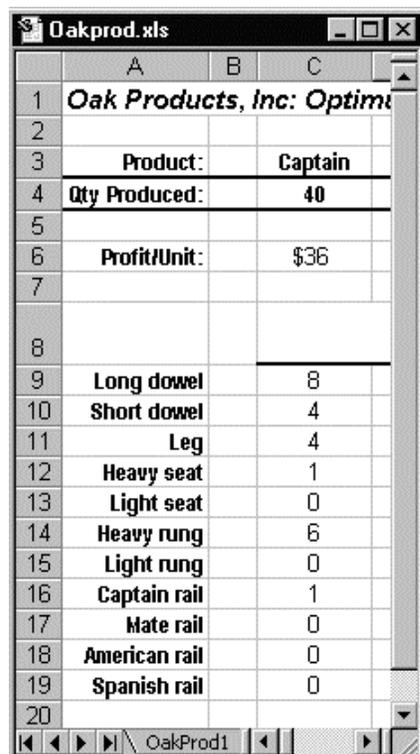
	A	B	C
1	Oak Products, Inc: Optim‍		
2			
3	Product:		Captain
4	Qty Produced:		40
5			
6	Profit/Unit:		$36
7			
8			
9	Long dowel		8
10	Short dowel		4
11	Leg		4
12	Heavy seat		1
13	Light seat		0
14	Heavy rung		6
15	Light rung		0
16	Captain rail		1
17	Mate rail		0
18	American rail		0
19	Spanish rail		0
20			

OakProd1

For example, in the illustration at left the column for Captain's chair holds the name, the number to produce, and the number of components required.

You'll see as we proceed that this arrangement simplifies construction of the formulas required by the model.

Since in August OP always makes forty chairs of each type, we fill the *Qty Produced* row with 40 for each chair. I've highlighted these critical decision variable cells with a border (explained in the section below on formatting) to distinguish them from data.

E. Add Formulas

At this point in my model building I'm ready to calculate *objectives* and *constrained quantities.* I can do this by means of formulas that reference the data and the decision variables. Writing formulas into the model, I calculate the following:

- How many of each component are required for the quantities of chairs (now set at 40 for each type) we'll produce? This information goes into a new column with the label *Total Usage.*

- How much inventory will be left over at the end of the manufacturing process. Naturally, values in this column can't be less than zero, but zero in each column would be ideal. I add a new *Ending Inventory* column to the model and a formula calculates ending inventory for each one of the components listed in the first column.

A preview of the Inventory and Total Usage columns:

	Capt	Mate	AmHi	AmLo	Spank	Spanq	Starting Inventory	Ending Inventory	Total Usage
Long dowel	8	0	12	0	8	4	1280	1280	0
Short dowel	4	12	0	12	4	8	1900	1600	300
Leg	4	4	4	4	4	4	1090	960	130
Heavy seat	1	0	0	0	1	1	190	120	70
Light seat	0	1	1	1	0	0	170	120	50
Heavy rung	6	0	4	0	5	0	1000	600	400
Light rung	0	4	0	5	0	6	1000	600	400
Captain rail	1	0	0	0	0	0	110	40	70
Mate rail	0	1	0	0	0	0	72	40	32
American rail	0	0	1	1	0	0	93	80	13
Spanish rail	0	0	0	0	1	1	85	80	5

- What profit will result from our product mix? The calculation that will give us this information goes into a cell with the label *Total Profit.* With this model, our objective is to maximize the *Total Profit* value.

Again, because this is a critical value for the model (like the number of each chair to manufacture), I locate it somewhere very visible near the top of the model.

The Constrained Quantities

In our model we need to track how many of each chair component we use. In our situation, components are a constrained quantity since we can't use more than what the factory has on hand for the month of August. We'll track that value for each chair component by means of a *Total Usage* calculation.

Because of the way the data is arranged, we can save time and effort and simplify the worksheet in our calculation of *Total Usage* by employing a built-in Excel function named **SUMPRODUCT**. This function allows us to easily compute the *Total Usage* for the first chair component (long dowel) for all six chair types.

	Capt	Mate	AmHi	AmLo	Spank	Spanq	Total Usage
Long dowel	8	0	12	0	8	4	**0**

Then we can copy the formula we've built for the first long dowel component so it calculates *Total Usage* for each of the rest of the components (short dowel, leg, heavy seat, etc.).

The SUMPRODUCT function is a shorthand way of doing the following:
1. Multiply the *Qty Produced* for the Captain's chair by the number of long dowels needed for that model. Then:

2. Multiply the *Qty Produced* for the Mate chair by the number of long dowels needed for that model. Then:

3. Do the same operation for the long dowel component for each of the quantities produced for each of the remaining four chair models, American High, American Low, Spanish King, and Spanish Queen. Then:

4. Add together the results for all the chair models for *Qty Produced* X number of long dowels components required. The result of this addition is the *Total Usage*, or the total number of long dowels required for the all the chairs.

The SUMPRODUCT function for the long dowel component has this format:

$$=SUMPRODUCT(\$C\$4:\$H\$4,C9:H9)$$

A version of the same information using names:

```
=SUMPRODUCT
        (Qty-to-Produce-for-All-Chairs-Range,
                Long-dowel-for-All-Chairs-Range)
```

In our example this formula goes into the first cell (Cell K9) in the *Total Usage* column. That is, in the row for long dowel.

To summarize:
$C$4:$H$4 is the range referring to the quantities of each chair produced.

C9:H9 is the range referring to the number of long dowels required for each chair type.

An Important Note on the SUMPRODUCT Formula Format[1]

Notice that in the SUMPRODUCT formula I've used *absolute addressing* for the reference to *Qty Produced,* that is cells C4, D4, E4, G4, and H4 (written in the formula as $C$4:$H$4). Using absolute addressing for this part of the formula allows me to properly copy the SUMPRODUCT function for long dowel down the column for the other ten components: short dowel through Spanish rail.

However, in the SUMPRODUCT formula I use Excel's *relative addressing* default in the part of the formula (C9:H9) that refers to the long dowels row. When I copy this formula down the *Total Usage* column, I want the relative row reference to automatically change to refer to the correct row for each of the other components.

The alternative to using absolute and relative addressing in this way is to enter ten separate formulas, a much less attractive option.

Copy the formula for the long dowel down the *Total Usage* column, to complete the formulas that are required for each of the rest of the components.

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[1] If you're not familiar with Excel's relative and absolute addressing be sure to brush up on this feature in a good reference guide or the handouts *Spreadsheets: Getting Started* and/or *Excel Efficiencies*.

The Objective

We can again use the SUMPRODUCT function to compute the *objective function*, which in this model is the *Total Profit.* We set aside a cell near the top of the model to hold this calculation and give the cell an appropriate label.

The SUMPRODUCT function for total profit is:

$$=\text{SUMPRODUCT}(C4{:}H4,C6{:}H6)$$

That is, the sum of:
- The number of Captain's chairs produced X the profit for each Captain's chair, *plus*
- The number of Mate's chairs produced X the profit for each Mate's chair, *plus*
- The number of American High chairs produced X the profit for each American High chair,
- *and so on* for all the chair models.

The Ending Inventory

With *Starting Inventory* figures already in the worksheet and *Total Usage* calculated, it's easy to add an additional column to calculate *Ending Inventory.* Having ending inventory figures is helpful as we perform manual manipulations of the model. Again, we want to make sure that we don't attempt to use more components than are on hand; e.g., that no cell in *Ending Inventory* holds a negative value. Enter the ending inventory formula for long dowel as =J9-K9. Copy this formula down the column for the other components.

We can also conditionally format this column, so formatting changes quickly flag any negative values. To apply conditional formatting, highlight the range in this column and choose *Format, Conditional Formatting.* Complete the *Conditional Formatting* dialog.

F. Format and Print

Formatting

You may want to highlight particular quantities in your model by means of formatting. For example:

> To surround the *Qty Produced* information with a single line border
> 1. Turn on Excel's *Formatting* toolbar with the *View, Toolbars* commands.
> 2. Select the cells in the range A4:H4.
> 3. Click the down arrow to the right of the *Borders* icon on the formatting toolbar.
> 4. To surround the selection with a single-line border select the last border shown.

> To use a font color and background pattern for the *Total Profit* figure
> 1. Select the cell that holds the *Total Profit* calculation (Cell J6).
> 2. Click the right-hand mouse button to get a pop-up menu of available options.
> 3. From the pop-up options, select *Format Cells.*
> 4. In the *Format Cells* dialog box, use the *Font* and *Patterns* selections to change the font color and add a patterned background to the cell.

Printing

Use the *File, Print* commands to print your worksheet.
Explore the printing options available under the *File, Page Setup* commands.

Use the commands *Tools, Options, View Formulas* to display your worksheet on the screen with formulas shown. You can print this version as you would a regular worksheet (you may want to copy it to a separate worksheet and adjust column widths first).

Headers and footers can be useful to include standard information (such as your name, the file name, the date, etc.) on each printed page. To set, choose *File, Page Setup* and select the *Headers and Footers* tab.

G.   Find Maximum Total Profit

At this point, the model is complete. We're ready to use it to determine maximum total profit. By changing the decision variables in the *Qty Produced* row, we manipulate the *Total Profit* figure in cell J6. (See the third version of the worksheet — OakProd3 — in the sample printouts.)

Maximizing Total Profit By Hand

The model starts with the production values originally mandated; that is, *Qty Produced* levels of 40 for each chair type. Oak Products' total profit under this scenario is **$8,760**.

Experiment with changing the *Qty Produced* values to try to increase Oak Products' total profit beyond the $8,760 level. Keep an eye on the values in the *Ending Inventory* column to make sure none of these values fall below zero. Negative values in this column indicate an unworkable model. The conditional formatting I added (less than zero values display bolded and in red) should make them easy to spot quickly.

Below are three results when we estimate what *Qty Produced* values to enter into the model.

Capt	Mate	AmHi	AmLo	SpanK	SpanQ	Total Profit
40	50	53	40	25	30	$8,970
40	40	40	53	40	40	$9,254
1	72	75	5	28	37	$8,386

Manual manipulation of the *Qty Produced* decision variables quickly shows how difficult it is to come up with an optimum product mix.

Tip:	*To manage a variety of different scenarios in a worksheet, consider using Excel's Scenario Manager. Use the Online Help subject search to see information on this topic.*

Maximizing Total Profit Using The Solver[2]

Instead of spending time manually changing decision variable values in
the model we can instead make use of Excel's Solver. The Solver can
quickly determine the best mix. Solver just needs to know what value to
maximize, what values can be changed, and any information we have
about constraints.

Invoke the Solver with the commands *Tools, Solver*. Complete the *Solver
Parameters* dialog box.

- The *Set Target Cell* is *Total Profit*, (Cell J6). Ask Solver to *maximize* this
  value.
- The *Changing Cells* are the decision variable cells, or *Qty Produced* (the
  range C4:H4). Solver adds the absolute referencing.
- Two constraints state that:
    1- We can't produce a negative quantity of any chair, or
       (C4:H4>=0).
    2- We can't use more inventory than we have on hand, or
       (K9:K19<=J9:J19).
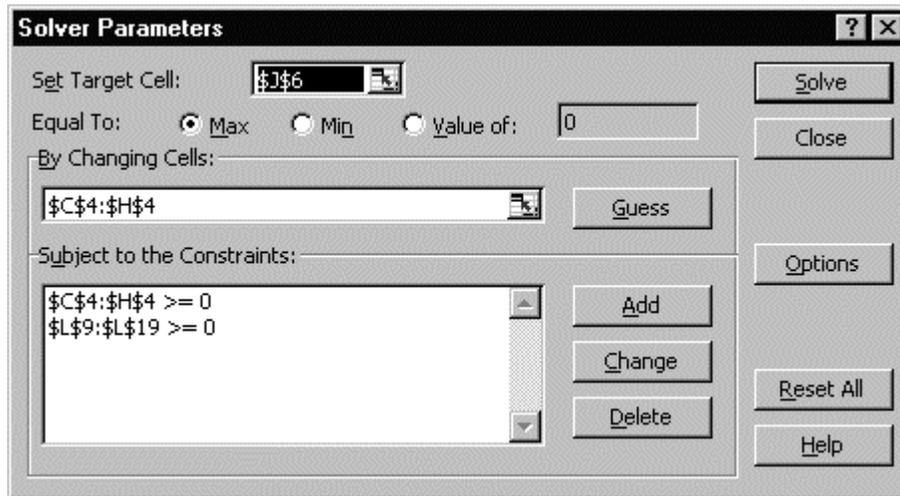
Click the *Options* button on the *Solver Parameters* dialog to see the *Solver
Options* screen. For this problem, specify:
- *Assume Linear Model*
- Set *Tolerance* to 0.05

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[2] Solver is an Excel add-in that's part of your MS Excel application. Use *Tools, Add-In* to open the Add-Ins
dialog. Toggle on the Solver entry in the list. If you don't find the Solver entry in this list, return to your
Excel installation media and start up the Excel install program. You need not reinstall Excel completely;
just find the Solver option and add it to your Excel configuration.

Click *OK* to return to the *Solver Parameters* dialog box. Click the *Solve* button to direct the Solver to start working to optimize *Total Profit* in the worksheet.

When Solver finds a solution, it displays a *Solver Results* dialog box. You can direct Solver to keep its solution (replacing *Set Cell* and *Changing Cell* values with the ones it's found), or if you want to reject Solver's suggested solution you can choose to retain your model's original values.

[You may submit a problem to Solver for which it can't find a solution. In that case, Solver displays a message to that effect and you're returned to the worksheet with the model values left unchanged.]

You can ask Solver to generate one or more of its reports on the process: the Answer Report, the Sensitivity Report, or the Limits Report. If you ask for a Solver report, the report appears on a separate sheet that Solver adds to your workbook. Not all reports can be generated for all model types.

Solver's Solution

In the final worksheet example that follows (the worksheet tab OakProd5), Solver's values are displayed in the *Qty Produced* row and for the *Total Profit* figure. Solver suggests that Oak Products drop the Spanish King and Spanish Queen models in August and concentrate on a product mix without them. This mix yields a profit of **$10,294**.

A Chart of the Results

As an alternative method of presenting your results, it might be useful to chart some of the data in the worksheet. Think about what numbers in the model are of most interest and what chart type might be most effective. An example chart is included with the worksheet printouts.

Next: Worksheet Examples

Oak Products Problem: Sample Printouts

Stage 1: Shows the data copied from the Word document into an Excel spreadsheet. Because Unit Profit values are key in this model, I've moved them from the bottom of the Word table to a row directly beneath chair type in this spreadsheet. I've added documentation and slightly changed a couple of labels to make them more clear.

	A	B	C	D	E	F	G	H	I	J
	Oakprod.xls									
1	Oak Products, Inc: Optimum Product Mix Finder									
2										
3	Product:		Captain	Mate	AmHi	AmLo	SpanK	SpanQ		
4										
5	Profit/Unit:		$36	$40	$45	$38	$35	$25		
6										
7					Product Resources Requirement					Starting Inventory
8	Long dowel		8	0	12	0	8	4		1280
9	Short dowel		4	12	0	12	4	8		1900
10	Leg		4	4	4	4	4	4		1090
11	Heavy seat		1	0	0	0	1	1		190
12	Light seat		0	1	1	1	0	0		170
13	Heavy rung		6	0	4	0	5	0		1000
14	Light rung		0	4	0	5	0	6		1000
15	Captain rail		1	0	0	0	0	0		110
16	Mate rail		0	1	0	0	0	0		72
17	American rail		0	0	1	1	0	0		93
18	Spanish rail		0	0	0	0	1	1		85

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Stage 2: Shows decision variables added. The decision variables have the label "Qty Produced" and are inserted between "Product" and "Profit/Unit".

	A	B	C	D	E	F	G	H	I	J
	Oakprod.xls									
1	Oak Products, Inc: Optimum Product Mix Finder									
2										
3	Product:		Captain	Mate	AmHi	AmLo	SpanK	SpanQ		
4	Qty Produced:		40	40	40	40	40	40		
5										
6	Profit/Unit:		$36	$40	$45	$38	$35	$25		
7										
8					Product Resources Requirement					Starting Inventory
9	Long dowel		8	0	12	0	8	4		1280
10	Short dowel		4	12	0	12	4	8		1900
11	Leg		4	4	4	4	4	4		1090
12	Heavy seat		1	0	0	0	1	1		190
13	Light seat		0	1	1	1	0	0		170
14	Heavy rung		6	0	4	0	5	0		1000
15	Light rung		0	4	0	5	0	6		1000
16	Captain rail		1	0	0	0	0	0		110
17	Mate rail		0	1	0	0	0	0		72
18	American rail		0	0	1	1	0	0		93
19	Spanish rail		0	0	0	0	1	1		85

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Stage 3: Shows objectives and constrained quantities added to the worksheet. The "Qty Produced" values are still set at 40/model.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Oak Products, Inc: Optimum Product Mix Finder											
2												
3	Product:		Captain	Mate	AmHi	AmLo	SpanK	SpanQ				
4	Qty Produced:		40	40	40	40	40	40				
5										Total Profit		
6	Profit/Unit:		$36	$40	$45	$38	$35	$25		$8,760		
7												
8					Product Resources Requirement					Starting Inventory	Total Usage	Ending Inventory
9	Long dowel		8	0	12	0	8	4		1280	1280	0
10	Short dowel		4	12	0	12	4	8		1900	1600	300
11	Leg		4	4	4	4	4	4		1090	960	130
12	Heavy seat		1	0	0	0	1	1		190	120	70
13	Light seat		0	1	1	1	0	0		170	120	50
14	Heavy rung		6	0	4	0	5	0		1000	600	400
15	Light rung		0	4	0	5	0	6		1000	600	400
16	Captain rail		1	0	0	0	0	0		110	40	70
17	Mate rail		0	1	0	0	0	0		72	40	32
18	American rail		0	0	1	1	0	0		93	80	13
19	Spanish rail		0	0	0	0	1	1		85	80	5

OakProd1 / OakProd2 \OakProd3 / OakProd4 /

Stage 4: Our worksheet with formulas displayed so most of the SUMPRODUCT calculations are visible. Note that the SUMPRODUCT formula (not entirely visible in Cell J6) contains the following formula: =SUMPRODUCT(C4:H4,C6:H6)

	A	B	C	D	E	F	G	H	I	J	K	L
1	Oak Product:											
2												
3	Product:		Captain	Mate	AmHi	AmLo	SpanK	SpanQ				
4	Qty Produced:		40	40	40	40	40	40				
5										Total Profit		
6	Profit/Unit:		36	40	45	38	35	25		=SUMPROD		
7												
8										Starting Inventory	Total Usage	Ending Inventory
9	Long dowel		8	0	12	0	8	4		1280	=SUMPRODUCT($C$4:$H$4,C9:H9)	=J9-K9
10	Short dowel		4	12	0	12	4	8		1900	=SUMPRODUCT($C$4:$H$4,C10:H10)	=J10-K10
11	Leg		4	4	4	4	4	4		1090	=SUMPRODUCT($C$4:$H$4,C11:H11)	=J11-K11
12	Heavy seat		1	0	0	0	1	1		190	=SUMPRODUCT($C$4:$H$4,C12:H12)	=J12-K12
13	Light seat		0	1	1	1	0	0		170	=SUMPRODUCT($C$4:$H$4,C13:H13)	=J13-K13
14	Heavy rung		6	0	4	0	5	0		1000	=SUMPRODUCT($C$4:$H$4,C14:H14)	=J14-K14
15	Light rung		0	4	0	5	0	6		1000	=SUMPRODUCT($C$4:$H$4,C15:H15)	=J15-K15
16	Captain rail		1	0	0	0	0	0		110	=SUMPRODUCT($C$4:$H$4,C16:H16)	=J16-K16
17	Mate rail		0	1	0	0	0	0		72	=SUMPRODUCT($C$4:$H$4,C17:H17)	=J17-K17
18	American rail		0	0	1	1	0	0		93	=SUMPRODUCT($C$4:$H$4,C18:H18)	=J18-K18
19	Spanish rail		0	0	0	0	1	1		85	=SUMPRODUCT($C$4:$H$4,C19:H19)	=J19-K19

OakProd1 / OakProd2 / OakProd3 \OakProd4 / Mix Chart / OakPr

Stage 5, the final worksheet: The final version of the worksheet, with the "Qty Produced" and "Total Profit" values Solver suggests.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Oak Products, Inc: Optimum Product Mix Finder											
2												
3	Product:		Captain	Mate	AmHi	AmLo	SpanK	SpanQ				
4	Qty Produced:		100	72	40	53	0	0				
5										Total Profit		
6	Profit/Unit:		$36	$40	$45	$38	$35	$25		$10,294		
7												
8					Product Resources Requirement					Starting Inventory	Total Usage	Ending Inventory
9	Long dowel		8	0	12	0	8	4		1280	1280	0
10	Short dowel		4	12	0	12	4	8		1900	1900	0
11	Leg		4	4	4	4	4	4		1090	1060	30
12	Heavy seat		1	0	0	0	1	1		190	100	90
13	Light seat		0	1	1	1	0	0		170	165	5
14	Heavy rung		6	0	4	0	5	0		1000	760	240
15	Light rung		0	4	0	5	0	6		1000	553	447
16	Captain rail		1	0	0	0	0	0		110	100	10
17	Mate rail		0	1	0	0	0	0		72	72	0
18	American rail		0	0	1	1	0	0		93	93	0
19	Spanish rail		0	0	0	0	1	1		85	0	85

End of the
Oak Products Problem