

## **Appendix A**

**Selected excerpts from behavior modeling session  
Examples of training screens**

## Selected Excerpts from Behavior Modeling tape

...Now, given that we've talked about how we can use Solver, let's take a look at it. I'll just pull up Solver by clicking here on the Tools menu and choosing Solver. [pulls down Tools menu and clicks Solver]...

[Solver screen opens up with data already entered in the edit boxes.]

This is good that this happened because it's something you might run into. You see, if someone else has worked in Solver before you, it does not erase what they did. So, one of the first things you'll often have to do is to reset Solver. So, if you open it up and there are numbers already there, then you'll want to click the Reset button here [clicks Reset button], and then Solver is going to come back and ask you "Are you sure you want to reset everything?" [Dialog box prompts user to verify] So, you'll just answer yes [clicks on yes button and Solver is reset ]

[ready to enter the inputs]

...Now, one of the nice things about the Solver dialog box is that you can move it around on the screen. That way you can see your spreadsheet. [moves dialog box around screen] It'll help you avoid mistakes.

[...later...]

Now, we'll start entering in our constraints...I'll use the pointing method again. Remember, our total labor cell has got to be less than or equal to some value. Now, notice this, right in the center we've got mathematical operators. See, in this problem I want total labor to be less than or equal to something. [points to  $\leq$  operator]. But Excel gives you choices [clicks on listbox that reveals  $\leq$ ,  $\geq$ , and  $=$ ]. You could click on less than or equal to or greater than or equal to, but in this problem, the operator I want to choose is less than or equal to. [selects  $\leq$ ] .....

[...later...]

Now, since that's my last constraint, I'll click the Add button instead of the OK button [clicks Add button].

[Solver's main window reappears]

Solver's really neat because it brings up the main window again to allow you to check to make sure you've entered everything correctly. That way you can capture any mistakes you might have made. Now, let's see. Here's our target cell, F13. That's right. Here's our changing cell. That's right. And here are our constraints. Total labor, less than or equal to 50,000-- That's fine. Total materials, less than or equal to 40,000---That's fine. Total cubic feet, less than or equal to 5,000. Wait a minute. That's not right. It's supposed to be 500. So, now that we've caught a mistake, we need to be able to fix it. Since this constraint is wrong, we need to click on it and then click the Change button [clicks Change button] and now we can change the 5000 to 500. [makes the change and exits out of screen].

**Example:** Suppose you are in charge of purchasing computers for a computer dealer. Your boss gives you a budget of \$15,000.00, and within that budget, you must purchase as many computers as possible. Each computer costs \$1,250.00. How many computers can you purchase?

**Step 1 of 4:** Set up the information.

	-A-	-B-	-C-	-D-	-E-	
1	Number of Computers to purchase				?	←-changing cell
2	Cost per computer				\$ 1,250.00	
3	Total cost of computers				=E1*E2	

The cell containing the number of computers should be left blank as this is the value for which you are trying to solve. This is called the "changing cell".

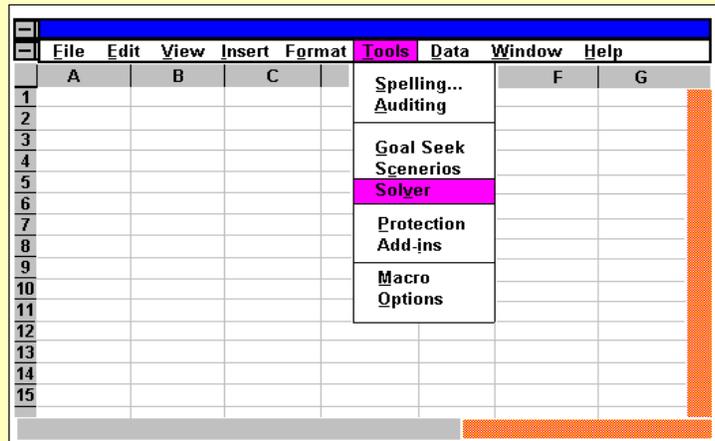
**Step 1 – continued...**

	-A-	-B-	-C-	-D-	-E-	
1	Number of Computers to purchase				?	
2	Cost per computer				\$ 1,250.00	
3	Total cost of computers				=E1*E2	←-target cell

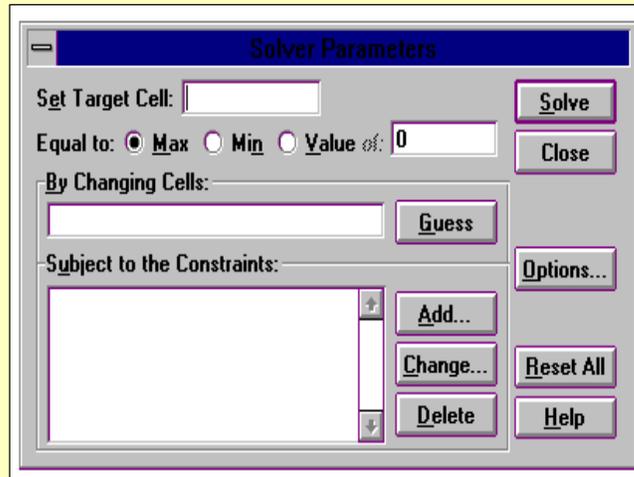
The cost per computer is given in the problem; therefore, you can enter this data directly into the "Cost per Computer" cell.

Notice that a formula goes into the cell for the "Total cost of Computers". Eventually, you want this cell's value to be equal to your budget. This is your "Target Cell." The budget amount is the value you want this cell to equal when Solver reaches a solution.

**Step 2 of 4: Select Solver from the Tools Menu**



After you select the Solver option, the following dialog box will appear that will ask you for (1) the Target cell, (2) whether you want to maximize, minimize, or set it equal to a certain value, (3) the changing cell or cells, and (4) any Constraints.



Let's first focus on the target cell.

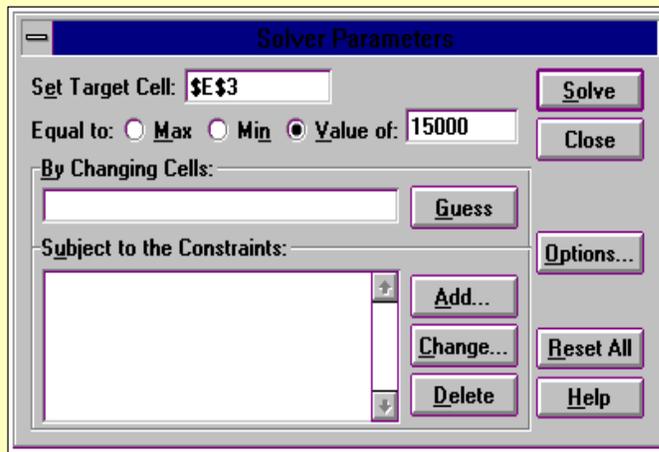
**Step 3 of 4: Specify the Target Cell**

Remember a few minutes ago, we said that the Target cell was the cell that contained the formula for Total Costs. We need to tell this to Excel by typing in the cell address or clicking on that cell while the target cell entry box is highlighted in the Solver dialog box.

	-A-	-B-	-C-	-D-	-E-
1	Number of Computers to purchase				?
2	Cost per computer				\$ 1,250.00
3	Total cost of computers				=E1*E2 ←target cell

**Step 3 -- continued...**

Once we have identified the target cell, we need to tell Excel what to do with this cell. Do we want to maximize it, minimize it, or set it equal to a certain value? In this case, we want to set it equal to our budgeted amount, \$15,000.00.



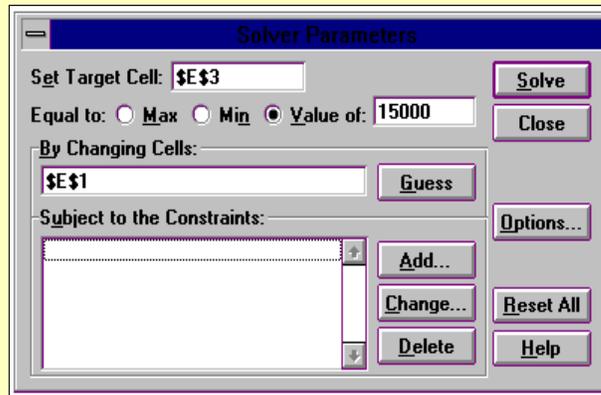
**Step 4 of 4: Specify the changing cell(s).**

After we have identified the target cell and set it equal to our budgeted amount, we need to tell Excel which cell on the worksheet should contain the value we are solving for. Remember, this is our changing cell, and in our example, it is the cell that contains the number of computers to purchase.

	-A-	-B-	-C-	-D-	-E-	
1		Number of Computers to purchase			?	<--changing cell
2		Cost per computer			\$ 1,250.00	
3		Total cost of computers			=E1*E2	

**Step 4 -- continued...**

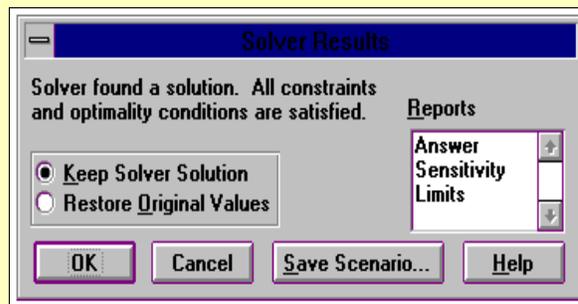
We enter the cell address of the changing cell (E1) in the "By Changing Cells" location in the dialog box. If you do not want to manually enter in the cell address, you can simply click on the cell and Excel will enter the address in the box for you.



After specifying all the information on the target cell and the changing cells, the final step is to click the "Solve" Button.

After clicking the "Solve" button, Excel will beep and produce a message informing you that Solver has found a solution. Solver will beep and produce an error message if no solution is feasible.

When Solver has found a solution, a dialog box like the one to the right will appear on your screen. This dialog box asks you whether you want to keep Solver's solution and whether you want to generate a report. Excel can generate three types of reports: (1) Answer, (2) Sensitivity, and (3) Limits.

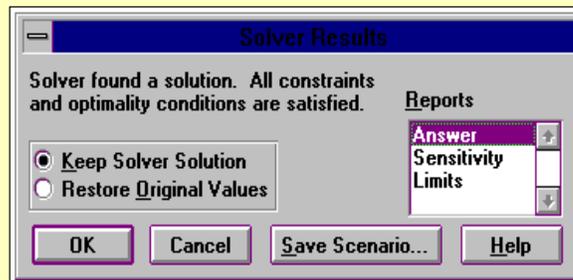


Of the three types of reports Excel will generate, the "Answer" report is the most useful for our purposes. An Answer report shows a listing of the cells that were involved in the analysis. It identifies the target cell, the changing cells, and any constraints (if used).

When Solver generates an Answer report, it places the report in a new sheet in front of the sheet on which you are currently working.

To generate an Answer report, simply click on "Answer" in the Reports listbox as shown to the right.

Always be sure to tell Excel to keep its solution by clicking on the button "Keep Solver Solution". Finally, click OK to view the solution.



To the right is an example of what an Answer report looks like. Notice that it shows the cell addresses of the target cell, the changing cell, and constraints (if used). It also shows the final values in each of these cells after Solver reaches its solution.



Microsoft Excel 5.0c Answer Report			
Report Created: 3/4/96 20:39			
Target Cell (Value Of)			
Cell Name	Original Value	Final Value	
\$E\$3	0	15000	
Adjustable Cells			
Cell Name	Original Value	Final Value	
\$E\$1	0	12	
Constraints			
NONE			

Now that you have seen how to use Solver to solve simple tasks, let's look at a more complex problem involving constraints.

Constraints are factors that limit a solution. For example, the number of computers you are able to purchase may be limited by, or constrained, by the amount of storage space you have available.

To illustrate the use of constraints, let's look at another example.

**Example:** Assume it is your responsibility to decide how many computers to produce for your company which is a computer manufacturer. For each computer, it costs \$150.00 in labor and \$200.00 in materials. Additionally, each computer requires 16 cubic feet of storage space to be held until it can be sold. The selling price for each computer is \$2,500.00.

Before making your decision, your boss tells you that only 500 cubic feet of storage space is available for your computers. Also, because of cutbacks, you cannot exceed a total of \$40,000 for labor and \$50,000 for materials. Working within these constraints, it is your responsibility to produce as many computers as possible in order to maximize total profit.

Step 1:

	-A-	-B-	-C-	-D-	-E-	
1	Number of Computers to produce				?	<--changing cell
2	Labor cost per computer				\$ 150.00	
3	Materials cost per computer				200.00	
4	Total cost per computer				=E2+E3	
5	Selling price per computer				\$ 2,500.00	
6	Total profit per computer				=E5-E4	
7						
8	Cubic feet per computer				16	
9						
10	Total labor (all computers)				=E1*E2	-constraint <=50,000
11	Total materials (all computers)				=E1*E3	-constraint <=40,000
12	Total profit (all computers)				=E1*E6	-target cell (maximize)
13	Total cubic feet (all computers)				=E1*E8	-constraint <=500

In this example, we have three constraints that we must specify in addition to the target cell and the changing cell. Also, in this example, the target cell should not be set to a specific value. Rather, it should be maximized because our goal is to make as much profit as possible.

The three constraints in this example are:

- (1) Cell E10 (Total labor) must be less than or equal to \$40,000.00,
- (2) Cell E11 (Total materials) must be less than or equal to \$50,000.00, and
- (3) Cell E13 (Total feet) must be less than or equal to 500.

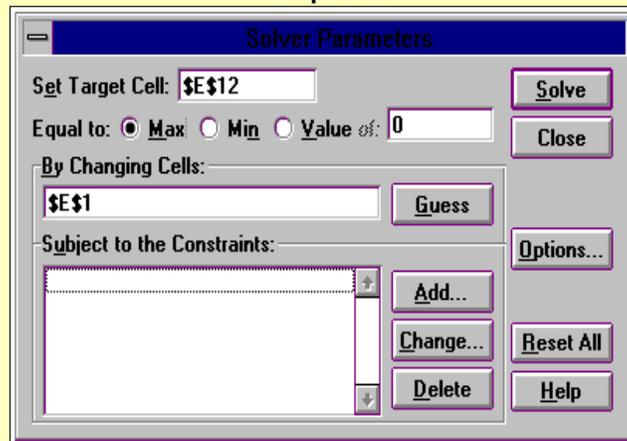
The target cell (to be maximized) is Cell E12.

The changing cell is Cell E1.

As in the previous example, to enter the target cell and the changing cell, you simply type in or click on the desired cells. In this example, notice that instead of setting the target cell equal to a value, we have chosen to "maximize" it.

Step 5 involves entering in constraints. To do this, simply click anywhere in the "Subject to Constraints" box and then click the "Add" button.

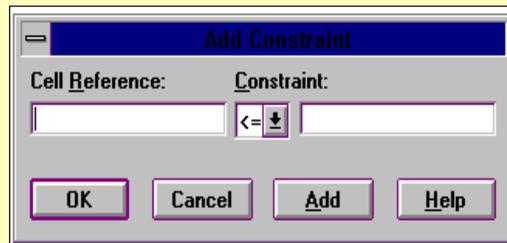
Steps 2-4...



When you click the "Add" button, the following dialog box will appear.

To specify your constraints, simply enter in the cell address of the first constraint or click on the cell that contains the constraint. Then, select the operator that best suits your constraint. In this example, the cell reference for the first constraint is E10 and the operator is  $\leq$ .

Step 5...

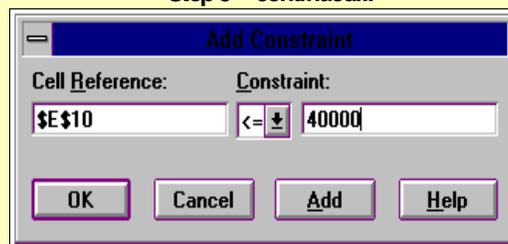


If you need to use an operator that is currently not showing, click the down arrow button beside the  $\leq$  symbol, and a listing of available operators will appear.

Finally, click in the white box beside the operator button and type in the value of your constraint. In this example, the value of the first constraint is 40,000.

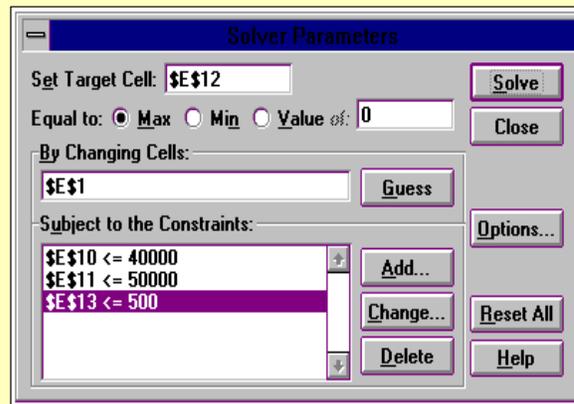
Step 5 -- continued...

If you have more constraints to add, then click the "Add" button. Clicking the "Add" button will cause this dialog box to reappear for you to enter in the next constraint.



If this is your last constraint, then click the "OK" button. Clicking this button will return you to the Solver dialog box and will show a listing of the constraints you specified in the "Subject to the Constraints" box.

If you make a mistake after you have specified your constraints, you can change any of them by highlighting the constraint and clicking the "Change" button. To delete an existing constraint, highlight the constraint and click the "Delete" button.



After all necessary items have been specified in the Solver dialog box, you can click the "Solve" button, and Solver will attempt to find a solution. As in the first example, when Solver reaches a solution, you can tell it to create an Answer report and keep its solution.

It is important to know that as you work through your Solver task, the Solver dialog box retains the last values entered into it. Therefore, if you open the Solver dialog box and values are already entered into the target cell, changing cell, and constraints boxes, you will need to click the "Reset" button to reset all values to zero before beginning.

This completes the training session on Solver. The next step in the experiment requires you to fill out two questionnaires and complete a Solver task.