LP Modeling and Using Excel@ Premium Solver for LP Modeling

- 1. Set up the data (objective function coefficients, constraint coefficients, and RHS values) for the LP model in the worksheet. A common layout is to have a column for each variable, a row for the objective function, and one row for each constraint (excluding non-negativity constraints). Be sure to enter numerical values without dollar signs and commas (you can format the cells so these are visible).
- 2. Select and label cells for each decision variable and set all initial values to 0. These cells are referred to as Changing Cells in Solver since their values change during the solution process.
- 3. Construct a SUMPRODUCT formula for the objective function that refers to the cells for the decision variables and objective function coefficients. To do this, go to the cell for the objective function and select the Formulas tab. Look for SUMPRODUCT in the "Math&Trig" category. (after you have used it, this function will be available under the "Recently Used" category). You will see a dialog box enter the formula as in the example. The cell that contains this formula is referred to as the Target Cell in Solver.
- 4. Construct a formula for the LHS of each constraint (excluding non-negativity constraints) that refers to the appropriate decision variables and coefficients. Be sure to use absolute references (e.g. \$D\$2) for the decision variables before copying any formulas to other cells. Note that the constraint relationships (≤, ≥, or =) will be entered later in the Solver dialog box and do not appear in the spreadsheet.
- 5. Select Solver from the Analysis group in the Data tab. If you do not see Solver in this location, click on the big Office button on the top LHS of your screen and click on the "Excel Options" button on the bottom right. Select "Add-Ins" from the choices on the left and then choose to Manage Excel Add-Ins and click on the Go button.

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Select Solver from the dialog box that appears and then click on OK.



Now you should be able to select Solver in the Analysis group under the Data tab and make the Solver Parameters dialog box appear:

- Specify the Target Cell as the cell containing the objective function and select Max or Min as the goal.
- Specify the Changing Cells as the cells in the spreadsheet that represent the decision variables. Be sure that decision variable values are set to 0 first.
- Select Add to define each of the constraints in the model. Constraints of the same type can be grouped together and entered once if they are located together on the spreadsheet.
- Select the Options button and choose Assume Linear Model and Assume Non-Negative.
- 6. To solve the LP model, select the Solve button in the Solver Parameters dialog box. The optimal solution values of the decision variables will appear in the cells on the spreadsheet if an optimal solution is found. Solver will identify infeasible LPs and LPs with unbounded solutions. Choose the Answer and Sensitivity reports to get more detailed information about the optimal solution.
- 7. Check the Answer Report to verify that the Original Values of the Adjustable Cells are 0. If not, delete both reports, change the values in the decision variable cells to 0, and solve the model again. Also look at the Sensitivity report to verify that it contains Shadow Prices. If the report shows Lagrange Multipliers, then the Assume Linear Model option was not selected. Deleted the wrong sheet and solve the model again with Assume Linear Model selected. Each time the model is solved, be sure to delete all wrong reports and initialize the values in the decision variable cells to 0.

- 8. Use formatting, shading, and/or borders to identify the various parts of the LP model and improve its presentation. Print the final spreadsheet with gridlines and Row/Column Headings. To do this, select the Page Layout tab and click on the relevant boxes under Sheet Options. Also print a copy of the spreadsheet that shows the <u>complete formula</u>. To see the formula on the screen, use CTRL and ~ keys. Formulas must be displayed on the screen before they can be printed. You will need to widen those cells with formula so the formula shows. In addition, print copies of the Answer and/or Sensitivity reports (as instructed). <u>NOTE</u>: Do not use any Excel filenames or worksheet names with apostrophes Solver does not run properly in these instances.
- 9. Be sure to save your spreadsheet. You MUST work the problem below as a practice run so you can successfully work on your homework. You will need to bring your copy of this file in when you have questions on Excel homework.

Recall the Advisor/Bulletin Publishing problem.

A = number of units of Advisors published

B = number of units of Bulletins published

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PQ Problem 1

Suppose you are a manager in PQ Manufacturing that makes Products P (Barnacle) and Q (Mariner) only. The demands for Products P and Q are 100 units per week for P at \$90 per unit and 50 units per week for Q at \$100 per unit. The production process to make products P and Q is given in the diagram bellow. The process starts from the bottom portion of the diagram. There are three raw materials: Steel Widget, Metal Bracket and Pine Gizmo for products P and Q. The unit costs for raw materials are \$25.00, \$20.00 and \$20.00 for Steel Widget, Metal Bracket and Pine Gizmo, respectively. Four major work centers for the production are Drilling, Painting, Welding and Assembling centers. Each work center has one operator who works 40 hours or 2400 minutes per week. As shown in the diagram, a product P is made from Steel Widget and Metal Bracket, and a product Q is made from Pine Gizmo and Metal Bracket. To make a P, Raw material Steel Widget is processed at Drilling for 15 minutes, processed at Painting for 15 minutes, processed at Drilling for 10 minutes, processed at Painting for 15 minutes, processed at Welding for 5 minutes, then spends 10 minutes to be assembled into a P with a part made from Steel Widget or spends 5 minutes to be assembled into a Q with a part made from Steel Widget or spends 5 minutes to be assembled into a Q with a part made from Steel Widget or spends 5 minutes to be assembled into a Q with a part made from Steel Widget or spends 5 minutes to be assembled into a Q with a part made from Steel Widget or spends 5 minutes to be assembled into a Q with a part made from Steel Widget or spends 5 minutes to be assembled into a Q with a part made from Steel Widget or spends 5 minutes to be assembled into a Q with a part made from Steel Widget or spends 5 minutes to be assembled into a Q with a part made from Steel Widget or spends 5 minutes to be assembled into a Q with a part made from Steel Widget or spends 5 minutes to be assembled into a Q with a part made from Steel Widget or spends 5 minutes to be ass



Assignment

- 1. Understand the problem
- 2. Draw a process flow chart for the PQ production to see the sequence of parts going through each of the machines or work centers
- 3. What is your criteria in deciding the product mix for P and Q? (Hint: How do people in Marketing, Accounting, Production and so forth make their decisions in a situation like this one? Do you think people in different department have different criteria? What are those criteria? Why?)
- 4. You may like to put your analytic skills in use to analyze the potential profit, to do break even analysis, to calculate capacity for work centers, and so on, to support your claims
- 5. What is your "common sense" solution to the problem?
- 6. Yon may not spend more than one hour on the problem. Please feel free to discuss the assignment with your peers.
- 7. Present your findings in class either individually or in group.
- 8. Bottleneck