CS 5



### *Summary of the Formulation*

The above analysis of the four components of the model has formulated the following linear programming model (in algebraic form) on the spreadsheet:

$$\text{Maximize} \quad \text{Exposure} = 1{,}300\text{TV} + 600M + 500\text{SS}$$

subject to

$$\text{Ad spending:} \quad 300\text{TV} + 150M + 100\text{SS} \leq 4{,}000$$

$$\text{Planning costs:} \quad 90\text{TV} + 30M + 40\text{SS} \leq 1{,}000$$

$$\text{Number of television spots:} \quad \text{TV} \leq 5$$

and

$$\text{TV} \geq 0 \quad M \geq 0 \quad \text{SS} \geq 0$$

The difficult work of defining the problem and gathering all the relevant data in Table 4.1 leads directly to this formulation.

### *Solving the Model*

**Excel Tip:** The Solver dialogue box is used to tell Solver the location on the spreadsheet of several of the elements of the model: the changing cells, the target cell, and the constraints.

To solve the spreadsheet model formulated above, some key information needs to be entered into the Solver dialogue box. The lower left-hand side of Figure 4.1 shows the needed entries: *the target cell (TotalExposures), the changing cells (NumberOfAds), the objective of maximizing the target cell,* and the constraints BudgetSpent ≤ BudgetAvailable and TVSpots ≤ MaxTVSpots. In addition, the lower left-hand corner of the figure shows that two Solver options need to be selected: Assume Linear Model (because the model is a linear programming model) and Assume Non-Negative (because negative levels of advertising are impossible). Clicking on the Solve button then tells the Solver to find an optimal solution for the model and display it in the changing cells.

The optimal solution given in row 13 of the spreadsheet provides the following plan for the promotional campaign:

Do not run any television commercials.

Run 20 advertisements in magazines.

Run 10 advertisements in Sunday supplements.

Since TotalExposures (H13) gives the expected number of exposures in thousands, this plan would be expected to provide 17,000,000 exposures.

### *Evaluation of the Adequacy of the Model*

When she chose to use a linear programming model to represent this advertising-mix problem, Claire recognized that this kind of model does not provide a perfect match to this problem. However, a mathematical model is intended to be only an approximate representation of the real problem. Approximations and simplifying assumptions generally are required to have a workable model. All that is really needed is that there be a reasonably high correlation between the prediction of the model and what would actually happen in the real problem. The team now needs to check whether this criterion is satisfied.

Linear programming models allow fractional solutions.

One assumption of linear programming is that *fractional* solutions are allowed. For the current problem, this means that a fractional number (e.g., 3½) of television commercials (or of ads in magazines or Sunday supplements) should be allowed. This is technically true, since a commercial can be aired for less than a normal run, or an ad can be run in just a fraction of the usual magazines or Sunday supplements. However, one defect of the model is that it assumes that Giacomi & Jackowitz's cost for planning and developing a commercial or ad that receives only a fraction of its usual run is only that fraction of its usual cost, even though the actual cost would be the same as for a full run. Fortunately, the optimal solution obtained above was an *integer* solution (0 television commercials, 20 ads in magazines, and 10 ads in Sunday supplements), so the assumption that fractional solutions are allowed was not even needed.