

CS 6

Linear programming models should use SUM or SUMPRODUCT functions for the output cells, including the target cell.

Another key assumption of linear programming is that the appropriate equation for each of the output cells, including the target cell, is one that can be expressed as a SUMPRODUCT of data cells and changing cells (or occasionally just a SUM of changing cells). For the target cell (cell H13) in Figure 4.1, this implies that the expected number of exposures to be obtained from each advertising medium is *proportional* to the number of advertisements in that medium. This proportionality seems true, since each viewing of the advertisements by some individual counts as another exposure. Another implication of using a SUMPRODUCT function is that the expected number of exposures to be obtained from an advertising medium is unaffected by the number of advertisements in the other media. Again, this implication seems valid, since viewings of advertisements in different media count as separate exposures.

Although a SUMPRODUCT function is appropriate for calculating the expected number of exposures, the choice of this number for the overall measure of performance is somewhat questionable. Management's real objective is to maximize the profit generated as a result of the advertising campaign, but this is difficult to measure so *expected number of exposures* was selected to be a surrogate for profit. This would be valid if profit were proportional to the expected number of exposures. However, proportionality is only an approximation in this case because too many exposures for the same individual reach a saturation level where the impact (potential profit) from one more exposure is substantially less than for the first exposure.

To check how reasonable it is to use expected number of exposures as a surrogate for profit, Claire meets with Sid Jackowitz, one of the senior partners of Giacomi & Jackowitz. Sid indicates that the contemplated promotional campaign (20 advertisements in magazines and 10 in Sunday supplements) is a relatively modest one well below saturation levels. Most readers will only notice these ads once or twice, and a second notice is very helpful for reinforcing the first one. Furthermore, the readership of magazines and Sunday supplements is sufficiently different that the interaction of the advertising impact in these two media should be small. Consequently, Claire concludes that using expected number of exposures for the target cell in Figure 4.1 provides a reasonable approximation. (A continuation of this case study in Case 10.1 will delve into the more complicated analysis that is required in order to use profit directly as the measure of performance to be recorded in the target cell instead of making this approximation.)

Next, Claire quizzes Sid about his firm's costs for planning and developing advertisements in these media. Is it reasonable to assume that the cost in a given medium is proportional to the number of advertisements in that medium? Is it reasonable to assume that the cost of developing advertisements in one medium would not be substantially reduced if the firm had just finished developing advertisements in another medium that might have similar themes? Sid acknowledges that there is some carryover in ad planning from one medium to another, especially if both are print media (e.g., magazines and Sunday supplements), but that the carryover is quite limited because of the distinct differences in these media. Furthermore, he feels that the proportionality assumption is quite reasonable for any given medium since the amount of work involved in planning and developing each additional advertisement in the medium is nearly the same as for the first one in the medium. The total fee that Super Grain will pay Giacomi & Jackowitz will eventually be based on a detailed accounting of the amount of work done by the firm. Nevertheless, Sid feels that the cost estimates previously provided by the firm (as entered in cells C9, D9, and E9 in units of thousands of dollars) give a reasonable basis for roughly projecting what the fee will be for any given plan (the entries in the changing cells) for the promotional campaign.

Based on this information, Claire concludes that using a SUMPRODUCT function for cell F9 provides a reasonable approximation. Doing the same for cell F8 is clearly justified. Given her earlier conclusions as well, Claire decides that the linear programming model incorporated into Figure 4.1 (plus any expansions of the model needed later for the detailed planning) is a sufficiently accurate representation of the real advertising-mix problem. It will not be necessary to refine the results from this model by turning next to a more complicated kind of mathematical model (such as those to be described in Chapter 10).

Therefore, Claire sends a memorandum to the company's president, David Sloan, describing a promotional campaign that corresponds to the optimal solution from the linear programming