

- b. Does the proportionality assumption of linear programming seem to be satisfied reasonably well for this product?
- c. To the extent that profit is not strictly proportional to the production rate, does this product have decreasing marginal returns, increasing marginal returns, or neither?
- E* d. Use Excel's curve fitting method to (1) obtain a nonlinear formula with a quadratic form for the profit graph and then (2) construct the graph.
- 8.2. Consider the following three cases for how the profit from an activity varies with the level of the activity.

Level of Activity	Profit (\$)		
	Case 1	Case 2	Case 3
0	0	0	0
1	9	6	5
2	16	14	6
3	21	24	3
4	24	36	4
5	25	50	7

- a. For each case, draw the profit graph by plotting the profits for the various levels of the activity and then drawing a smooth curve through the points by hand.
- b. For each case, indicate whether the activity has decreasing marginal returns, increasing marginal returns, or neither.
- c. How would your answers in part *b* change if the graphs plotted in part *a* were cost graphs instead of profit graphs?
- E* d. For each case, use Excel's curve fitting method to (1) obtain a nonlinear formula with a quadratic form for the profit graph and then (2) construct the graph. For any case where the activity has neither decreasing marginal returns nor increasing marginal returns, comment on how good a fit is provided by using a quadratic form.

8.3. The Chiplet Corporation is about to launch the production and marketing of a new microchip that is more powerful than anything that is currently on the market. Not surprisingly, the profitability of this microchip will depend greatly on its reception in this highly competitive and fast-moving market. If the sales are fairly low, the company will still be able to make a respectable profit because it will have enough available production capacity to produce the microchip with its current facilities. However, if sales are somewhat higher, the company will need to expand its production facilities, which will have the effect of depressing the profit from the microchip if sales only reach a moderate level. (Fully meeting this demand would still be worthwhile because one of top management's prime goals is to continue increasing the company's market share as it points toward future generations of microchips already under development.) Fortunately, if sales reach a relatively high level, the profit from the microchip will become very substantial. The following table shows the estimated profit for various levels of sales over the short lifetime of this microchip.

Sales	Profit (millions of dollars)
0	0
100,000	15
200,000	18
300,000	13
400,000	4
500,000	1
600,000	6
700,000	30
800,000	70

- a. Draw a profit graph for this microchip by plotting the profits for the various sales levels and then drawing a smooth curve that passes through (or very near) these points.
- b. Does the microchip have decreasing marginal returns, increasing marginal returns, or neither?
- E* c. Use Excel's curve fitting method to (1) obtain a nonlinear formula with a quadratic form (a polynomial of order 2) for the profit graph and then (2) construct the graph.
- E* d. Repeat part *c* when using the Excel option of a polynomial of order 3 instead of order 2.
- e. Which of the Excel options used in parts *c* and *d* does a better job of fitting the profit graph to the data?

8.4. The following table shows the estimated daily profit from a new product for several of the alternative choices for the production rate.

Production Rate (<i>R</i>)	Profit per Day (<i>P</i>)
0	0
1	\$ 95
2	184
3	255
4	320

Because the profit goes up less than proportionally with the production rate (decreasing marginal returns), the management science team analyzing what this production rate (and the production rates of some other products) should be has decided to approximate the profit (*P*) by a simple *nonlinear function* of the production rate *R*.

- a. One such approximation is $P = \$100R - \$5R^2$. How closely does this nonlinear function approximate the five values of *P* given in the table?
- b. Repeat part *a* for the approximation, $P = \$104R - \$6R^2$.
- c. Which of these two nonlinear functions provides the better fit to all the data?
- E* d. Use Excel's curve fitting method to (1) obtain a nonlinear formula with a quadratic form for the profit graph and then (2) construct the graph.

8.5. Read the referenced article that fully describes the management science study summarized in the application vignette presented in Section 8.2. Briefly describe how nonlinear programming was applied in this study. Then list the various financial and nonfinancial benefits that resulted from this study.