Introduction to Modeling

Example:

The Woodworks Company produces a variety of custom-designed wood furniture for its customers. One favorite item is a bookshelf, made from either cherry or oak. The company knows that wood prices and labor costs are likely to increase in the future. Below table shows the number of board-feet and labor hours required for a bookshelf, the current costs per board-foot and labor hour, and the anticipated annual increases in these costs. Build a spreadsheet model that enables the company to experiment with the growth rates in wood and labor costs so that a manager can see, both numerically and graphically, how the costs of the bookshelves vary in the next few years.

Resource	Cherry	Oak	Labor
Required per Bookshelf	30	30	16
Current Unit Cost	$5.50	$4.30	$18.50
Anticipated Annual Cost Increase	2.4%	1.7%	1.5%

Table: Input Data

- Input Variables: Wood and labor requirements per bookshelf, current unit costs of wood and labor, anticipated annual increases in unit costs.
- Output Variables: Projected unit costs of wood and labor, projected total bookshelf costs.

Example:

The Quality Sweaters Company sells hand-knitted sweaters. The company is planning to print a catalog of its products and undertake a direct mail campaign. The cost of printing the catalog is $20,000 plus $0.10 per catalog. The cost of mailing each catalog (including postage, order forms, and buying names from a mail-order database) is $0.15. In addition, the company plans to include direct reply envelopes in its mailings and incurs $0.20 in extra costs for each direct mail envelope used by a respondent. The average size of a customer order is $40, and the company's variable cost per order (due primarily to labor and material costs) averages about 80% of the order's value—that is, $32. The company plans to mail 100,000 catalogs. It wants to develop a spreadsheet model to answer the following questions:

1. How does a change in the response rate affect profit?
2. For what response rate does the company break even?
3. If the company estimates a response rate of 3%, should it proceed with the mailing?
4. How does the presence of uncertainty affect the usefulness of the model?

We also have,

- Input Variables: Various unit costs, average order size, response rate
- Decision Variables: Number mailed
- Output Variables: Profit, Number of Responses, Revenue, and Cost Totals

Example:

The Links Company sells its golf clubs at golf outlet stores throughout the United States. The company knows that demand for its clubs varies considerably with price. In fact, the price has varied over the past 12 months, and the demand at each price level has been observed. The data are in the below table. For example, during the past month, when the price was $390, 6800 sets of clubs were sold. The company wants to estimate the relationship between demand and price and then use this estimated relationship to answer the following questions:

- Assuming the unit cost of producing a set of clubs is $250 and the price must be a multiple of $10, what price should Links charge to maximize its profit?
- How does the optimal price depend on the unit cost of producing a set of clubs?

Month	Price	Demand
1	450	45
2	300	103
3	440	49
4	360	86
5	290	125
6	450	52
7	340	87
8	370	68
9	500	45
10	490	44
11	430	58
12	390	68

Table: Input Data

We consider the following 3 models:

- Linear: $y = a + bx$
- Power: $y = ax^n$
- Exponential: $y = ae^{bx}$

We also have

- Input Variables: Unit Cost to Produce
- Decision Variables: Unit Price
- Output Variables: Profit, Predicted Demand, Total Revenue, Total Cost

Example:

The Pigskin Company produces footballs. Pigskin must decide how many footballs to produce each month. The company has decided to use a six-month planning horizon. The forecasted monthly demands for the next six months are 10,000, 15,000, 30,000, 35,000, 25,000, and 10,000. Pigskin wants to meet these demands on time, knowing that it currently has 5000 footballs in inventory and that it can use a given month's production to help meet the demand for that month. (For simplicity, we assume that production occurs during the month, and demand occurs at the end of the month.) During each month there is enough production capacity to produce up to 30,000 footballs, and there is enough storage capacity to store up to 10,000 footballs at the end of the month, after demand has occurred. The forecasted production costs per football for the next six months are $12.50, $12.55, $12.70, $12.80, $12.85, and $12.95, respectively. The holding cost per football held in inventory at the end of any month is figured at 5% of the production cost for that month. (This cost includes the cost of storage and also the cost of money tied up in inventory.) The selling price for footballs is not considered relevant to the production decision because Pigskin will satisfy all customer demand exactly when it occurs—at whatever the selling price is. Therefore, Pigskin wants to determine the production schedule that minimizes the total production and holding costs.

We have

- Input Variables: Initial Inventory, Holding Cost as %, Production Cost, Production Capacity, Demand, Storage Capacity
- Decision Variables: Units Produced
- Output Variables: Total Cost