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# A Product Mix Optimization Model

by Leonardo P. Sangalang, Jr.*

In an environment where the demand for a company's products is more than its plant capacity, management is usually faced with the task of deciding which product lines to produce and push in the market. Offhand, the products with higher profit contributions are considered and generally selected. The company makes a profit and the stockholders are pleased. In this situation, a critical question, normally overlooked because the company is making money, is whether the company has actually achieved the maximum profit from the use of its limited resources.

Let us take the case of a company which produces electrical wires and cables.

To produce its numerous products, the company uses the following resources, among others.

1. Raw materials, (more significantly, copper)
2. Machines.

Since these resources are limited, especially the machines, these constrain the company from producing as much as the market can absorb. Additional constraints are commitments to customers made by the sales department to deliver specified quantities of several products. Furthermore, even though the market as a whole is more than the company's plant capacity, the potential sales quantities of individual products are not infinite.

The other important factors in the selection of the product mix are the net selling prices and unit costs of the products, their usages of materials and utilization of machines. Unit contribution of a product is defined as its net selling price less its unit cost.

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The interplay of the resources, sales commitments and potentials, unit contributions, materials usages and machine utilization will determine the optimal product mix. This determination is easier said than done or explained.

**Data Preparation**

With the aid of a computer, the company created a product standards data bank (STANDARDS File) which contained for each product the following data (simplified):

1. Selling price
2. Materials usages (including wastages)
3. Machine utilization (including set-up time.)

In another computer file (GENERAL DATA File) are contained the more variable data, such as:

1. Raw materials costs and supply
2. Machine capacities
3. Power usages and costs
4. Labor costs
5. Discount rates

The main reason for separating the two files mentioned above is the frequency of revisions. The STANDARDS File is rarely revised since it contains basically static data. The GENERAL DATA File is usually revised every six months when the company budget is reviewed and prepared.

During the budget preparation, the sales department prepares the sales commitments and potentials of the company products. Commitments are product quantities which the company is obliged to deliver to customers. Potentials are the maximum product quantities which the sales department thinks the market can absorb. These are recorded in another computer file (SALES File).

**Product Mix Optimization**

Using the STANDARDS and GENERAL DATA Files, the following data per product are calculated:

1. Net Selling price
2. Variable manufacturing costs
   a) Material Cost
   b) Labor Cost
   c) Power Cost
3. Unit contribution (Net selling price less variable manufacturing cost)
4. Materials usages
5. Machine utilization

At this point, an OR technique called *linear programming* is used. Putting it in layman's terms, the application of this technique to the company is summed up as follows:

1. When a product quantity is produced, raw materials are used and machines are utilized. However, raw materials supply and machine capacities are limited.
2. When a product quantity is produced and sold, the company earns the excess of the net selling price over the variable costs. This is called the product's contribution to profit.
3. The product quantity produced must be at least equal to the committed sales but not more than what the market can absorb (potential sales).
4. The LP technique will determine the product mix between the committed sales and sales potentials which maximizes the total contribution but will not exceed the materials supply and machine capacity constraints.

**How This Model Was Used**

The model was used primarily to assist in the preparation of the sales budget for the coming year. This was done every semester.

1. The purchasing department makes a forecast of the raw material prices and delivery schedule.
2. The production department supplies the machine capacities data.
3. The methods group reviews the production method sheets to determine the validity of the product standards (e.g., running time, set up time, economical run, etc.)
4. The finance/accounting department provides the standard costs of manpower, power and other utilities.
5. The sales department estimates the potential and committed sales quantities.
6. The above data are forwarded to the EDP section for collation.
7. The computer files are updated and the linear programming software is applied on the data to generate the optimum product mix.
8. The computer program prints out several reports:
   a) Machine utilization (% of capacity)
   b) Material usages
   c) Product mix listing
   d) Breakdown of overall variable manufacturing costs
   e) Profit and loss statement
9. The reports are reviewed by senior management and program re-runs are made until the final sales budget is agreed upon.

Aside from this budget preparation exercise, the model was also used in plant expansion plans. Sales forecasts for the next five years are made to determine which machines need additional units.

## SIMPLIFIED SAMPLE MATRIX

| | Product | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *1* | *2* | *3* | *4* | *5* | | | |
| Material 1 | 1 | 1 | 2 | 2 | 2 ⩽ | Material | 1 | Supply |
| 2 | 0 | 1 | 0 | 1 | 0 ⩽ | " | 2 | " |
| 3 | 2 | 1 | 0 | 1 | 1 ⩽ | " | 3 | " |
| 4 | 0 | 0 | 2 | 1 | 1 ⩽ | " | 4 | " |
| Machine 1 | 10 | 10 | 20 | 20 | 20 ⩽ | Machine | 1 | Capacity |
| 2 | 0 | 5 | 0 | 0 | 10 ⩽ | " | 2 | " |
| 3 | 20 | 5 | 0 | 0 | 10 ⩽ | " | 3 | " |
| 4 | 0 | 0 | 10 | 5 | 0 ⩽ | " | 4 | " |
| 5 | 0 | 0 | 10 | 5 | 10 ⩽ | " | 5 | " |
| 6 | 10 | 5 | 0 | 10 | 0 ⩽ | " | 6 | " |
| Unit Contribution (MAX) | 20 | 30 | 20 | 5 | 10 | | | |
| Commitments | 100 | 0 | 200 | 50 | 150 | | | |
| Potentials | 1,000 | 2,000 | 600 | 700 | 500 | | | |