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Economics of using Substitutes or Synthetics as Raw Materials

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In the processing of raw materials into finished goods, the potential exists of using a cheaper substitute for a traditional material. But its utility must be tested — and this costs money. Here's a way to find —

THE ECONOMICS OF USING SUBSTITUTES OR SYNTHETICS AS RAW MATERIALS

by Robert D. Zemnickas
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On Monday morning Supplier A contacts Company XYZ offering to supply a raw material at x cents a pound lower than the price of a currently used material. Monday afternoon brings Supplier B to Company XYZ requesting an evaluation of his product, which will reduce the raw material cost of Company XYZ y cents per pound. Tuesday Supplier C submits to Company XYZ a raw material equal in cost to a material now in use but able to accomplish the identical results when used in lesser amount. Company XYZ must now make some decisions. Should Company XYZ incur the development and evaluation costs of studying all of these materials, some of them, or none? Almost all firms today are faced with making these decisions, especially companies in process industries such as the chemical or textile industries.

It is economic suicide for a company to investigate and evaluate all the new products that offer a potential increase in a firm's profits. Some amount of applied research and development is necessary, however, or a firm cannot remain competitive in today's market. A complete analysis is an expensive procedure, and the results may be inconsequential. The costs of nonproductive evaluations must be paid for out of revenues created out of present operations, are not recoverable through increased profits, and detract from current profits.

A method by which a firm, be it a single proprietorship, partnership, or corporation, can determine before the actual analysis whether an

evaluation is economically advantageous or not is therefore desirable. This preliminary economic analysis will increase the return on the costs of applied research in the long run. Such a method is described in this article and illustrated by means of an example from the synthetic rubber industry.

Economic analysis

In an operation that is not utilizing all of its facilities this type of analysis is not imperative. In this situation almost all possible evaluations can be made. Keeping the facilities and manpower functioning is better than idle time. But if an operation has to eliminate some projects because of undercapacity, a preliminary cost analysis is imperative. Each possible project should be evaluated so that the firm can use its existing development resources in such a way as to minimize the firm's opportunity costs, maximize the benefits, and therefore optimize the internal rate of return. This result would be attained by evaluating only those materials likely to return the greatest benefits.

If the outcome of this economic analysis shows that the total cost of the evaluation is less than the probable benefits, the evaluation should be run. If, however, the preliminary economic analysis reveals that the benefits to the company will not recover the costs of the evaluation, the analysis of the raw material substitution should not be started. This will leave the company free to investigate other possible areas where the returns to the company will be beneficial.

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The use of a PERT (Program Evaluation Review Technique) analysis in the evaluation of a possible raw material change has definite advantages. Figure 1 on page 35 is a typical PERT chart showing the events required for raw material substitution in the synthetic rubber industry. One must think the procedure through, isolating all activities that comprise an evaluation in a systematic, orderly manner. This indicates the decision points throughout the entire evaluation. The costs of the analysis can then be determined and evaluated against any possible increase in profits that might result if the material is actually incorporated into the product. The total cost is the summation of the individual costs from the initial decision to investigate to the final decision of whether to substitute or not. This total cost is the critical figure needed to implement this model.

Price/cost relationship

To determine whether the total cost of the evaluation will be recovered and profits will actually increase within a definite period of time if the substitution occurs, it is necessary to develop a manufacturing cost versus selling price relationship. This relationship will be different for each industry and for each firm within a particular market.

The synthetic rubber industry is a high-volume low-margin industry, as indicated in Figure 2 on page 36. Firms that are in this type of market are extremely cost conscious. A small percentage reduction in their costs will have a proportionately larger effect on their profit margin.

For the purpose of this economic evaluation it is assumed that a constant unit selling price prevails (i.e., constant price/unit volume). This is assumed because to develop a comprehensive evaluation of the pricing structure would involve a complete analysis of the external environment of the firm. The entire marketing structure of the industry and firm would have to be simulated. The details and methods presented in this article would apply to such an analysis, but a detailed evaluation of this type is beyond the scope of this paper. A detailed analysis of the cost components is therefore necessary to develop a meaningful price/cost relationship. This necessitates isolating fixed costs from variable costs. What we are interested in is finding costs that are constant over time and volume [$C = C\ (t,v)$] and costs which are not [$C = f\ (t,v)$].

It can be assumed that the present raw material cost/selling price relationship will remain unchanged. Companies will raise their selling prices as currently used raw material prices increase to maintain the current profit margin. Administration and general expenses are considered fixed. It can also be assumed that inventories, overhead, sales, and marketing costs remain constant at a given level of output. With these parameters constant, the factor of production that will be considered as variable is the cost of direct labor.

The cost of direct labor is assumed to be rising so that at some future time the cost per unit of output will equal the selling price. This follows from our earlier assumption that selling price per unit volume is fixed or will only increase to maintain the same profit margin when raw material prices increase. This is illustrated by Point A in Figure 2. This defines the production cost/selling price relationship for the purpose of this economic model. The relationship is now defined in such a way that the effect a raw material substitution will have upon the returns to a company may be analyzed.

Return on investment

Figure 3 on page 36 presents the cost structure of an evaluation and its effects upon the returns to a company. The expenses during the time from t_o, when the decision was

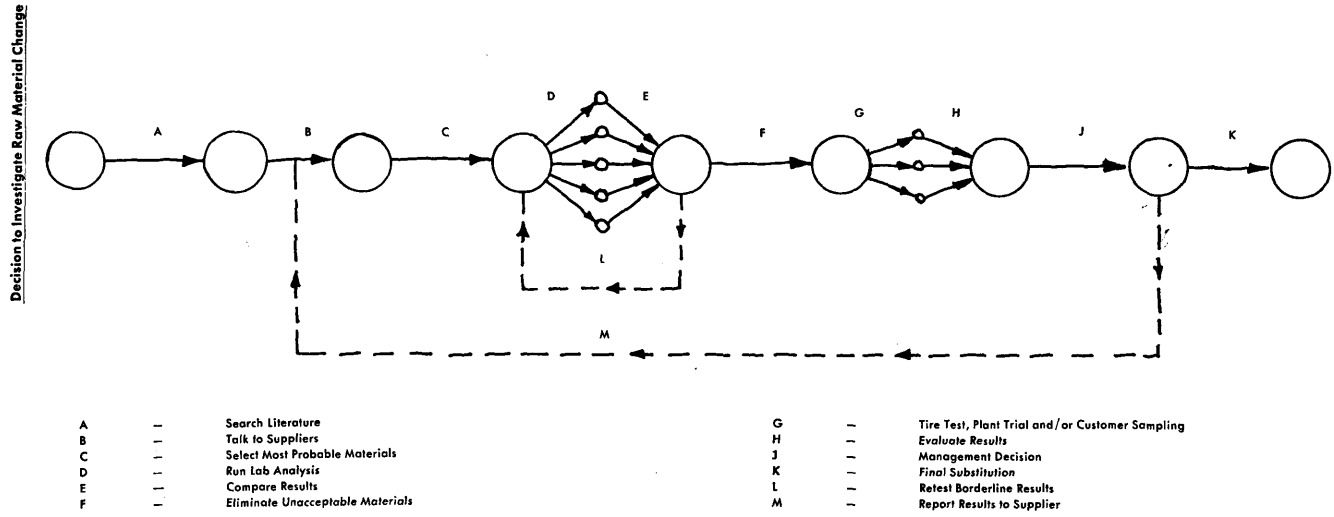


FIGURE 1

made to investigate the raw material substitution, until the time t_d, when the decision to substitute or not is made, indicates the total cost of the evaluation from inception. These are expenses that have been incurred. They must be paid for out of the firm's revenues.

If at time t_d the decision is that the material cannot be substituted into the product, the evaluation has economically been useless and detrimental to the firm's financial position. It will take until time t_{ns} to recover the evaluation costs at the firm's present profit margin. Having to pay for the evaluation will detract from present profits. Furthermore, the total profits of the firm will never be as high as they would have been if the cost of the evaluation had not been incurred.

If, on the other hand, at time t_d the decision was made to substitute the material into the product, the time to recover the cost of the evaluation would be t_s, a shorter period of time because of a faster rate of return. This time decrease (t_{ns}-t_s), however, must be significantly large enough to increase the rate of return so that the time necessary to recover the evaluation costs is reasonable. A "reasonable" time will differ from industry to industry depending upon the structure of the individual industry and firm.

This increase in profits is the figure that must be compared against the cost of the evaluation. Unless the increase in profits will at least recover the development and evaluation costs and return a rate of return higher than the present price/cost structure, a company is only fooling itself by even evaluating the new material. Unless this type of analysis is done, the development expenses may well cost more than the benefits returned.

The price/cost relationship model has been defined. It is now possible to determine the effect that a study to determine the feasibility of substituting a new raw material for a currently used material will have upon the returns to a firm.

Implementation of the model

The previously determined PERT chart (Figure 1) is the basis for evaluating those costs that must be defined. Figure 4 on page 37 is the cost flow chart for a raw material substitution showing the costs that will be incurred during the investigation. The isolation of the individual costs and an exact determination of them are of critical importance.

If even one of these costs is incorrect, an unsound decision may result. If the costs determined are too high, investigations that might actually benefit the firm will be deleted. On the other hand, if the costs reported are too low, evaluations that might not benefit the firm will be explored. Decisions based upon both types of errors will detract from profits. Costs that are too high will reduce the firm's profits in the long run while costs that are too low will detract from the firm's short-run position by increasing present expenses.

Example

The cost flow chart showed that to evaluate a specific raw material the firm will incur a total cost of $2,300. This $2,300 is the figure upon which all possible future evaluations of this type of raw material will be based. The criterion now has been determined; its application can be examined.

Suppliers A, B, and C contact a

FIGURE 2

Cost/Price Relationship for the Synthetic Rubber Industry

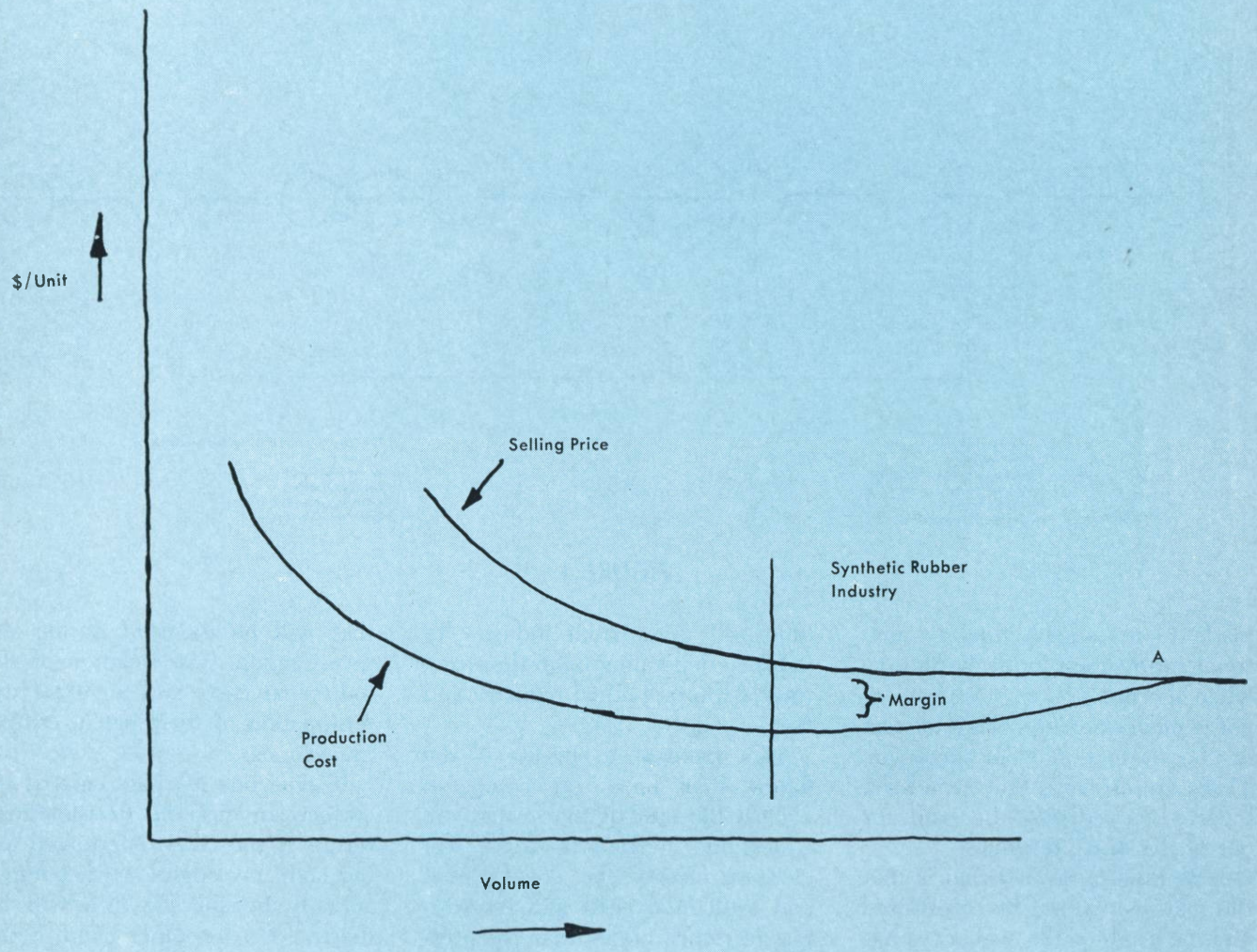


FIGURE 3

Outlay and Return on Raw Material Costs

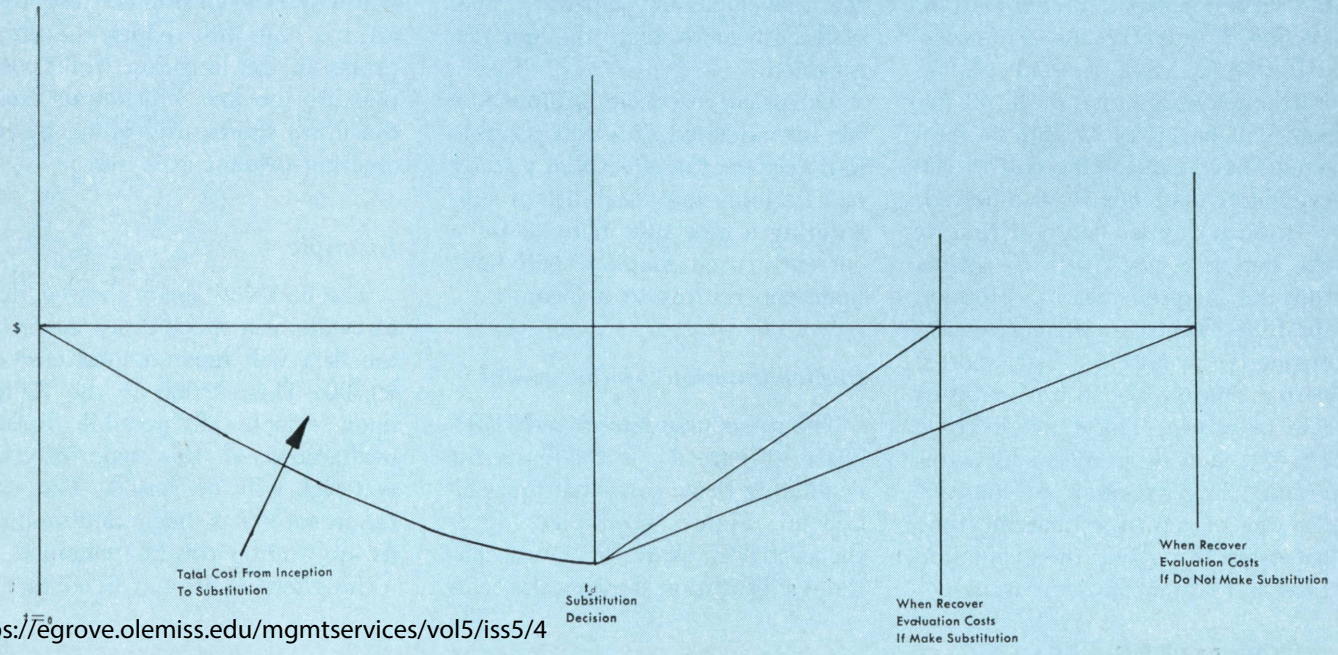
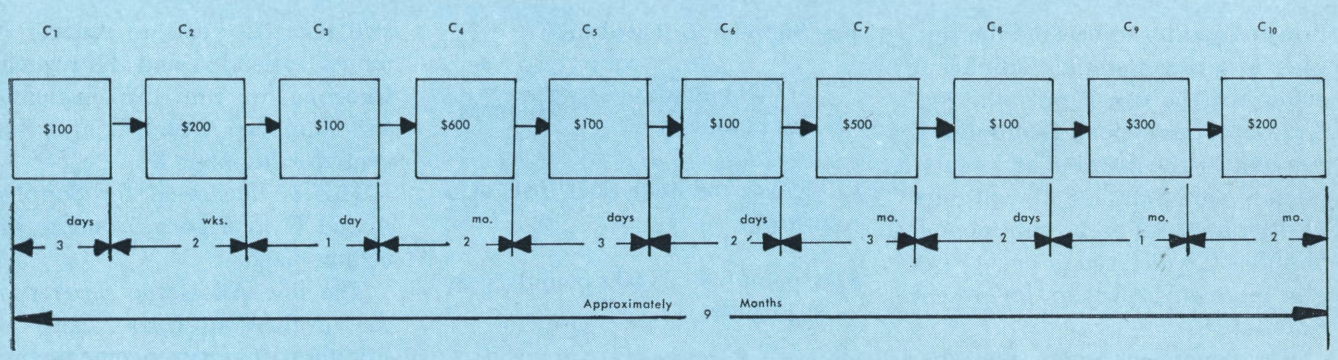


FIGURE 4

Cost and Time Flow for Raw Material Substitution

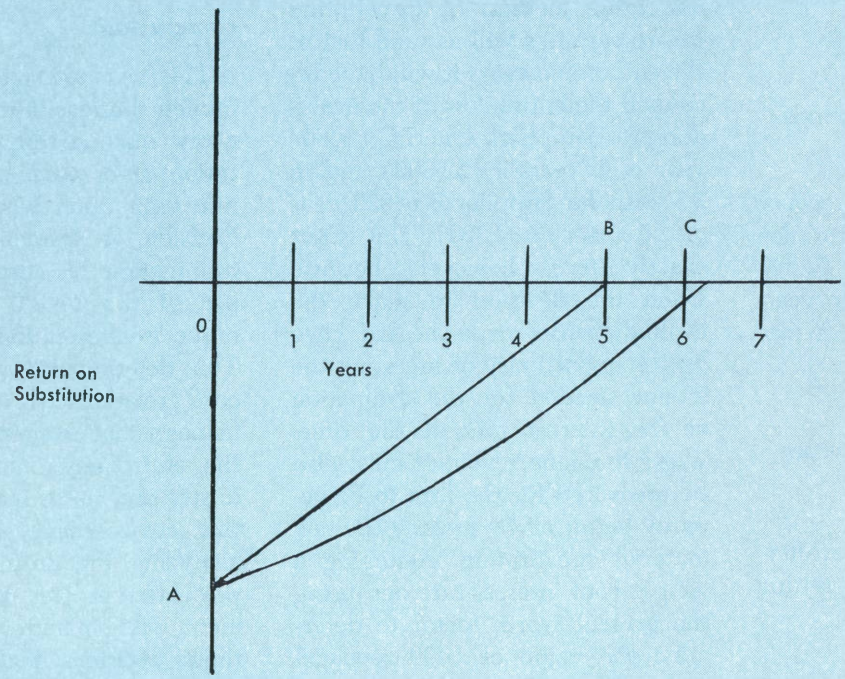


Costs Incurred

C_1	—	Search Literature
C_2	—	Talk to Suppliers
C_3	—	Select Materials
C_4	—	Laboratory Testing
C_5	—	Analyze Results
C_6	—	Eliminate Unacceptable Materials
C_7	—	Tire Test, Customer Sampling, Plant Trial
C_8	—	Evaluate Results
C_9	—	Management Decision
C_{10}	—	Final Substitution

FIGURE 5

Straight Line Versus Present Value Return Analysis



Increase in profits is the figure that must be compared with evaluation costs

firm, requesting to become the supplier of a raw material. Supplier A states that he can supply the material at x cents/pound; Supplier B can deliver the material at y cents/pound; and Supplier C will supply the material at z cents/pound. Supplier C's material is twenty per cent more efficient than the present material.

The economic model now becomes useful.

The firm that must run the evaluation knows that the price it is paying for its current raw material is $.10 a pound. Furthermore, the price quoted by Supplier A is two cents a pound less than that paid for the current material; the price suggested by Supplier B is four cents a pound less; and the price of Supplier C is equal to the price of the current material. The firm also knows that the evaluation will cost $2,300. Therefore, the firm must use

$$\frac{\$2{,}300}{\$.02/\text{pound}} = 115{,}000 \text{ pounds}$$

of Supplier A's material and

$$\frac{\$2{,}300}{\$.04/\text{pound}} = 57{,}500 \text{ pounds}$$

of Supplier B's material to recover the evaluation costs. The firm also knows that it now uses 23,000 pounds of this material per year. At this level for Supplier A's material it will take

$$\frac{115{,}000 \text{ pounds}}{23{,}000 \text{ pounds/year}} = 5 \text{ years}$$

to recover the cost of the evaluation, with an annual dollar return to the firm of

$.02/pound × 23,000 pounds/year = $460/year.

For Supplier B it will take

$$\frac{57{,}000 \text{ pounds}}{23{,}000 \text{ pounds/year}} = 2.5 \text{ years}$$

to recover the analytical costs at a return of

$.04/pound × 23,000 pounds/year = $920/year.

Supplier C, by reducing the amount needed by twenty per cent, will lower the annual consumption to

23,000 pounds/year − .20(23,000 pounds/year) = 18,400 pounds/year or a cost reduction of

(23,000 pounds/year) (.$10/year) − (18,400 pounds/year) ($.10/pound) = $460/year.

Therefore, it will take

$$\frac{\$2{,}300}{\$460/\text{year}} = 5 \text{ years}$$

to recover the costs of evaluating Supplier C's material.

A firm that does not use the present value method of discounting future earnings will assume that at the end of five years it will have recouped the entire cost of the evaluation for Suppliers A and C ($460/year × 5 years = $2,300) and in 2.5 years for Supplier B ($920/year × 2.5 years = $2,300). This is not exactly true, however, because when the decision to make the evaluation was made the firm gave up the opportunity of investing the money needed for the evaluation at the interest rate at the time. These foregone revenues must also be recovered for the firm to be actually better off by making the raw material substitution. Assuming a six per cent interest rate and using the present worth factor to determine the value of $460 received over a future time, the present value calculation shows it actually will take 6.2 years to recover the money expended and the revenues foregone to run this evaluation for Suppliers A and C and three years for Supplier B.

This is illustrated for Suppliers A and C in Figure 5 on the preceding page.

The line AB is the recovery of the evaluation costs using the straight cost versus income method. However, the present value method shows that the cost of capital (the area ABC) must also be recovered, which takes the original 5 years plus an additional 1.2 years to recover the opportunity costs given up by undertaking this evaluation. The 6.2- and 3-year figures are the times that a firm should use when determining if the evaluation should be undertaken.

If the firm is in an industry where, because of economic conditions, a four-year payback is required, then it knows that it should evaluate only Supplier B's material and not the material of Suppliers A and C.

Conclusion

This economic model for determining the feasibility of evaluating a raw material for possible substitution gives to management definite data upon which to base its decision. A systematic, exact determination of costs through the use of the PERT analysis technique isolates individual expenses. The determination of the price/cost relationship demands that management examine and analyze the entire environment of an industry and its own position within this environment. By thoroughly analyzing the entire relationships presented in this paper management will be better able to make those decisions that will increase the overall long-run benefits to the firm.