An analytical approach to make-or-buy problems involving intra-company product transfers.

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AN ANALYTICAL APPROACH TO MAKE-OR-BUY PROBLEMS
IN VOLVING INTRA-COMPANY PRODUCT TRANSFERS

by

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ABSTRACT

There is currently among industrial firms a lack of uniformity and of objectivity concerning their approach to make-or-buy problems, especially those involving intra-company transfers.

The lack of uniformity stems from the general absence of written make-or-buy policies, and the lack of objectivity is rooted in a widespread naivete concerning the factors which may affect a make-or-buy decision. The paper abstracted here deals mainly with the identification of pertinent factors and the development of analytical techniques for the solution of make-or-buy problems.

Make-or-buy decisions should not be made unilaterally by any one department or individual. Inputs should, as a minimum, be obtained from the manufacturing department, the purchasing department, and the user department (the end-user of the product). Inputs from other departments should be obtained as appropriate.

Financial analysis of make alternatives should include a summation of purchased material costs, purchasing overheads, direct labor expenses, engineering expenses, general and administrative expenses, tooling and equipment costs, inventory expenses, and any extraordinary expenses. If the product demand extends over a period exceeding one year, present value...
calculations must be employed to determine true costs.

Financial analysis of buy alternatives should include a summation of purchase prices, payment terms adjustments, purchasing overheads, accounts payable overheads, receiving expenses, inspection costs, miscellaneous overheads, trade credits, overhead absorption losses, and any extraordinary expenses. Again, present value analyses are appropriate for periods exceeding one year.

An analysis of non-financial factors begins by listing all objectives to be met by the decision. Weights are applied to those objectives and the ability of each alternative to meet those objectives is determined in a systematic quantitative fashion. The overall acceptability of the alternatives relative to each other then becomes apparent. A review of the potential problems associated with each alternative concludes the non-financial analysis.

Make-or-buy decisions should be made independently of the transfer pricing decision. Make-or-buy decisions must be made for the corporation whereas transfer prices determine the benefits to the profit centers within the corporation.

It was concluded that analytical models could be tailored to specific make-or-buy situations and that many companies could benefit from the adoption of written procedures embodying such models.
CHAPTER I
BACKGROUND

Make-or-buy problems refer to the decisions which must be made by industrial managers whenever they are faced with the alternatives of either manufacturing products in their own facilities or purchasing those same products from outside suppliers. A review of recent literature on the subject and the writer's personal experience with make-or-buy provided an indication of the most common make-or-buy practices in use.

A. Current Make-or-Buy Practice

Following are descriptions of the responsibilities typically assumed by the various departments of a medium to large size corporation when engaged in make-or-buy problems. In a small corporation, some of those responsibilities would be combined into one position, but the same concepts would be applicable.

Purchasing Department

Although not normally responsible for the ultimate decision-making, purchasing departments seem to be universally involved in an advisory capacity to those who are responsible for make-or-buy decisions. And it is usually the purchasing department that is responsible for drafting and coordinating whatever make-or-buy procedures a company may have. Aljian suggests one reason why purchasing is a key participant:
"Make-or-buy" decisions must be based on a considerable number of factors, many of which are not susceptible to straight cost analysis. Such decisions, except when concerning relatively minor matters, cannot be the responsibility of any one department. In owner-operated enterprises, the owner may presume to make his own decision, but unless he has the counsel of others, including purchasing, he is only guessing.1

Lee and Dobler state their premise a little differently:

A purchasing department is responsible for investigating all potential suppliers and for placing the order with the supplier which will, in the long run, provide a satisfactory product at the lowest cost to the company. Among the suppliers that should be considered is the buyer's own firm.2

If asked "what is the most important part of a make-or-buy analysis?", most managers would respond with "a comparison of in-house manufacturing costs with the costs to purchase from an outside firm." Unless the decision involves a type of transaction not normally handled by the purchasing department such as a corporate acquisition or a merger, it is purchasing who is in the best position to determine outside pricing. Although anyone can call a vendor to obtain a price, purchasing is generally more knowledgeable with regard to choosing the most competitive suppliers and experienced in communicating the right kind of information. A poorly executed inquiry is usually answered with incomplete bids or


improper bids due to misinterpretation of the inquiry.

It is also advisable in the case of intra-company transfers for the purchasing department to act as the liason between the user and the manufacturing group. Purchasing should provide manufacturing with the same inquiry and specifications as transmitted to the vendors. This ensures all bidders of having an equal opportunity to quote.

Manufacturing Department

"The make-or-buy decision is one that needs to be realistically faced by the manufacturing manager and not essentially decided on the basis, "we can do it here" or "we need the work." This attitude will get nowhere but in the loss column."^ The saying "you can't be all things to all people" also applies to manufacturing plants and products as well as people.

The first and most important realization to be accepted by the manufacturing department is that they cannot manufacture all things economically and that they must willingly participate in and even instigate make-or-buy analyses on a routine basis. Next in importance would be their responsibility to constantly be aware of their strengths and weaknesses relative to the marketplace such that make-or-buy analyses can be made on a selective basis. It is neither

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practical nor feasible to analyze every product and every manufacturing operation for every product to determine whether it should be a make or a buy; therefore the astute manager will reserve detailed analyses for the truly questionable products or operations and use common sense and good business judgment for the balance of his decisions.

Most manufacturing departments have one or more industrial engineers responsible for developing estimates of manufacturing costs. These estimates are used as the basis of comparison with the prices for which the product can be purchased from competitive manufacturers. It is essential that the in-house estimate be prepared without knowledge of the outside prices. Foreknowledge of outside prices could "taint" the in-house estimate if the estimator were predisposed to make or to buy.

Manufacturing is also responsible for development of the manufacturing methods and tooling best suited for the anticipated volumes of production. Some of this development work will in itself require make-or-buy decisions for the purchase of component parts and subcontracting of specialized manufacturing operations.

User Department

"User department" in this context refers to any department, division, profit center, or other operating group within the same company as, but having a separate
accountability of profits from, the manufacturing department which can become a customer for the manufacturing department's products. Such a relationship results in intra-company transfers, and it is only in the case of these transfers that the concept of a user department comes into play.

The user is responsible for the preparation of purchase specifications whether they be for the company's own manufacturing department or for an outside vendor. "Specifications are detailed descriptions, or an enumeration in detail, of the characteristics of products, designated operations, and equipment... Accurate specifications lower the rejection rate, save rejection costs, and raise product quality." 4

At times the specifications will include detailed designs for the products in which case the vendor or manufacturing group is given little or no flexibility for making cost effective design improvements. Conversely it is also true that the specification will sometimes define only the required performance or fitness for a particular purpose. The user may, however, reserve the right to review the design of the manufacturer prior to the beginning of production. This will generally be done when the user wants added assurance that the manufacturer has properly interpreted the specification; only when the user and manufacturer

are participating in a joint development effort will the user assume any responsibility for the design after the review process.

The user will also assist the purchasing department during the qualification of bidders and bid reviews. Rarely are the buyers qualified to make the sole technical evaluations for their companies.

Controller's Office

Although not common to all companies, some choose to use the corporate controller as an independent, unbiased judge of the economic factors in make-or-buy. When used, the manufacturing department and the purchasing department will submit, independently, summaries of the cost data supporting their make or buy alternatives respectively. The controller will then review the data and make a recommendation of the best alternative. Rarely, however, is the ultimate decision made by the controller; invariably it requires a negotiated agreement of all the involved parties, i.e. purchasing, manufacturing, the user, and, in this case, the controller.

The controller also makes a vital contribution when many "make or buy" situations develop simultaneously, making their effect cumulative. Each decision causes changes to the firm's operating situation. Many such decisions will change substantially the set of operating conditions upon which each division is based, nullifying any computations and comparisons based on that set of conditions. To reduce the effect of these limitations, the "make or buy" decision always should be reviewed by
some control entity within the firm. Without this review process, all elements of planning, control, and coordination with respect to the firm's goals are lost, which again is detrimental to the firm's long-range survival.5

B. Transfer Pricing

It must be emphasized at the outset of this discussion that the concept of transfer pricing between divisions of a company should not become a part of the make-or-buy decision making process. Make-or-buy analyses should be made on the basis of the net benefit to the entire corporation, not the benefit or disadvantage to any particular division. This is contrary to the present practice in many corporations, and it is for this reason only that transfer pricing is included as a part of the discussion of make-or-buy practice.

Many make-or-buy decisions involving intra-company product transfers become bogged down when the manufacturing and the user departments become entangled in negotiations of transfer prices. Because of this, some make or buy alternatives are chosen for the wrong reasons, and the company is then penalized by a less than optimum decision.

Before elaborating on the techniques which can be used to establish transfer prices, the objectives for the use of transfer prices should be understood. Having a need for intra-company transfers infers that the company is made up of two or more

5Jim Madison, "The "Make or Buy" Decision," Management Accounting, LIV (Feb., 1973), pp. 32-34.
profit centers wherein their general managers have nearly autonomous responsibility for the profitability of their operations. Although this objective is not always met, most companies manufacture products with the intention of making a profit. When transfers of products or components are made between profit centers before the products are sold outside the company, a question arises as to which department(s) should be credited with the profits earned.

John Dearden is quoted by Larson as having concluded that profit decentralization appeals so much to executives in the U.S. because "The operating decisions are made by people closest to the problem. Because these people are held responsible for the affect that their decisions will have on profits, they are motivated to make the decision that will create maximum profit." When products are transferred between divisions, it is only natural, then, that the divisional managers will compete for their share of the profits.

The most important use of transfer prices appears to be the measurement of managerial performance. In order for that to be true and to work successfully, the profit center managers must be given flexibility in managing their operations and as a minimum:

1) must have the freedom to negotiate transfer price levels

must have the option of purchasing its requirements outside the company if such action is in the best interests of the company (not just the profit center, though).

The National Association of Accountants recognizes two alternative bases for pricing interunit transfers:

1) Market or adjusted market
2) Cost or adjusted cost

The advantages and applications of both bases are discussed in the following sections.

**Market or Adjusted Market Basis**

Under this basis, transfer prices are established using fair market prices as the basis. Fair market prices are defined as the lowest prices at which goods which meet the product specifications can be purchased from outside sources. This definition implies that goods not meeting the product specifications, for example goods of inferior quality, should not be used as a basis for comparison.

The NAA has found from its studies that "...income attributable to individual profit responsibilities is best measured by interunit transfer prices which are based upon values established in a competitive market." Such a method

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7National Association of Accountants, Accounting for Intra-Company Transfers, Research Series No. 30 (June 1, 1956), p. 6.

8Ibid., p. 9.
ensures that the user group is not being penalized for buying within the company while at the same time it ensures that the manufacturing department is at least afforded the opportunity for profits commensurate with those typical in the marketplace.

There are times when it is difficult to establish fair market prices. A company's products may be of such a proprietary nature that no perfectly equivalent product exists in the competitive market. Such a situation may require the determination of prices for substitute products which are functionally equivalent but not of the same design. Or, it may require that the prices for inferior (or superior) products be adjusted for the perceived value of the differences in quality or function.

If the company is not purchasing any portion of its products from outside suppliers, it may be difficult for the purchasing department to ascertain fair market prices. This is especially true in oligopolistic markets where prices are not published. Where the number of producers is so small, those producers quickly learn who their competition is, so a buyer seeking competitive pricing is handicapped if his bidders know that his own company manufactures the same product and that he is only attempting to determine fair market prices for the sake of establishing transfer prices. The buyer who persists in obtaining competitive quotes under the guise of an intent to purchase is engaging in unethical business practices.

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Fair market prices will not necessarily be equal to their associated transfer prices. It may be necessary to adjust the market prices to reflect costs of procurement other than the purchase prices themselves. These other costs would be the same as those examined in the financial analysis of the buy alternative (see Chapter V, Results, Section C., Supporting Financial Information Required). The ultimate cost to the user should be the same whether he is procuring from within or outside the company.

Cost or Adjusted Cost Basis

If the problems in trying to establish fair market prices are insurmountable or the company chooses to exclude intra-company transfers from the measurement of its profit centers' performances, then it becomes practical to use manufacturing costs as the basis for transfer prices.

There are several variances in the cost bases for intra-company transfers. These are described more fully in the National Association of Accountants' Research Paper No. 30\(^9\) and are only summarized here.

Pricing transfers at manufacturing costs implies that goods are transferred at inventoriable costs since the primary objective is to account for internal inventory

\(^9\)Ibid., pp. 31-36.
movements. Manufacturing costs would not include corporate overhead expenses.

Full cost transfer prices would include corporate overheads such as general administration, research, selling and advertising expenses, but would not include any profit allowances. Such a system would be necessary in fully decentralized companies where all expenses must be allocated to the profit centers.

Full cost plus transfer pricing is used when it is not possible to use fair market prices but it is desirable for the manufacturing group to show a profit. Other applications would be where a pricing routine is established to reduce time devoted to negotiation and where interunit markup rates are used to implement policy governing pricing of an end product.

The danger of using cost based transfer prices is that there is little incentive for the manufacturing department to control costs. This danger can be offset to some extent through the use of standard costs and cost savings incentive plans, but neither is as effective as pure competition in controlling costs.
CHAPTER II
INTRODUCTION

Make-or-buy is a familiar phrase among most modern manufacturing companies. Despite its familiarity, though, make-or-buy problems manifest themselves in all companies, large and small, and may involve the procurement of parts costing just a few dollars or the acquisition of complete companies worth millions of dollars.

Make-or-buy problems are oftentimes clouded by the difficulty of trying to evaluate all of the variables simultaneously and then trying to predict their composite effects. By definition, an analytical approach requires separation of the problem into its component parts in order that each can be examined separately. Given the proper techniques, the findings of those independent examinations of component parts can be combined to form objective conclusions.

An underlying assumption was made (based upon the author's experience) that few companies were adept at solving their make-or-buy problems and that most would be interested in improving their approach to make-or-buy. It was decided at the outset that any analytical approach proposed must meet the following criteria in order to gain any degree of acceptance among industrial management:

1) It must be comprehensive enough to include all significant factors yet flexible enough to work with only partial data if necessary.
2) It must not be dependent upon data not readily available through existing information systems.

3) It must provide a means for weighing purely subjective factors along with measurable objective data.

4) Independent analyses by reasonable people should lead to similar conclusions.

One of the most significant outgrowths of modern scientific management has been the concept of independently accountable profit centers within a single company. Profit centers effectively allow the decentralization of management such that the authority to make decisions is placed as near as possible to the actions affected by those decisions. Another concept of scientific management is the integration of activities within an organization. Among individual profit centers, integration relies upon the transfer of products between those centers such that one's output becomes another's input. In order to be truly accountable for his profit center's performance, the general manager must have the freedom, at least within corporate guidelines, to choose the sources for the inputs to his products. Thus we are led to the make-or-buy problem involving intra-company product transfers.
CHAPTER III

STATEMENT OF THE PROBLEM

Although their primary objectives should all contribute to the survival and growth of the entire company, profit center managers do compete for recognition and each strives to maximize his contribution to the company. Make-or-buy problems involving intra-company transfers actually share all of the same component parts of non-transfer make-or-buys but are further complicated by the necessity of establishing transfer prices. Both the methodology and the psychology of coping with intra-company transfers are presented in the paper.

The ultimate objectives of the paper are to present an analytical approach to make-or-buy which, if followed, will lead to a more uniform application of make-or-buy analyses to procurement decisions and to demonstrate that make-or-buy analysis can become an effective management tool if applied systematically.
Several companies were chosen which were thought likely to actively involve themselves in make-or-buy problems. The top purchasing executive in each of the companies was then interviewed for the purpose of determining their companies' current practices for make-or-buy.

Due to the geographic separation of the companies interviewed and the anticipated diversity of replies to the questions asked, face to face interviews and written questionnaires were ruled out as possible means of gathering information. Subsequently, all of the interviews were conducted over the telephone. As there was no intent to statistically prove that one make-or-buy procedure was better or more popular than another, the sample size did not need to be large. The intent was strictly to gain a general understanding of companies' attitudes toward make-or-buy and to learn whether formal make-or-buy procedures were in use and, if so, to determine their basic structure.

Company A

The first company interviewed was a large, multi-divisional manufacturer of process machinery. The person interviewed was the Vice President of Purchasing responsible for the entire company's procurement activities. Purchasing in Company A was highly
decentralized in that each of the company's eight major manufacturing plants had a Purchasing Manager who reported to the Vice President of Purchasing at the corporate headquarters.

When asked if the company had a make-or-buy policy, the vice president responded with a great deal of interest as his company did not presently have such a policy, but he had recognized the need for one and had recently asked each of the plant purchasing managers to prepare a description of the policies which they had been using. The replies ranged from "complete dumbfoundment" to "twenty page dissertations". Of the written responses, there was a near total lack of agreement on the proper policies or procedures to be followed.

Several of company A's plants only used make-or-buy analysis as a convenience tool when the shops became overloaded. When the shops were at or under capacity, make-or-buy was ignored.

The vice president interviewed indicated that some of his managers had suggested that he simply write a procedure and they would follow it. In his judgment he felt that it would be wiser to have the managers participate in the formulation of the procedure since the managers would be more likely to use rather than ignore a procedure which they had helped create. One of the topics on the agenda for company A's next purchasing council meeting was make-or-buy.
Company B's Director of Corporate Purchasing explained that they had no written make-or-buy policy but he himself gave the impression of one who was well versed in the theory of make-or-buy. He described his company's make-or-buy as "a countervailing power situation where the purchasing department should constantly test the marketplace."

The general managers of each of company B's divisions were responsible for make-or-buy decisions. The controllers of each of those divisions were responsible for gathering information from the purchasing department (in this case a central purchasing department reporting to the Director of Corporate Purchasing) and the manufacturing departments and then presenting the information in an unbiased form to the general manager for his decision. The director commented that they sometimes found it difficult to obtain accurate in-house manufacturing costs. In addition, because the purchasing department did not report to any of the divisional general managers, the buyers were free to pursue their own make-or-buy analyses.

Company B's current business strategy because of the then current slow-growth economy had been to rely on other companies' capital intensive operations for new products unless considerations of cost, quality, or proprietary designs dictated in-house manufacture. Some existing products were restricted to in-house
manufacture due to large previous capital investments.

When transferring products between divisions, negotiation of transfer prices was left to the general managers. Only if the divisions were not able to agree on prices did the purchasing department obtain outside prices; the purchasing department would then act as a "low key honest broker' between the managers until an agreement was reached.

Company C

The next person interviewed was the Vice President of Purchasing and Traffic for a large manufacturer of basic construction materials. His company had no make-or-buy policy; they currently were "playing it by ear on a case by case basis." This vice president recognized the need to establish a make-or-buy policy, but his company had not yet "faced reality."

Company C transfers a lot of products between divisions and uses fair market prices obtained at arm's length as the basis for transfer prices. The fair market prices were obtained by purchasing.

Company D

Company D's make-or-buy policy was covered by their Capital Analysis Appropriation Program which applies to everything from day to day purchases to new plant construction or acquisitions.

The Vice President of Material for this company indicated that they did not become involved in too many intra-company product
transfers. This person was unwilling to discuss any details of their Capital Analysis Appropriation Program and only commented that the level of management responsible for their make-or-buy decisions varied with the value and importance to the company.

Company E

Company E's Director of Procurement described their approach to make-or-buy as decentralized in that each plant location was responsible for setting their own policy. Both financial and non-financial conditions were considered as a part of a typical make-or-buy analysis.

Make-or-buy decisions were made by teams at the plant level. Such teams typically included representatives from purchasing, manufacturing, and the controller's office. Further details of company E's make-or-buy and transfer price policies were considered confidential and would not be disclosed to the author.

Company F

Company F is a diversified multi-national manufacturer of industrial equipment having many independent manufacturing plants. Company F's Director of Materials stated that they had no written make-or-buy policies for both valid and invalid reasons. The valid reason was that they were concerned about possible union reaction to any policy which would clearly state that some products would be purchased rather than made under certain circumstances. The invalid reason was that each manufacturing plant had its own policy and the company had not tried to standardize those policies.
Company F's make-or-buy decisions are generally made by a committee consisting of the product engineer, an industrial engineer, the purchasing manager, and sometimes the inventory manager. These people will then decide which alternative is most economically feasible.

Standard costs are developed for all parts manufactured by company F. On a weekly basis, the controller will list the five parts having the highest variance from standard costs. The purchasing and industrial engineering departments then meet to try to reduce the costs of the parts. Buy alternatives are usually considered as a way to reduce costs. The buy alternative must be significantly less costly (greater than 10%), however, before the parts will be purchased on the outside.

Transfer prices between divisions vary with the shop loads and with the part's ability to carry overhead burden. The maximum transfer price is ultimately controlled by the market price for the part.

The director emphasized that make-or-buy should be an integral part of any value analysis program.
A. Observations of Present Practice

As can be seen from the interview summaries, there is a striking lack of uniformity among the companies' views of make-or-buy, and none of the companies interviewed, with the possible exception of company D, had a documented policy to provide direction to those responsible for the decisions. Additionally, except for company F, none of the companies' representatives made reference to any systematic or quantitative methods of analysis which leads one to believe that the decisions made were very subjective in nature.

It has been the author's experience that where no written policies or procedures exist there is disagreement even as to who is responsible for making the decisions let alone as to how the decisions are to be made. The lack of definitive policies not only leads to internal conflicts but also leads to disgruntlement among outside suppliers who are never confident that when bidding against in-house manufacturing departments they are being considered objectively and fairly.

It is also acknowledged by most that there is a lot of emotionalism prevalent in make-or-buy. Although currently being challenged by some behavioral scientists, there is still a lot of support for the economists' view of man, i.e. "...a rational,
economic being acting primarily in his own self interest.\textsuperscript{10} This self-serving attitude is brought into sharp focus when divisional managers begin to debate their positions for make or for buy and to negotiate transfer prices for inter-divisional transfers.

In the following sections the factors relevant to most make-or-buy decisions will be described in detail and techniques for analyzing their cumulative effects will be presented.

B. Supporting Non-financial Information Required

Strategic Plans

The "make or buy" decision is basically one of determining which alternative is economically most desirable and most effectively utilizes the firm's resources. Individually these decisions may or may not produce a significant impact on the firm's operation; however, taken in aggregate, they can have a critical long-range effect on the firm's operating characteristics. These decisions can affect the firm's production methods and capacities, available working capital, cost of borrowing funds, and competitive position. Therefore, before the "make or buy" decision can be made, the firm must establish a goal with respect to the nature and extent of its production facilities. The firm also must define the manufacturing processes that are congruent with its overall company goals and strategies. With these basic considerations established, the firm can proceed to an analysis of the cost, quality, and quantity considerations of the individual "make or buy" decisions.\textsuperscript{11}

As most companies grow, they become integrated to include the

\textsuperscript{10}Larson, p. 51.

\textsuperscript{11}Madison, \textit{Management Accounting,} pp. 32-34.
manufacture of products which become the raw materials or equipment required for the production of secondary products by the same company. The steel industry offers a good example of broad scale integration: consider that some of these mine their own iron ore, and they also mine coal for the production of coke (which is required for the iron-making process); after the steel is made it is rolled, forged, or cast into shapes which have some use to an end-user which again may be the steel company if it is involved in any aspect of steel fabrication. As extensively integrated as the steel industry is, even it must still rely heavily on the products of other industries for its operations; machinery must be purchased, buildings must be erected, railroads must be built and maintained, etc. The point is that every company, large or small, must decide what business it is going to be in and what businesses it is not going to be in.

Typically, corporate charters describe in very general terms what the company's line of business will be. The charters are intentionally general such that the company has flexibility in planning its destiny as the company grows or changes. In order for a company to be successful, however, it must have detailed strategic plans which provide direction to the manufacturing organization's efforts.
Most manufacturing departments will participate in the development of their strategic plans, but the ultimate responsibility for approving those plans generally is reserved for top level management. Once the plan is approved, the manufacturing manager has the freedom to direct his department's or division's business within those guidelines. A good strategic plan will automatically answer many make-or-buy questions by preventing the company from manufacturing products which are outside its agreed upon line of business.

Strategic plans may also eliminate the manufacture of certain products by establishing minimum acceptable levels of profitability or return on investment. Had they had and adhered to such strategic plans, many a company could have been spared the agony of bankruptcy caused by a dogged participation in unprofitable lines of business.

Dr. Edwin Land, the founder of the Polaroid company, established somewhat unusual plans or aims for his company:

We have two basic aims here at Polaroid. One is to make products which are genuinely new and useful to the public and are products of the highest quality at reasonable costs. In this way, we assure the financial success of the company and each of us has the satisfaction of helping to make a creative contribution to society. The other basic aim is to give everyone working for Polaroid a personal opportunity within the company for full exercise of his talents, to express his opinions, to share in the progress of the company as far as his capacities permit, to earn enough money
so that the need for earning more will not always be the first thing on his mind; opportunity, in short, to make his work here a fully rewarding, important part of his life.12

Land's strategies, particularly his second "aim" have caused Polaroid to subcontract or "buy" some of the manufacturing processes normally attributed to a manufacturer such as Polaroid. For example, Polaroid rarely performs the final assembly operations for its cameras in-house on the basis that the work is not complex and would require a large force of unskilled labor which would not meet the intent of the second aim.

A company sells its competencies. It sells its ability to produce a better product, the same product at a lower price, a unique product, or a service that induces the customer to specify what the company is selling. In almost every industry some company is noted for quality, some company for price, some for service--sometimes it is the same company in two of the three or all three. To the extent that manufacturing can produce it at a lower cost, or assist in the provision of better service, to that degree it will exert a favorable influence over the product mix.13

Reference to the company's or manufacturing department's strategic plan should be one of the first steps in a make-or-buy analysis. If a decision to "make" would not be supportive of the letter or intent of the strategic plan,


the decision should be made without further analysis in favor of the "buy" alternative.

Proprietary Technology

The success of many businesses has been a direct result of their development of new technology and their ability to market that technology in the form of new products which surpass anything previously available in terms of quality, cost, performance, or other measures of relative worth.

Fortunately, our American forefathers had the wisdom to make provision in our constitution for the protection of inventor's rights. Article I, Section 8 states "The Congress shall have the power to promote the progress of science and the useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." Unfortunately, however, there are many loopholes in the patent process which make it necessary for manufacturers to be extremely protective of their inventions. For example, there is a time lapse of several years, depending on the Patent Office's backlog, between the date of application and the date of award of a patent; few companies can afford to wait for patent protection before marketing their new products. Also, there are many technological developments which cannot be patented.

As a result of limited patent protection, there is a
large amount of information relative to designs and manufacturing processes which is kept confidential or at least classified as proprietary information. Many make-or-buy decisions must be made on the basis of proprietary considerations in order to protect the company's investment in research and development.

Proprietary products need not necessarily be manufactured in-house since it is possible to enter into secrecy agreements with other companies which require strict protection of proprietary information, but, more often than not, the owners of new technology prefer to manufacture their technologically superior products in-house. Many competing companies work arduously at stealing each other's designs and worry about patent infringement later.

Every company should maintain a current list of those proprietary products which will always be manufactured in-house so that there need not be any make-or-buy analysis each time those products are to be manufactured. Also, the existence of such a list should prevent a well-meaning buyer from inadvertently leaking proprietary information to other potential manufacturers of those products. In a few instances the list may work in reverse by thwarting attempts by over-protective manufacturing managers to keep non-proprietary products out of the scrutiny of a make-or-buy analysis on the basis of its supposed proprietary nature.
Market Forecasts

An important part of any make-or-buy analysis is the market forecast for the product under review. The literature abounds in detailed descriptions of the many forecasting techniques available; as there is no one technique particularly suited to make-or-buy analyses, no attempt is made here to describe the forecasting methods which could be used. The results of the forecast, however, are a very important input to the make-or-buy decision, so it is imperative that the best, economically justifiable methods of forecasting be used.

Without an accurate forecast of product demand by period it is impossible to estimate manufacturing costs accurately. The cost profile of any manufactured product includes many costs which must be amortized over some anticipated quantity, the prime example being design development costs. Design development costs may be a significant part of the cost to build ten units but probably become insignificant on a unit basis for a quantity of one thousand units.

Besides guiding the analyst in his allocation of fixed expenses, forecasts also aid the manufacturing engineer in his development of tooling design and costs. A sand casting pattern which is to be used only a few times may be carved from a softwood but a pattern to be used hundreds of times may
require the use of hardwood with metal wear strips which is much more costly as an initial investment but more economical in the long run.

The need to review forecasts as a part of make-or-buy is not limited to the product being considered. Every manufacturing plant has a master schedule which is derived from both actual backlogs and forecasted work. "In most business situations different products contribute different amounts of gross profit, and varying the mix of these products influences the overall profit performance." The relative expected profit contribution of the make-or-buy product should be measured as an opportunity cost against the profitability of other products on the master schedule. If the prospective product can only be added at the sacrifice of a more profitable product, there is strong support for the buy alternative.

**Learning Curves**

Another area where the demand forecast is of vital importance is in the application of learning curves to manufacturing costs. Any time a new product goes into production, the cost to manufacture the first unit can be expected to be higher than the cost to manufacture the...
second unit with each succeeding unit costing still less. Such cost reductions are due primarily to reduced direct labor hours. This phenomenon can be described mathematically through the use of learning curve models if the reductions in labor hours are sufficiently regular.

Ostwald\(^{15}\) has presented some interesting findings of the relative contributions to learning made by functional areas of the company: the operator is responsible for approximately 15% of the total reduction in unit labor costs while management and their programs contribute the remaining 85%; of the 85%, 50% is attributable to product engineering in a manufacturing firm and the remaining 35% is credited to manufacturing and industrial engineering efforts. Ostwald also points out that learning models are best applied to high unit cost, low production volume items such as ships, computers, and machine tools as opposed to low unit cost, high production volume items such as TV's.

In order to understand the application of learning curves to make-or-buy analyses, a basic understanding of the model is required. Most learning curve functions produce straight line graphs when unit direct labor hours are plotted against production quantities on log-log paper. Learning

rates are then commonly described as the percentage reduction in hours realized each time the production quantity is doubled. For example, if the first unit required 1000 direct labor hours to produce, a 20% learning rate would predict that 800 hours were required for the second unit, 640 hours for the fourth unit, 512 hours for the eighth unit and so on.

If a learning rate can be predicted from experience with similar previous products and if the demand forecast is known, it thus becomes possible to predict the cumulative average number of direct labor hours required per unit of production. This is not only important to the development of in-house manufacturing costs but also to the prediction or negotiation of purchase prices which would be paid if the product were bought from an outside source. The vendor's type of operation or manufacturing experience may lead to a different learning rate or he may have orders from other customers for the same product which would reduce his cumulative average. Such an advantage would favor a decision to buy.

Unfortunately, few salesmen are knowledgeable enough to tell the prospective buyer what his firm's learning rate is and, of those who do know, fewer still are willing to divulge such information since they know it might be used against them during negotiations. It then becomes necessary
for those making the make-or-buy analysis to develop intuitive comparisons of their shop's and the vendor's shop's learning rate. If neither the buyer's shop nor the vendor's shop has ever built a stainless steel pressure vessel but the vendor's shop has built carbon steel pressure vessels whereas the buyer's shop has never built any type of pressure vessel, it can safely be assumed that the vendor's learning rate will be higher (faster) than the buyer's.

Formulas derived from the learning curve model which may be of use to the cost estimator involved in make-or-buy are reviewed in the Appendix.

Quality

Quality is universally recognized as one of the key determinants in the selection of sources as evidenced by the classical definition of purchasing's objectives: "to buy materials and services of the right quality, in the right quantity, at the right price, from the right source, and at the right time."16 In order to evaluate the effects of quality on the make-or-buy decision, the first step must be to establish a standard for comparison. A simple but actual example of this would be the establishment of a standard or specification for the gasket surface finishes

16Dobler and Lee, p. 295.
of pipe flanges. It has been found that the optimum finish for minimum leakage on flange gasket surfaces is in the range of 125 to 250 micro-inches (rms) for certain types of gaskets. As the 125-250 finish is not a standard specification for flange manufacturers, nearly all flanges purchased had to be remachined in order to achieve the required finish. As the company has in-house capability for remachining the flange surfaces, the question was raised as to whether the flange supplier should arrange for the machining or should the company (the buyer) do the machining.

The importance of quality to make-or-buy decisions will vary from problem to problem. Although no manufacturer, i.e. no ethical manufacturer, will intentionally produce inferior goods, the quality inherent in a manufactured product should not substantially exceed that required by the product specification. Quality costs money and better than required quality levels are a waste of money. Conversely, the buyer must be assured that his chosen source is capable of maintaining the specified quality level and the buyer should accept nothing less.

Some products to which make-or-buy analyses are applied require a very stringent quality level which may be very difficult to maintain. It may also be true that that quality level is an intrinsic part of the product's value to its customers. Where quality is of such importance, management
may decide that in order to assure the value of its products to its customers, it must retain complete, in-house control over quality. Such a situation would inevitably cause quality to carry an even higher priority than cost.

Other products may only require a commercially standard level of quality which implies that any reasonable manufacturer should be capable of maintaining the required quality level. This would result in quality carrying a very low priority in the make-or-buy analysis.

It should also be emphasized that the quality standards developed must be uniformly applied to products manufactured both in-house and by outside suppliers. Non-uniform application is difficult to detect but can have dramatic effects on the make-or-buy analysis. Quality control inspectors have been known to be very meticulous while inspecting work sub-contracted to outside shops while the same work done in-house is inspected very forgivingly. There are two basic reasons why this disparity sometimes exists. The first and most noble is that inspectors tend to place more confidence in their own shop's work with which they are familiar and let minor variations slide by unnoticed. The second and decidedly less noble is that most inspectors are smart enough to realize that work sub-contracted to the outside means less work for their own shop and therefore presents a threat to their job security; if they make it appear that the quality control
in their own shop is superior to that obtainable on the outside, the make alternative is likely to be chosen more often than not.

The key, of course, is to maintain comprehensive and objective quality standards and to ensure that those standards are applied as equitably as possible.

**Scheduling**

Scheduling becomes an important factor in make-or-buy in two respects: can the delivery requirements be met and what are some of the scheduling pitfalls which can adversely affect the make-or-buy decision? Many make-or-buy decisions have been made on the weight of delivery requirements alone. This happens most frequently when relatively inexpensive component parts are required for an expensive finished product where the supplier offering the best delivery is awarded the order irregardless of the price. Even though the impact of such spend-thrift buying on the products' profitability may be small, companies should strive to plan far enough in advance to avoid time forced decisions.

"Inability to meet delivery schedules is probably the one failure experienced most frequently by suppliers."\(^{17}\) Dobler and Lee's hypothesis applies equally well to one's own company and is one to be considered in the make-or-buy decision. Careful records of both in-house and outside

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\(^{17}\)Ibid., p. 137.
delivery performance should be kept as an aid to the make-or-buy analyst such that delivery promises can be adjusted to reflect less than perfect performances for comparison.

It should be remembered that if a buyer makes delivery a material requirement of his purchase contract, by use of the phrase "delivery is of the essence" or other obvious terminology, the supplier is legally bound to meet that delivery and may be held liable for damages resulting from his failure to deliver on time. A company cannot, however, take legal action against itself (specifically, its own shop) if it fails to perform as promised. For this specific reason, some critical work is subcontracted which otherwise might be done in-house.

One of the pitfalls to be avoided in make-or-buy is the not-so-well meaning user who deliberately plans the release of his requirements at the right time such that only one source, be it in-house or outside, is able to meet his required delivery. This is usually accomplished by feeding the favored source preliminary information which allows him to complete manufacturing and design development ahead of the competition.

Another pitfall is carelessness in getting the supplier to commit to a delivery promise before placement of an order. To the extent that a supplier can do so without jeopardizing future business potential, he can set delivery schedules to
suit his own convenience after receipt of orders if he has made no previous commitment.

Although overhead rates are not normally adjusted for differences in production line balancing losses (inefficiencies) on a project by project basis, production control's ability to schedule operations among work stations will have a direct impact on indirect costs in the long run. For this reason, production runs which lead to large balancing losses should be avoided in favor of products or batch sizes which allow for more efficient capacity utilization. Many multi-product shops are finding that their production scheduling practices can be improved through the adoption of materials requirements planning which provides for the batching of like components from different products for optimum production efficiency.

Production leveling is another very influential factor in make-or-buy. Fine and Westing have this to say of production leveling:

If a plant is only in partial operation, it may be desirable from several points of view to utilize space, facilities, and personnel in making items that were formerly purchased. Such use is especially desirable if the items can be made with existing equipment. A more complete utilization of capacity enables the firm to spread its overhead costs over greater production and thus to lower unit fixed costs to some extent. Such production also enables a company to serve itself better by stabilizing its organization.18

The value of an investment in design and manufacturing development is often overlooked by a firm considering make-or-buy. This can happen both in situations where the company has produced the product previously and where the product has not yet gone through the development stage.

Manufacturing firms routinely include in their cost estimates overhead fees to cover their investments in buildings and equipment and to cover indirect labor and expenses but rarely is there an accounting for previous investments in design and development. In the case of repetitive products, the costs of design and development are usually amortized over a forecasted demand quantity which may include several production runs. Design and development costs, after the investments have been made, should be treated as sunken costs, i.e. when evaluating whether or not to continue in the business of manufacturing a given product, only future cash flows should be considered and not previous investments. Referring again, though, to the capital equipment analogy, idle designs like idle equipment do not make money for their owners.

If the company has never manufactured a product being considered for make-or-buy, it should take into account any future benefits which might accrue from the design and development investment. For example, if the design and
development costs can be fully recovered in the first production run, is there potential for follow-on business which could increase the return on investment in design and development? Or, is it conceivable that there may be some secondary benefits resulting from the work such as the development of new technology which may have application in other product areas? Whether measurable or not, these factors should be weighed in the make-or-buy decision.

**Business Ethics and Vendor Relations**

Vendors are particularly sensitive to the way in which they are treated when asked to compete against a potential buyer's own shop. It is incumbent upon the buyer to ensure that he adheres to the highest code of professional ethics when involved in such dealings in order to avoid not only hurt feelings in the event products are kept in-house but also to avoid possible legal confrontations as will be explained.

A not uncommon practice among companies involved in make-or-buy is the solicitation of "arm's length" quotations to be used as fair market prices which in turn become the bases for transfer prices between profit centers. Vendors are usually willing to cooperate by making such quotations if they sense that they are being given a fair opportunity to win the business. Unfortunately, many companies solicit bids with no intention of buying on the outside and such
practices cause a rapid degeneration of vendor relations which can be quite risky if the possibility exists that the buyer may have to someday fall back on those suppliers when his own shop is unable to perform. If the company has no intention of buying outside, the safest policies to adopt would be to either base transfer prices on in-house costs, to obtain published prices for standard products similar to the company's own products and adjust the published prices for design differences or expected discounts as appropriate or to obtain competitive selling price information from the company's salesmen or from market surveys.

Another area which should be of concern to buyers is the credit which should be given to vendors who contribute valuable ideas while bidding on make-or-buy goods. Lawrence D. Miles has related a case study in "Purchasing World" magazine which describes the way in which one manager dealt with the problem:

In this particular plant, it was customary for the manager of manufacturing engineering to make the make-or-buy decisions. He was considerably challenged by these lower competitive costs and arranged for a study of his own manufacturing operations on the items in question. In all but one of a dozen cases, he was able to lower his costs comparably, and so he allowed only the one part to be placed with a supplier. That decision was protested by the purchasing department, which had been instrumental in helping select the vendors who provided the lower quotes.

The case was resolved in the higher manager's office. There, after the facts were developed, the question was asked: What is the right action for us to take in cases of this type? It was quickly decided and accepted that
the right action was whenever suppliers had made contributions, to compensate them in some suitable form.

The manufacturing engineer, however, felt that the suppliers had not contributed. "They didn't show us how to speed up our machines, how to use different types of cutting tools, how to plan some of the parts more effectively. We did all this ourselves."

The manager's response was, "Whenever anyone comes here and takes any action that causes us to eliminate substantial amounts of unnecessary costs from our products, he has made a contribution regardless of all other circumstances." He again raised the question: What is the appropriate action to take in this case?

After discussing the issues involved, he instructed that at least one-third of the jobs on which suppliers had developed effective bids and made constructive quotations should be awarded to them regardless of other factors and that they should continue to enjoy the business for approximately a year, even though the factory now had improved its own processing to meet the lower costs.

In this case, the buyers' knowledge contributed two long-range benefits to their company. Not only did the company gain extra earnings on the particular parts, but it also streamlined its own internal production methods for even greater savings.19

Another situation requiring strict application of business ethics is the protection of proprietary information supplied in conjunction with or as part of a vendor's quotation. Just as the buyer could not ethically share a vendor's proprietary information among other vendors competing for the buyer's business, the buyer also cannot ethically share vendors' proprietary information with his own shop.

This can become an extremely delicate political situation in-house, but if the buyer and his company wish to remain above

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reproach they must abide by this policy; failure to do so could even be considered a case in tort for which the vendor could bring a civil action against the company.

Psychological Effects

Inevitably there are tremendous psychological pressures which come to bear at various points in the organization when make-or-buy problems arise. These are natural pressures which evolve from within one's ego and there is little that can be done to relieve the pressures, but a better understanding of the psychological factors which cause those pressures may make them more tolerable.

Contrary to the way in which some of the earlier companies (Industrial Revolution era) were essentially controlled by one person, the owner, most companies of this day except for the very smallest proprietorships have organizational structures which require broad delegation of authority. As a result, many upper and middle level managers behave as if they owned at least the part of the organization under their control. Some early studies\(^{20}\) of the motivations of middle-level executives indicate that "They conceive of themselves as hard-working and achieving persons who must accomplish in order to be happy" and "They feel the necessity of moving

continually upward and of accumulating the rewards of increased accomplishment."

Because of these inner drives, manufacturing managers are logically biased toward make rather than buy alternatives for their company. Their objectives are to keep their shops busy and to manufacture products which will contribute to the company's success. It is nearly axiomatic that competition breeds desires to win and a manufacturing manager "wins" when he demonstrates his department's ability to manufacture products as well as or better, all things considered, than his competition, i.e. outside suppliers. It is understandable then and even expected of him by his superiors that he will fight hard to keep products in-house.

Other managers, be they of the purchasing department, the controller's office, the user's department, or at the executive level will also have a natural bias toward making rather than buying since they all benefit directly or indirectly from the success of any one part of the organization. It is not likely, however, that their bias would be as strong as the manufacturing managers' so their analyses will usually result in buy conclusions more often than the manufacturing managers'.

It is important, therefore, that careful consideration be given to the assignment of responsibility for the
make-or-buy decision. The assignment will vary depending upon the size and shape of the organization, and it may be appropriate to place the make-or-buy decision at progressively higher levels of management as the value of the product or the impact of the decision increases. Decision by committee, based upon the management interviews conducted, seems to be the most popular approach to make-or-buy. The committee will consist, as a minimum, of representatives from purchasing, manufacturing, and the user department. Other representatives, such as from law, accounting, treasury, the controller's office, planning and others, will participate as needed.

However the assignment of responsibility is made, it should ensure that all affected departments are party to the decision and that those making the decisions have broad enough perspectives to know the overall objectives of the firm and to predict the effects of their decisions on the accomplishment of those objectives.

**Summary**

It should now be apparent that there are many non-financial considerations which must be analyzed in order to solve the make-or-buy problem. Any one of them may prove to be the deciding factor on a case by case basis, so it is impossible to rank them in order of importance as a fixed decision rule.

There are, however, ways of systematically evaluating
and weighing such subjective evidence in order to arrive at logical conclusions; these ways are described in Section D of this chapter, "The Model." Analytical models are no replacement for intuitive judgment, which is the key to corporate success or failure, but they do offer a means for challenging one's own intuition and should thereby lead to better decisions.

C. Supporting Financial Information Required

**Purchase Costs**

It must first be understood that there is a distinct difference between purchase costs and purchase prices. Using the concept of set theory, purchase prices would be a subset of the larger set of purchase costs. This is a distinction which some companies and even some researchers have overlooked.

Purchase prices are, by definition, the consideration (monies) paid to suppliers of goods and services for goods received or services rendered. There will also in many cases be other costs for which the supplier is compensated which are not included in the purchase prices. These may include prepaid freight, federal, state, or local taxes, import or export duties, demurrage, or other special fees as may be negotiated between the buyer and seller. All, of course, should be included in the summation of purchase costs.

The other and often overlooked purchase costs are those
incurred within the organization and which do not result in the exchange of money between companies. These are somewhat hidden and hard to measure but they are real costs of operation.

Current estimates place the cost of processing a single purchase order at between $25 and $50. A more accurate view, at least on an aggregate basis, is to measure purchasing expenses as a percent of the value of goods purchased. Colton has determined that the ratio varies with company size, apparently due to economies of scale, as illustrated in the following table:

<table>
<thead>
<tr>
<th>Companies' Gross Sales in 1955</th>
<th>Purchasing Expenses as a % of Value of Goods Purchased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under $500,000</td>
<td>4.33%</td>
</tr>
<tr>
<td>$500,000 to $1 million</td>
<td>3.14</td>
</tr>
<tr>
<td>$1 million to $5 million</td>
<td>0.90</td>
</tr>
<tr>
<td>$5 million to $25 million</td>
<td>0.88</td>
</tr>
<tr>
<td>$25 million to $100 million</td>
<td>0.37</td>
</tr>
<tr>
<td>Over $100 million</td>
<td>0.57</td>
</tr>
</tbody>
</table>

Colton offers no explanation for the anomaly of an increase in the percentage from the $25-$100 million range to the over $100 million range; it is believed that this may be due to a typographical error. Lee and Dobler reference

21Raymond R. Colton, p. 300.

22Donald W. Dobler and Lamar Lee, Jr., p. 389.
the same table in their work and have transposed the last two percentages.

Purchasing departments recover their costs of operation from their companies through the use of several different accounting methods. If the department is a corporate staff group, it may recover its expenses as a corporate fee allocated to divisions as a percentage of sales or of purchases by or for the divisions. If the department is sufficiently decentralized such that small purchasing groups become a part of line functions within the corporation, the purchasing expenses may be borne wholly by the divisions directly served by the purchasing groups. A way of recognizing the variation of order placement costs as a function of order value is to apply a sliding scale of overhead percentages whereby requisitioning departments are charged a percentage of order values to cover purchasing overhead; the percentages will vary with the order value. The cost estimator should be familiar with his company's procedure for purchasing overhead recovery such that the overheads may be included in purchase costs. After the orders are placed, there may be other costs incurred by the purchasing department while expediting, but those costs would normally be included as an integral part of the purchasing overhead recovery.

The accounts payables department, like the purchasing department, must recover its expenses incurred in posting
invoices, verifying receipts of materials, and processing payments. The methods used for recovering accounts payable expenses are similar to those of purchasing departments except that they are more likely to use fixed overhead percentages rather than sliding scales based on order values.

Receiving and source inspection costs must not be overlooked. If the goods are to be shipped to the buying company rather than directly to a third party, quality control procedures require inspection before being sent into production or before being shipped to a customer. If the inspection procedures are lengthy the costs for those services may be treated as direct labor; otherwise they may be allocated by formula.

Source inspection, i.e. inspection of goods by the buyer's inspectors at the seller's plant, is an expensive practice reserved for high value purchases, for goods requiring the witness of performance tests, cleaning procedures, etc. or in cases where logistics or schedules would not permit the return of goods for repair or replacement if found defective at the receiving location. Source inspection costs are usually treated as direct expenses.

Inventory costs can become significant if the purchased goods are stored for more than a few weeks before further processing or shipment to a customer. These may be among the most difficult to estimate since they require a valuation
of building or yard space and of the handling required while the material is in storage. Inventory shrinkage through theft, damage, or obsolescence must also be anticipated.

Trade credit can also become significant for large volumes of business. This is a benefit which accrues to the buy alternative as a result of not having to pay for goods received for some agreed upon time period (usually about 30 days).

One cost which may best be described as an opportunity cost is the loss of overhead absorption resulting from buying rather than making a product. If the firm has idle production capacity or has products presently being manufactured which offer a lower rate of return on investment than those being considered for make-or-buy (and which could be pushed outside for the sake of the new product), then the incremental loss in overhead recovery should be added to the cost of purchase.

Any extraordinary costs incurred by engineering, quality control, law or other departments while qualifying suppliers, negotiating contracts, or otherwise assisting the purchasing department should also be added to the purchase costs if possible.

Although simpler than manufacturing costs to identify and account for, it can be seen that an analysis of purchase costs goes far beyond the seller's quotation and should be
done carefully.

Manufacturing Costs

"The elements making up a cost estimate vary from industry to industry. Estimates are normally made on direct charges and the indirect charges are added on a percentage or weight basis, and, whereas one company might have a particular type of work as a direct charge, another company might very well have it as an indirect charge."23 In spite of Clugston's concern over the differentiation between direct and indirect expenses which is certainly a valid concern, the following breakdown of direct and indirect expenses is considered typical of most manufacturing companies:

<table>
<thead>
<tr>
<th>Direct Expenses</th>
<th>Indirect Expenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchased material</td>
<td>Expense materials (low value)</td>
</tr>
<tr>
<td>Purchased services</td>
<td>Non-production labor</td>
</tr>
<tr>
<td>Production labor</td>
<td>Buildings</td>
</tr>
<tr>
<td>Product engineering</td>
<td>Production equipment</td>
</tr>
<tr>
<td>Manufacturing engineering</td>
<td>Utilities</td>
</tr>
<tr>
<td>Tooling</td>
<td>Taxes</td>
</tr>
<tr>
<td>Testing</td>
<td>Administration</td>
</tr>
<tr>
<td>Inspection</td>
<td>Staff department overheads</td>
</tr>
<tr>
<td></td>
<td>Corporate fees</td>
</tr>
<tr>
<td></td>
<td>Non-production equipment</td>
</tr>
<tr>
<td></td>
<td>Warranty repairs</td>
</tr>
<tr>
<td></td>
<td>Inventory</td>
</tr>
</tbody>
</table>

Direct expenses are basically those which can be identified with a particular product and indirect expenses are those which cannot be discreetly allocated to any particular product, i.e. they must be distributed over a group of or all

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products manufactured in a single facility.

The costs associated with purchased materials and services are subject to the same added costs as described previously in the "Purchase Costs" section preceeding. When evaluating material and services costs in support of a make alternative, however, it is usually not prudent to analyze the costs in the same detail as required in support of the buy alternative; it is more practical to simply apply an average multiplier to account for the miscellaneous purchase costs.

The cost estimator may base his purchased materials and services expenses upon recent historical data or from actual quotations received from suppliers. In either event, the estimator must ensure that he has taken the effects of quantity into account. The prices paid for materials or services may vary widely with changing quantities.

Production labor, product engineering, and manufacturing engineering are all labor expenses which can be monitored through the use of time cards.

The hourly rates included in the estimate should include wages, fringe benefits, and all the expenses associated with the employment of the individual. Average rates will be used rather than actual rates to avoid the burden of trying to account for differences in individual wages or costs of employment.

Labor hours will be estimated using historical data.
from similar products and from cost estimating standards
developed through the use of time studies and historical
data. For example, a metal fabricator will know what it costs
per inch of weld in material of a known specification and
thickness. These standards must continually be updated and
refined in order to keep manufacturing estimates accurate.

Production quantities must be known in order to estimate
labor costs accurately. The effects of learning on production
costs were discussed in Chapter V, Section B, "Supporting
Non-financial Information Required." In addition, the
production quantity will affect the way in which something is
produced. The approach to machining ten identical pieces is
completely different from the approach to one thousand pieces.

Product engineering is that engineering required for
the detail design of the products and will include the
development of all drawings and data necessary for release
of the designs to manufacturing. Manufacturing engineering
is responsible for the development of the methods, tooling,
and manufacturing sequences best suited to the production of
the goods.

Tooling expenses include both the cost of hardware,
which may be manufactured or purchased, and the costs to design
and prove out the tooling. The total value of tooling will
increase as the production quantities increase due to the
higher level of sophistication required to produce larger
quantities economically, but the tooling cost per unit of product will decrease as the production quantity increases. There are also maintenance expenses which are associated with some types of tooling and must be included in the estimate.

Not all products require testing, but this can be a major expense for some types of products. Some destructive test methods even require that one or more units of a product be sacrificed in order to prove the integrity of the remainder of the production run. Testing expenses are made up of labor and material components just as direct production expenses, but due to their specialized nature they are kept separate.

Inspection costs could as easily be classified as indirect as direct depending on the nature of the operation. These expenses would include the costs of all intermediate and final inspections.

Expense materials are inexpensive items such as fasteners, tool bits, marking pencils, etc. which are purchased in bulk and meted out as required without being charged to specific manufacturing accounts.

Non-production labor would cover the expense of foremen, maintenance crews, cleaning crews, etc. which do not participate in actual production activities.

Buildings and production equipment are depreciable expenses which, after purchased, become fixed expenses which do not vary with production volume. Should it become necessary
to acquire new equipment or buildings in order to pursue "make" alternatives, detailed justifications for these purchases should be made and their costs properly assigned. A thesis written by Thomas Lynch\(^\text{24}\) addresses the problem of justifying equipment purchases in the face of make-or-buy decisions—the reader is referred to that work for further information relative to equipment expenses.

Utilities expenses refer to the costs of electricity, water, sewage disposal, etc. necessary for heat, light, personnel accommodations, etc. Taxes would include primarily real estate and inventory taxes. Corporate income taxes are not considered as a part of the manufacturing cost analysis.

Staff department overheads and corporate fees would encompass those expenses necessary to the overall operation of the company which are allocated to the various departments based upon their size or level of activity. Such assessments are necessary to cover upper management and executive level compensation, research and development, corporate planning, and other staff functions.

Examples of non-production equipment are plant air compressors, overhead cranes, forklift trucks, and floor sweepers. These also represent fixed expenses.

Warranty repairs are included as a contingent expense which will be incurred as some portion of the products shipped are returned for repair at the manufacturer's expense. If the products are not of the type that would be covered by warranties, this would not be a manufacturing cost to be included.

The detail with which a cost estimator analyzes all of the foregoing costs will vary with the complexity and expense of the product. A new product which has never been produced will receive much closer scrutiny than one which was previously manufactured or one which is similar to a previous product. Most cost estimates will be developed using direct labor and material expenses as the leading determinants of cost as most of the other expenses will vary as a function of the direct expenses. Following is an example of the way in which a typical cost estimate will be derived:

Step 1. Determine or estimate the costs of all materials and components shown on the bill of materials.

Step 2. Estimate the number of direct labor hours required for all operations and, using established shop rates, determine the total direct labor expense.

Step 3. Estimate engineering, tooling, and other extraordinary expenses.

Step 4. Add the costs found in steps 1, 2, and 3 and multiply the total by a predetermined factor which has been calculated to reflect
typical general and administrative (G. & A.) expenses.

After having discussed the many types of direct and indirect expenses which make up manufacturing costs, the above example may appear to be a rather insecure way of estimating costs, but it is a time-proven method which works for many companies. It may not provide a perfectly accurate representation of manufacturing costs, but any estimate has some uncertainty associated with it. Only through feedback of costs after production begins can the manufacturing department determine the true accuracy of its estimates.

Short-term vs. Long-term Costs

It has been shown that there are many elements which should be included in an analysis of either make or buy costs. There is one final element to be discussed which is at least as important as any discussed thus far--the element of time.

The span of time to be used for the make-or-buy decision will be determined from the marketing analysis and may vary from the length of time required to produce one unit of product to several years depending on the anticipated demand for and useful design life (prior to obsolescence) of the product.

The length of time will affect the make-or-buy analysis in two ways. First, if the relevant time period is in
excess of one year, it will be necessary to discount future cash flows such that all financial comparisons can be made on the basis of present values. Secondly, the time span may affect the inclusion or exclusion of certain types of costs from the analysis. The Committee on Management Accounting Practices (MAP) of the National Association of Accountants has stated "On a short-term basis, the incremental or marginal cost and investment factors may be controlling; however, the Committee strongly emphasizes that make-or-buy evaluations must give consideration to the long-term implications based on full cost and full investment."25

The MAP Committee defines full cost and full investment as the aggregate of all cost (investment) elements directly and indirectly assignable to support a specific cost (investment) objective on a long-term going concern basis under which every aspect of business activity bears its proper portion of all costs (investments) and all costs (investments) are assigned to specific cost (investment) objectives. It must be noted that cost objectives may encompass more than one product so that even in a job shop situation where make-or-buy analyses may be applied to one unit of production at a time, the cost objectives should encompass a family of products.

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production at a time, the cost objectives should encompass a family of products such that the overall objectives can be met. With objectives defined in this manner, it may become necessary to make decisions for a few products on a marginal cost basis, but the overall mix of products should meet the stated objective if the company is to survive.

More detailed illustrations of the effects of time can be found in the following section, the "Non-financial Model".

D. The Model

Non-financial Model

Evaluating and weighing non-quantitative, subjective data is always a difficult chore for most managers. Even more difficult can be the presentation of the conclusions and recommendations to higher level management in a manner which adequately yet briefly summarizes the thought processes which entered into the analysis.

The model presented here for the evaluation of non-financial data has been adopted from techniques developed and marketed by Kepner-Tregoe, Inc. The techniques were not developed for the solution of make-or-buy problems per se and so are equally adaptable to other types of problems. Only the questions proposed for the make-or-buy model are unique.

The first step in the model requires the definition of specific objectives to be accomplished through the results of the make-or-buy decision. Based upon the factors discussed in Chapter V, Section B, "Supporting Non-financial Information Required", the following list of objectives, stated in the form of questions, is presented as a foundation for a typical make-or-buy problem analysis. The questions can and should be modified to tailor the model to the differing objectives of different companies. Answers to the questions would state how well either the make or the buy alternatives meet the objectives.

**Make-or-Buy Objectives**

1. Does it conform to the strategic plan?

2. Does it adequately protect any proprietary technology required for the manufacturing process?

3. Is the manufacturer prepared to meet the forecasted demand for the product?

4. Does this product's projected profit contribution compare favorably with other products competing for space in the buying company's own plant?

5. Would the manufacture of this product utilize labor skills already present in the plant?

6. Would the specified quality standards be met?

7. Could the required delivery schedule be met?

8. Is it likely to result in the layoff of people from the buying company?

9. Does the manufacture of this product utilize existing designs, methods, and tooling?
10. Would it enhance the buying company's ability to enter future markets for similar or complementary products?

11. Would it meet any ethical obligations which may have developed?

12. If the need should arise, is the decision reversible?

13. Will selection of this alternative be supported by those affected by the decision?

An example of the way in which the above questions could be modified to suit a particular situation would be a revision of question 12: If the selected manufacturer should go on strike, would it be possible to cancel the order and place it with the alternative source? The questions should always be worded such that a "yes" answer is favorable to the selection of that alternative. Modification of a question may result in the generation of several questions more specific than the original.

The next step in the development of the model is the determination of which objectives from the list just developed are "musts" and which are "wants." "Must" questions will be answered with either a yes or a no; a no for either alternative would indicate that that alternative is unacceptable and that no further consideration is warranted. "Want" questions will be answered on a graduated scale from "0" to "10" with a "0" indicating that the alternative does not meet the objective at all whereas a "10" would indicate that the alternative completely fulfills the objective; any rating
between "0" and "10" would indicate partial fulfillment or less than ideal fulfillment of the objective.

Before answering the questions for each of the alternatives, the analyst must assign weights to each of the "want" objectives. A weight of "10" would be given to the most important objectives (may be one or more) and a weight of "1" would be given to a nearly insignificant objective. At least one objective should be given a weight of "ten" such that it may be used as the standard for determining the relative importance of each of the remaining "wants". More than one "want" may be given the same weight and it is not necessary for the lowest weight to be "1"; if all objectives are considered to be fairly important, they may all be given high weights (close to "10").

The objectives should be arranged in a format as shown on the following page. Then each question is asked for each alternative and yes or no answers shown for the "musts" and ratings shown for each "want". Ratings are multiplied by weights to obtain "scores" for each "want" and after scoring each "want", total scores for each alternative are calculated. The alternative producing the highest score is the most favorable alternative. It must be re-emphasized that if the answer to any of the "must" questions is "no", there is no need to score the "want" questions for that alternative since it is already eliminated from further consideration.

-64-
<table>
<thead>
<tr>
<th>OBJECTIVES</th>
<th>ALTERNATIVES</th>
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<tbody>
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<td></td>
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<td>2.</td>
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<tr>
<td><strong>MUSTS</strong></td>
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<tr>
<td><strong>WANTS</strong></td>
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<td>Wt.</td>
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<td>Comments</td>
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<tr>
<td><strong>Total Scores</strong></td>
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</table>
After scoring the alternatives, the test of intuition should be applied to the results. If the analyst feels uncomfortable with the outcome, he should review the reasonableness of the weights and scores applied to each objective and alternative. If a "no" for one of the "musts" eliminated an otherwise attractive alternative, additional thought should be given to the assignment of that objective to the "must" or "want" category; if a qualified "yes" would not cause the alternative to be completely unacceptable, perhaps reclassification of the "must" to a "want" is in order. If after reevaluating all the categories the analyst still feels uncomfortable with the final results, it is probably a case where the analytical approach has led to a better choice than the purely intuitive approach.

There is one final step in the Kepner-Tregoe method, however, which must not be overlooked and which might substantiate any feeling of discomfort. This final step is referred to as potential problem analysis.

The analyst should try to write down every potential problem which might arise (refer to Murphy's first law -- "In any field of scientific endeavor, anything that can go wrong, will go wrong.") with each alternative. Each potential problem should be weighed in terms of its probability of occurrence and its seriousness if it should occur. A high probability of occurrence combined with a low seriousness may
be comparable to a low probability combined with a high seriousness. It is not recommended that total scores be calculated for potential problems. Whether the comparison of potential problems between alternatives is significant enough to change the decision is a purely subjective judgment.

An example of how the model might be applied is described in the section "Illustration of the Model" following.

No claim is made that the model proposed here will produce mathematically correct decisions. The only claim made is that this method will force a systematic consideration of all make-or-buy objectives and that it provides an objective way of comparing alternatives on the basis of subjective information. The model also provides a suitable framework for presentation of the justification for a decision to management. Management can, at its option, agree or disagree with the inputs to the decision.

Since the non-financial analysis is only half the process, the reader may ask at this point how he can consolidate non-financial and financial conclusions, especially if they are contradictory. The solution lies in the addition of one more objective to the list of non-financial objectives: "Would it produce financially attractive results?" This question may turn out to be the one carrying the highest weight as a "want" in most analyses. The new total scores will reflect the relative desirability of the "make" or "buy"
alternatives based upon both financial and non-financial considerations.

No mention has been made to this point of the possibility of both making and buying a given product simultaneously. There is nothing in either the non-financial or the financial make-or-buy models which would preclude such a joint effort. This would only add one or more additional alternatives for consideration in exactly the same manner as strictly "make" or "buy" alternatives.

Financial Model

There is a common shortcoming among many companies' approaches to the financial analysis portion of make-or-buy problems. That shortcoming is the failure to consider the time value of money over the life of the product. Even when companies make a concerted effort to identify all of the costs discussed in Chapter V, Section C, "Supporting Financial Information Required", some of those same companies still fail to discount their cash flows.

Net present value and internal rate of return are two generally accepted methods of evaluating alternative proposals which take into account the time value of money. Both methods produce identical answers with respect to the acceptance or rejection of investment projects. When two or more proposals are mutually exclusive, however, as in make-or-buy decisions, the methods may produce different results. The internal rate
of return method implies that funds are reinvested at the internal rate of return over the remaining life of the proposal, whereas the present value method implies reinvestment at a rate equivalent to the required rate of return used as the discount rate.\textsuperscript{27}

Because not all investment opportunities available to a company offer the same rate of return, the present value method has been chosen as the basis for the make-or-buy model since it will produce consistent results (assuming a constant discount rate) and be somewhat more conservative. The present value method is also simpler to deal with mathematically which is a welcome advantage to analysts and managers.

Madison\textsuperscript{28} has promoted a make-or-buy model (first developed by Edward Mock and David Miller) which utilizes the present value method. Although his model is felt to be too simplistic and subject to error, he does present some good assumptions which would be applicable to the model to be presented here.

1. The firm must have and maintain adequate planning and sales forecasting techniques which will predict reliable future demands for the firm's product and consequently component parts.


\textsuperscript{28}Madison, Management Accounting, pp. 32-34.
2. The firm must take into account the fact that it has limited resources available to invest in different strategies.

3. There must be an adequate capital budgeting system which evaluates potential investment rates of return and compares them with returns available from alternative uses of the firm's resources.

The possible alternatives inherent in any make-or-buy decision would be to:

1. make all of the product,
2. buy all of the product,
3. make some of the product and buy the rest, or
4. do nothing, i.e. make no investment.

It is very doubtful that a straight financial analysis would lead to the selection of alternative 3., but some of the non-financial factors such as delivery or production capacity may suggest a split procurement. The ratio of make to buy quantities would be determined by the subjective factors.

Alternative 4., do nothing, might result on rare occasion if the net present values of all alternatives including expected revenues were found to be less than zero, but it is assumed that most firms who have reached the make-or-buy question have already justified procurement by one method or another.

In the spirit of comparing full costs and investments as described in Chapter V, Section C, "Supporting Financial
Information Required", most of the usual cost factors are listed on the following two pages in forms suitable for the net present value calculation. Only make and buy alternatives are shown; if the procurement were to be split between make and buy, a second set of sheets would be completed with the quantities applicable for each alternative shown and the costs determined on the basis of the split quantities. Present values for both alternatives would then be added and compared to the net present values developed for the make and buy alternatives alone.

The discount value used for both alternatives should be the same and should equal the firm's minimum acceptable internal rate of return on investment. Some of the extraordinary expenses which might be included in the calculations would be taxes, freight, warranty expenses, and import duties. Only those expenses required to place the make and buy alternatives on equal bases should be included.

When considering overhead absorption losses for the buy alternative, as a general rule these should only be included in the years preceding any expansion of the firm's production capacity for the type of product under consideration. When justifying the size of an expansion, it is assumed that the company would not penalize the buy alternative to that expansion with overhead absorption loss which would result if the expansion were made and the product still
### Present Value Analysis

**Make Alternative**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Cash Flows by Year</th>
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<tbody>
<tr>
<td></td>
<td>0</td>
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<tr>
<td>Year</td>
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<tr>
<td>Quantity</td>
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</tbody>
</table>

1. Purchased Mat'ls. & Svcs.
   \((1. \times \%)\)
3. Direct Labor Expenses
4. Engineering Expenses
5. Gen. & Admin. Expenses  
   \(((1.+2.+3.+4.) \times \%)\)
6. Tooling & Equipment
7. Inventory Expenses  
   7.1 Raw Material  
   7.2 In-process  
   7.3 Finished Goods
8. Extraordinary Expenses

---

**Unadjusted Totals**

**Discounted* Totals**

*Discount Rate = \(\%\)
## Present Value Analysis

### Buy Alternative

#### Cash Flows by Year

<table>
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<tr>
<th>Year</th>
<th>0</th>
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<td>1. Purchase Price</td>
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<td>2. Payment Terms Adjustment</td>
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<td>3. Purchasing Overhead</td>
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<td>4. Accounts Payable Overhead</td>
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<td>5. Receiving Overhead</td>
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<td>6. Inspection Overhead</td>
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<td>7. Other Overheads</td>
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<td>8. Trade Credit</td>
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<td>9. Overhead Absorption Loss</td>
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<tr>
<td>10. Extraordinary Expenses</td>
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</tbody>
</table>

Unadjusted Totals

Discounted* Totals

*Discount Rate = \( \% \)
purchased on the outside. If the company presently has excess capacity and there are no other products competing for that excess capacity, the overhead absorption loss would equal the general and administrative (G. & A.) expenses (line 5.) of the "make" alternative. That amount would be reduced by the G. & A. of any products competing for the same production capacity, i.e. if the company does not make one product, it will probably make the other.

It is assumed that the revenues produced (through sales or other income-producing activities) for all alternatives will be the same, thus it is not necessary to include revenues in the present value analysis. The total present values will then be net expenses so the more favorable alternative will be the one having the lower value of expenses.

If the present value of expenses for each of the alternatives changes from year to year in a predictable fashion, it is possible to determine break-even quantities which would be the cumulative production quantity at which the company will be indifferent between the procurement alternatives, i.e. the present values of expenses will be equal. The break-even point can be found graphically by plotting cumulative present values for each alternative against cumulative production quantities as shown on the following page.
Although this will not always be true, the "make" curve will start at some positive value of expenses equal to the initial investments in tooling, equipment, and engineering and from that point will have a decreasing slope which would parallel the firm's learning curve whereas the "buy" curve will start at zero and decrease in slope at a slower rate than the "make" curve since the seller must amortize his initial investment over his anticipated production quantity; if the buyer is not able to obtain any quantity discounts, the "buy" curve would become a straight line.

In the financial model, emphasis is placed upon the time value of money since most make-or-buy projects extend over several years' time. There are a number of projects, however, which do not extend beyond one year's time and even some which only involve the production of one or a few units. In these cases, there would be no need to discount the cash flows, but the financial model would still be useable.

Illustration of the Model

The following example is an actual make-or-buy problem encountered by Air Products and Chemicals, Inc., the author's employer at the time of this writing. The data has been modified somewhat, however, to protect its confidentiality.

Air Products' Equipment Department is a manufacturer of several different types of cryogenic equipment including a line of cryogenic storage tanks for industrial gases. The
storage tank line includes both standard models ranging in capacity from 1600 to 11,000 gallons and non-standard models up to 55,000 gallons capacity.

A decision was made to construct a new air separation plant for the Gases Department which would require a 30,000 gallon cryogenic storage tank, a non-standard model for Air Products' shop. There were several other companies capable of fabricating the tank in question, so Air Products was faced with a make-or-buy problem.

Air Products' Equipment and Purchasing departments were requested by the Gases department to determine the costs associated with the make and buy alternatives respectively. Also, the marketing and engineering groups within the Gases department were asked to estimate the future demand for additional 30,000 gallon tanks.

Although the model presented in this paper had not yet been developed and was, therefore, not used in solving Air Products' make-or-buy problem, the model could have been applied as shown on the following pages. Although it is not mandatory to follow this sequence, please note that the financial analysis precedes the non-financial analysis in this application.
## Present Value Analysis

### Make Alternative

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Flows by Year, $000</th>
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<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Factor</td>
<td>1</td>
</tr>
</tbody>
</table>

1. Purchased Mat'ls. & Svcs.  
   0  | 62.0 | 0 | 146.0 | 77.4 | 82.8 | 368.2 |
   (1. x 2%)  
   0  | 1.2 | 0 | 2.9 | 1.5 | 1.7 | 7.3 |
3. Direct Labor Expenses  
   0  | 70.0 | 0 | 138.7 | 73.5 | 77.9 | 360.1 |
4. Engineering Expenses  
   0  | 4.0 | 0 | 1.0 | 0.6 | 0.7 | 6.3 |
5. Gen. & Admin. Expenses  
   ((1+2+3+4) x 10%)  
   0  | 13.7 | 0 | 28.9 | 15.3 | 16.3 | 74.2 |
6. Tooling & Equipment  
   0  | 2.0 | 0 | 0 | 0 | 0 | 2.0 |
7. Inventory Expenses  
   0  | 7.1 Raw Material | 1.2 | 0 | 2.9 | 1.5 | 1.7 | 7.3 |
   0  | 7.2 In-process | 2.5 | 0 | 5.8 | 3.1 | 3.3 | 14.7 |
   0  | 7.3 Finished Goods | 0 | 0 | 0 | 0 | 0 | 0 |
8. Extraordinary Expenses  

| Unadjusted Totals | 156.6 | 0 | 326.2 | 172.9 | 184.4 | 840.1 |
| Discounted* Totals | 156.6 | 0 | 260.1 | 123.1 | 117.1 | 656.9 |

*Discount Rate = 12%
## Present Value Analysis

### Buy Alternative

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash Flows by Year, $000</th>
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<tbody>
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<td></td>
<td>0</td>
</tr>
<tr>
<td>Factor</td>
<td>1</td>
</tr>
<tr>
<td>1. Purchase Price (total)</td>
<td>137.8</td>
</tr>
<tr>
<td>2. Payment Terms Adjustment</td>
<td>0</td>
</tr>
<tr>
<td>3. Purchasing Overhead</td>
<td>2.1</td>
</tr>
<tr>
<td>4. Accounts Payable Overhead</td>
<td>0.1</td>
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<tr>
<td>5. Receiving Overhead</td>
<td>0</td>
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<tr>
<td>6. Inspection Overhead</td>
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<td>7. Other Overheads</td>
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<tr>
<td>8. Trade Credit</td>
<td>1.4</td>
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<tr>
<td>9. Overhead Absorption Loss</td>
<td>13.7</td>
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<tr>
<td>10. Extraordinary Expenses</td>
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<tr>
<td>Field install decals</td>
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<tr>
<td>Unadjusted Totals</td>
<td>155.8</td>
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<tr>
<td>Discounted* Totals</td>
<td>155.8</td>
</tr>
</tbody>
</table>

*Discount Rate = 12%
The non-financial factors pertinent to this make-or-buy decision along with their relative weights would have been as follow:

<table>
<thead>
<tr>
<th>Weight</th>
<th>Factor</th>
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<tbody>
<tr>
<td>Must</td>
<td>1. Does the alternative conform to the strategic plan which states in part:</td>
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<tr>
<td></td>
<td>a. The company will develop and maintain manufacturing capability for cryogenic tanks in the size range of 1500 to 60,000 gallons.</td>
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<tr>
<td></td>
<td>b. The company will only purchase cryogenic tanks from outside suppliers if the company's own shop cannot meet the market price or delivery.</td>
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<td>8</td>
<td>2. How well does the alternative protect the proprietary nature of the design?</td>
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<td>3. How well can the manufacturer meet the long term demand for the product?</td>
</tr>
<tr>
<td>10</td>
<td>4. How favorably does this alternative contribute to the maximization of the company's return on its investment in manufacturing facilities?</td>
</tr>
<tr>
<td>7</td>
<td>5. How well is this alternative commensurate with labor skills already in the shop?</td>
</tr>
<tr>
<td>10</td>
<td>6. How well would the specified quality standards be met?</td>
</tr>
<tr>
<td>5</td>
<td>7. How well is the manufacturer equipped with existing designs, methods, and tooling for this size tank?</td>
</tr>
<tr>
<td>8</td>
<td>8. How well is it going to contribute to the company's attainment of an optimum shop load?</td>
</tr>
<tr>
<td>Must</td>
<td>9. Could the tank be delivered by 1 September 1978?</td>
</tr>
<tr>
<td>4</td>
<td>10. How well would the alternative contribute to the company's future ability to build cryogenic tanks?</td>
</tr>
</tbody>
</table>

-80-
11. How well would the alternative meet the company's obligations for ethical business practice?

12. If the need should arise, how easily can another alternative be implemented for future requirements?

13. How well will the selection of this alternative be accepted by others within the company?

Having defined the above objectives, they then would have been rearranged in the Kepner-Tregoe format and scored as shown on the following pages.

As additional background information, it should be noted that Air Products had planned to expand its manufacturing facility in the beginning of the second year of the analysis. This expansion would have included the purchase of some new fabrication equipment and the rearrangement of work stations which was expected to reduce direct labor requirements for this size tank about 15%. This reduction is reflected in the financial analysis of the "make" alternative. Also, Air Products currently had excess capacity sufficient to build the tank and had no other products competing for the same shop time.

The following conclusions could be drawn from the financial and non-financial analyses:

1. The financial estimates of the make and buy costs are within 1% of each other in both the short and long terms which is considered an insignificant difference between the alternatives financially.
<table>
<thead>
<tr>
<th>OBJECTIVES</th>
<th>ALTERNATIVES</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
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<tbody>
<tr>
<td>1. Meets strategic plan?</td>
<td>Make: Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Buy: Yes</td>
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<tr>
<td>9. Can meet 1 Sept. deliv.?</td>
<td>Make: Yes</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Buy: Yes</td>
<td></td>
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</tr>
<tr>
<td><strong>MUSTS</strong></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>2. Protects 8 prop. nat.</td>
<td>Wt: 8</td>
<td>9</td>
<td>72</td>
<td></td>
<td>Comments: Common kno'dge</td>
<td>Rating: 8</td>
<td>Score: 64</td>
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</tr>
<tr>
<td>3. Meet long 6 term dem.</td>
<td>Wt: 6</td>
<td>10</td>
<td>60</td>
<td></td>
<td>Comments: Comp'ng cust'mers</td>
<td>Rating: 8</td>
<td>Score: 48</td>
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<tr>
<td>5. Com'te w/ skills</td>
<td>Wt: 7</td>
<td>10</td>
<td>70</td>
<td></td>
<td></td>
<td>Rating: 10</td>
<td>Score: 70</td>
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<tr>
<td><strong>WANTS</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Exst'ng designs</td>
<td>Wt: 5</td>
<td>7</td>
<td>35</td>
<td></td>
<td>Comments: Has built</td>
<td>Rating: 10</td>
<td>Score: 50</td>
<td></td>
</tr>
<tr>
<td>8. Optimum shop load</td>
<td>Wt: 8</td>
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<td>80</td>
<td></td>
<td></td>
<td>Rating: 5</td>
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<tr>
<td>10. Future ability</td>
<td>Wt: 4</td>
<td>10</td>
<td>40</td>
<td></td>
<td></td>
<td>Rating: 7</td>
<td>Score: 70</td>
<td></td>
</tr>
<tr>
<td>11. Ethical oblig'ns</td>
<td>Wt: 9</td>
<td>7</td>
<td>63</td>
<td></td>
<td>Comments: Ast'd w/ spec.</td>
<td>Rating: 9</td>
<td>Score: 81</td>
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<tr>
<td>12. Can be changed</td>
<td>Wt: 5</td>
<td>8</td>
<td>40</td>
<td></td>
<td></td>
<td>Rating: 9</td>
<td>Score: 45</td>
<td></td>
</tr>
<tr>
<td>13. Will be acc'ptd</td>
<td>Wt: 6</td>
<td>6</td>
<td>36</td>
<td></td>
<td></td>
<td>Rating: 9</td>
<td>Score: 54</td>
<td></td>
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<td><strong>Total Scores</strong></td>
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<td></td>
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<td></td>
<td></td>
<td>682</td>
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</tbody>
</table>
## Potential Problem Analysis

<table>
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<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. May fill up capacity req'd later for more profitable heat exch'grs</td>
<td>6</td>
<td>6</td>
<td>36</td>
<td>1. May go on strike before tank is delivered</td>
<td>9</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>2. Warranty expenses may exceed estimate</td>
<td>5</td>
<td>6</td>
<td>30</td>
<td>2. May miss required date</td>
<td>6</td>
<td>8</td>
<td>48</td>
</tr>
<tr>
<td>3. May miss required date</td>
<td>9</td>
<td>8</td>
<td>72</td>
<td></td>
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</tr>
</tbody>
</table>
2. The non-financial analysis favors the buy alternative slightly.

3. The potential problem analysis indicates that the buy alternative has associated with it a significant potential problem, i.e. there is a high probability that the vendor's shop will go on strike before the tank is shipped. The seriousness of this is high because it could mean an extended delay in delivery resulting in slippage of the start-up date for the air separation plant which in turn would cause a significant loss of revenue to Air Products.

4. The potential problem of a strike by the outside supplier is felt to outweigh the slight non-financial advantage of the "buy" alternative. Other vendors had bid on the tank, but their prices were significantly higher which would have caused the financial analysis to strongly favor the "make" alternative.

5. It can then be concluded that Air Products should build the tank in its own shop.
CHAPTER VI
CONCLUSIONS

It would be impractical to conclude that every company should approach its make-or-buy decisions in the same manner. Each company must decide for itself what method best suits its operations, and some companies will have to adopt more than one method in order to meet the needs of their diversified operations.

It is reasonable to conclude, however, that an analytical approach to make-or-buy decisions as presented in this paper could benefit any company not currently using such a method. The benefits of an analytical method as compared to a non-analytical method would include:

1. An increased probability of arriving at optimal decisions
2. A greater degree of confidence by management in its decisions
3. An auditable method of decision-making
4. A uniform and repeatable method less subject to individual preferences

The model proposed can be tailored to accommodate any make-or-buy situation and has been designed to stimulate the analyst's thinking so that all pertinent variables are considered. There has existed a common belief that make-or-buy decisions are made simply on the basis of a comparison of in-house manufacturing costs with outside purchase prices; exposure to the model should dispel that belief. There appears to be no single controlling
variable on which make-or-buy decisions can be based.

Make-or-buy decisions involving intra-company transfers are best handled as if there were no transfer. The tendency to confuse the determination of transfer prices with make-or-buy decisions only adds to the difficulty of arriving at sound decisions. Once the decision has been made to make, then the parties can decide the best basis for the transfer price. The decision to use a market based or cost based system is dependent upon the type of product and the accounting practices of the firm.

Finally, based upon the management interviews, it can be concluded that many companies could benefit simply by developing a written make-or-buy policy. Much of the confusion surrounding make-or-buy could be eliminated if companies were to document their policies and make them known to those responsible for making the decisions.
CHAPTER VII
SUGGESTIONS FOR FURTHER INVESTIGATION

It is possible that the model could be refined further if it were applied to a wide variety of industrial operations. This might be accomplished through presentation of the model to professional societies or publication of a professional paper on the subject.

No attempt was made at the conclusion of the work to test the acceptability of the model to industry. It is suggested that a mail survey could be taken to test its acceptability in comparison to companies' present practices.

Further investigative work could also be done to determine the effectiveness of the model for improving the optimality of make-or-buy decisions. This could be done by examining several make-or-buy problems and having control groups arrive at decisions based upon conventional techniques (whatever they might be in the test company) and having other groups familiar with the use of the analytical model develop their decisions for the same model. It would be difficult, though, to determine the ultimate relative value of the decisions since the make and buy alternatives are usually mutually exclusive meaning that implementation of one of the alternatives precludes measurement of the performance of the other alternative.
BIBLIOGRAPHY


Learning Rate Formulae

The number of direct labor hours required to produce the nth unit of product (Tₙ) can be predicted by:

\[ Tₙ = T₁ × r^{\frac{\log n}{2}} \]

where \( T₁ \) = number of direct labor hours required to produce the first unit
\( r = \) the ratio \( \frac{T₂n}{T₁n} \)

The total number of direct labor hours required to produce \( N \) units (\( Tₜ \)) can be found by summation:

\[ Tₜ = \sum_{n=1}^{N} Tₙ \]

where \( Tₙ \) = number of direct labor hours required to produce the nth unit

The cumulative average number of direct labor hours required per unit (\( Tₛ \)) can be calculated as:

\[ T₄ = \frac{Tₜ}{N} \]
A typical learning curve will appear as follows when plotted on standard graph paper:

![Graph showing direct labor hours per unit decreasing as the number of units produced increases.]

and as follows on log-log graph paper:

![Graph showing the direct labor hours per unit decreasing at a constant rate as the number of units produced increases.]

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VITA

PERSONAL DATA

Name: Dennis Lee Derr
Birthdate: 1 January 1950
Birthplace: Bloomsburg, Pennsylvania
Parents: Paul Eugene Derr
         Harriet Bernice (Reichard) Derr
Wife: Virginia Lee (Tyson) Derr

EDUCATION

Danville High School  1964-1967
College Preparatory Course

Pennsylvania State University  1967-1971
Bachelor of Science, Mechanical Engineering

Lehigh University  1973-1978
Master of Science, Industrial Engineering

AWARDS AND HONORS

National Honor Society  1965-1967

National Merit Scholarship Qualifying Test  1967
Letter of Commendation

Highest Score in High School Class on  1967
U.S. Navy Aptitude Test

Olin Summer Grant  1970

Rockwell Undergraduate Teaching Assistantship  1970

Second Place Award in ASME Region III  1971
Student Paper Competition

PROFESSIONAL EXPERIENCE

Design Engineer, Link-Belt Division of FMC Corporation, Colmar, Pennsylvania 1971-1972


Buyer, Air Products and Chemicals, Inc. 1973

Assistant Purchasing Agent, Air Products and Chemicals, Inc. 1973-1975

Purchasing Supervisor, Air Products and Chemicals, Inc. 1975-