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GUIDELINES FOR PRELIMINARY APPRAISALS OF CAPITAL PROJECTS

PART II - MANUFACTURING PROJECTS

Prepared for

AGENCY FOR INTERNATIONAL DEVELOPMENT
Under Contract AID/csd-2583

by

ROBERT R. NATHAN ASSOCIATES, INC.
Washington, D.C.

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FOREWORD

The project analyst using these guidelines should first read Part I, General Guidelines. It discusses key considerations for preliminary project appraisals (PPA's) in all sectors, with a detailed discussion of the methodology for calculating the internal rates of return, the cost-benefit ratios, and other relevant measures of the worth of a project.

These guidelines deal expressly with those matters relevant to manufacturing. They tell the analyst how to think about a manufacturing project; what to look for; and how to assure consideration of all elements essential to a project. They suggest institutional, cultural, political, and other factors which can weigh heavily on the outcome of a project. They encourage concentration on big issues in broad orders of magnitude, leaving details and matters of lesser importance to be explored in a detailed feasibility study.

I. INTRODUCTION

These guidelines are designed to aid in the preliminary evaluation of manufacturing projects.

Few developing countries can achieve rising standards of living without some expansion in manufacturing. Certain manufacturing industries are vital to low-cost inputs for agriculture; other manufacturing industries are needed to meet basic consumption requirements that would be excessively costly if filled by imports. Moreover, those countries which have achieved the most rapid rates of growth in the 1960's have looked to the export of manufactured goods to provide the impetus for development.

Easily accessible, price-competitive natural resources and infrastructure facilities aid industrial growth. So do populations of a size large enough to provide markets for efficiently sized factories. However, these are only aids to projects in manufacturing. Such projects have their own exacting technical and commercial requirements. Their success hinges very heavily on national economic policies, and their fortunes are tied to developments in other sectors of the economy and in world markets.

The task of these guidelines is to determine the requirements for a successful project. The analyst must judge whether they can be met.

Why Manufacturing Is More Exacting

Manufacturing is perhaps the most demanding field of activity for developing countries. The success of projects in the manufacturing sector will depend on several critical factors, of which the following merit special comment.

. World competition. More than any other, the manufacturing sector is subject to worldwide competition. In this competition, appeal to consumer taste, changing technology, comparative advantage, credit and the ability to maintain standards of quality play important roles. The manufactured goods of developing countries are in competition with the products of experienced, talented, and well-endowed producers of the world, unless these goods are shielded in the domestic market. The shielding process, however, is potentially costly to the economy.

. Entrepreneurship. Along with the ability to meet competition, manufacturing projects require a high order of entrepreneurial ability, particularly in the early stages of the enterprise. The starting of new manufacturing enterprises requires persons who will be bold and innovative and who will take responsibility for results. While every society has such individuals, special inducements may be necessary to get them engaged in manufacturing enterprises.

. Management and the use of labor. Experience in managing manufacturing activities is limited in most LDC's, and yet success depends greatly on the quality of management. Also, the labor force is unlikely to be familiar with manufacturing activities; in some countries it tends to resist the discipline required by industrial employment. Typically, productivity is considerably lower in developing countries than in industrially more mature countries. Although wages are also lower, labor costs per unit of product are not necessarily lower.

. Demand and returns to scale. The demand for most manufactured goods is sensitive to that part of income which is above subsistence requirements. In proportion to population, therefore, the demand for manufactured products is low in developing countries because such a high percentage of income is absorbed by expenditures for unprocessed -- or lightly processed -- foods and other subsistence goods. At the same time, costs of manufactured products tend to be high because of the small volume of production. Particularly for the smaller countries, the domestic market is often too small to adequately support manufacturing activities at levels of efficiency comparable to those in countries with larger markets. Thus, the country may be faced with the choices of (1) abstaining from the development of manufacturing, (2) starting uneconomical production for a limited domestic market, or (3) establishing manufacturing activities geared to foreign markets.

. Preference for imported goods. Prejudice against locally manufactured goods is a common obstacle faced by domestic manufacturers in many LDC's. In part this reflects snobbishness on the part of consumers, because possession of scarce imported items is a status symbol. Sometimes, however, the prejudice is well founded in experience.

To overcome its initial disadvantages in manufacturing, a developing country has to devise a suitable strategy for the sector. This will be discussed in a later section.

Some Characteristics of Manufacturing

While manufacturing has distinctive characteristics as compared to other sectors, within itself it is an extremely diverse activity. Each plant has its distinct technology. Projects can vary considerably with respect to the following characteristics:

. Availability of technology - some technology is readily available, others are closely held.

. Training requirement - manufacturing requires complex skills, and also a wide diversity of skills. The latter characteristic complicates the training function.

. Returns to scale - the gains from size vary considerably among potential projects.

. Risk - changes in consumer tastes and changes in technology make some lines of manufacturing more risky than others.

. Sensitivity to management - this is closely related to consumer tastes and changes in technology, and also to the complexity of the production processes.

. Sensitivity to international competition - some lines of manufacturing are very sensitive to competition from abroad (high rates of value to bulk, sensitivity to quality).

. Importance of fixed costs - some lines of endeavor have very high fixed costs, making them vulnerable to underutilization of capacity.

. Dependence on other activities - industries vary in their dependence on other manufacturing, other sectors, and policies of government.

. Employment per unit of investment - industries differ with respect to employment generated per unit of investment.

. External economies - some industries generate and benefit from complementary activities.

. External diseconomies - such as pollution, noise.

. Market orientation - industries differ in their requirement for close proximity to the market, or at least for a close liaison with the market.

. Raw material orientation - some industries require close proximity to the raw material.

Importance of an Industrial Strategy

Manufacturing is extremely sensitive to the form, size and circumstances under which incentives are made available to it. The incentives themselves will be very much influenced by whether an inward-looking or outward-looking strategy is adopted for manufacturing.

The inward strategy for industry undertakes to make the domestic market for manufactured goods attractive to indigenous industry by the use of credit, subsidies, customs exemptions for raw material, and protection of the domestic market from foreign competition. An inward strategy tends to create many industries covering a large variety of needs -- largely substitutes for imports.

The outward strategy for industry undertakes to make export of industrial products attractive to indigenous and foreign-owned industry by selective use of credit, subsidies, rebates, technical assistance and other means. An outward strategy tends to create fewer number of industries, but those created are more likely to be competitive.

It is possible for a country to use both strategies simultaneously, but to do so requires special care. The danger that has to be avoided is that the output of a protected industry will be overpriced and will saddle other domestic industries with high cost inputs. Thus, industries geared to the world market find themselves with costs so high that exports are unprofitable. The project analyst must take existing strategies as given but should point out their consequences.

Certain strategies come about for ad hoc and programmatic reasons. A country may choose certain industries to develop because of the desirability of giving employment to a large number of persons, of building up a prosperous industry on the basis of a natural advantage, of saving foreign exchange, or because it is determined to create a given type of industry that will over time have a comparative advantage. Such decisions can take a variety of forms. A country with

petroleum or natural gas could decide to create a petrochemical complex. Or a country may decide to provide services and incentives that will attract light industry requiring relatively large amounts of employment.

A strategy may designate certain types of industries as promising for providing employment or achieving national defense or regional development goals; still, the project analyst seeks to ascertain whether a project has a favorable net national rate of return. Industrial projects that do not achieve high national rates of return contribute little to economic growth and can represent serious obstacles to future growth, even if they are consistent with declared strategies. The PPA performs a critical function in making explicit the real cost, in terms of foregone opportunities.

Each country must decide which industries, if any, will be owned or operated by the government or by government entities, and which will be privately operated or owned. Government enterprises may enjoy certain competitive advantages over private firms. Hence, private investments will be inhibited unless clear ground rules establish a fair basis of competition between the two enterprises. A PPA should treat this subject explicitly.

II. PERSPECTIVE FOR THE PROJECT: ITS RELATION TO MACROECONOMIC, POLITICAL, AND CULTURAL FACTORS AND TO SECTOR SURVEYS

Macroeconomic Factors

The General Guidelines emphasize -- and indeed cannot overemphasize -- the influence that macroeconomic objectives, plans, and strategies have on a project's feasibility. The analyst's task is to judge which matters are of paramount importance and to see them reflected in the calculations made later concerning the project's worth. Of like importance, they will reinforce his qualitative judgments about the project. The following illustrative list delineates a few of the many macroeconomic variables that affect a manufacturing project.

- The growth of the economy in terms of total and per capita income, population, and exports

- The development strategy of the country, with particular regard to policies on incentives for import substitution and export of manufactured goods

- The amount of capital available for investment in industry

- The status of and investments to be made in health, transport, education, power, forestry, fisheries, and agriculture that may affect a project in manufacturing by affecting the demand for its outputs, competition for its inputs, the infrastructure available to it and its efficiency in general

- The foreign exchange and exchange rate policies that will affect import costs and the development of export markets

- Tax and price policies that will affect sales and profits and that will favor or discriminate against products of the manufacturing sector

- Credit policies, costs, and availabilities that will affect the funds available for investments in manufacturing

- Tariff policies that will affect competition from imports and the costs of imported inputs

- Emphasis in the national plan on regional development -- both within the country and with neighbors -- and decisions to enter into complementary agreements in which designated facilities are developed along lines that will maximize inter-industry linkages.

The project analyst must identify these, as well as many other, macroeconomic factors and give them their due weight in the PPA.

The Importance of the Sector Study

An industrial sector study may provide valuable background for the project appraisal. It will provide such data and insights as:

- Measures of aggregate income and other variables closely related to the demand for manufactured goods, i.e., price and income elasticities of demand for the output of manufactured goods

- A survey of capital markets and credit institutions and the availability and terms of funds to finance projects in the manufacturing sector

- An inventory of manufacturing facilities, potential sites, potentially useful domestic raw materials, and markets that are or can be made accessible

- Availability of skills, levels of education, work habits, absenteeism, and other factors relating to the efficiency of the work force

- Information on costs of production within the country, within the sector, and possibly for like projects; and comparisons with costs of imports

- Incentives available for both import substitution and export projects, and the circumstances under which projects qualify

- Difficulties and assistance that can be expected from governmental and other agencies and institutions that must be dealt with

- Taxation and credit policies affecting industrial enterprises

- Policies on conditions under which foreign investors can operate in industry

- Experience in the country for like or related projects, which will offer a valuable perspective for the project under consideration.

Useful sources of background macroeconomic and sectoral economic data have been cited in the General Guidelines. For the needs of manufacturing, use should be made of industrial censuses or of sample studies made in conjunction with these censuses. If vital information is lacking, the analyst may make direct inquiries, especially among suppliers and customers. Such inquiries can be quite informative because there typically are few significant manufacturing firms, importers, and exporters in an industry in the smaller developing countries. However, in keeping with the objectives of a PPA, the collection of primary data should be restricted to that which is absolutely essential to the appraisal.

Perspective for the Project Appraisal

The analyst may not be an expert in the industry concerned. To remedy his lack of insight and information, he must turn to readily available and obvious sources such as:

- Input-output tables establishing interindustry relationships in the country concerned or elsewhere

- Identical or similar projects undertaken in the same country or in other countries

- Different projects which draw upon the same kinds of materials, labor, and other factors, thus revealing information on quality and costs of inputs

- Business censuses, trade reports, technical manuals, and import data, which may provide pertinent information

- Information from engineering, management, and business journals and catalogues that sheds light on businesses and projects of various kinds

- Population censuses from which information may be gathered on the size and composition of the labor force by age, sex, skills, occupations, formal education and location

. Intelligence gathered from banks, businessmen, trade associations, importers, and exporters involved in the industry concerned or generally familiar with industrial conditions in the country

. Other sources, including government, that can provide information on actual or potential markets.

The Problem of Delineation

The factors to be considered in the PPA are only those elements essential to a project, including its direct linkages to other sectors. It is essential, therefore, to establish the limits of a project -- to distinguish between the internal and external elements of a project to assure that the computation of costs and outputs is all embracing.

. Those infrastructure services used exclusively by the project are clearly internal and chargeable to it: a power source, an access road, a water supply facility.

. If the infrastructure is to be otherwise provided (e.g., state-constructed road or publicly financed electric utility), the PPA need not include as inputs the capital costs thereof if the project is being appraised from the enterprise point of view. The cost of the purchased service (e.g., power) would be included as an input in the project.

. When the net national rate of return (NNRR) is calculated, the project must be charged with the entire cost of the infrastructure, even if it is paid for by others, <u>if</u> the project itself is the cause for its construction. If the project is one for several users, then the cost must be allocated. The analyst can then note that the NNRR would be higher if the project were credited with side-benefits that the specially created facility would bring to, say, industries served by a newly created port or a specially built road.

. The BERR should not be charged with the cost of training workers, of subsidized (low-cost) capital, or of other benefits conferred on it by the state. The NNRR must be charged with these costs.

. A manufacturing project may be a link in a chain of activities that is in the nature of a complex (e.g., a metalworking complex). It should not be presumed that each link must be included within the project. There may be a more economical option to import.

. In defining the extent of capital requirements for a project, the inseparability of certain aspects of it must be considered. Thus, in the case of a metalworking complex where a foundry supplies castings to two other projects, it may be necessary to treat the two projects plus the foundry as a single project, if the justification for the foundry depends on the success of the two other projects. Where separability is possible, the so-called test of differences provides a guide as to the arrangement -- combination or separation -- that is best. (See General Guidelines, chapter IV.)

The project analyst must ultimately decide the limits of the project. There are no inelastic rules governing the right coverage. How far does the project's influence extend and, therefore, what costs and benefits must be considered? The analyst must make clear how far he has gone. However, the analyst can be fairly certain that the coverage for the NNRR is wider than for the BERR.

Sociocultural Environment

Attitudes, habits, and behavior patterns in the community must be considered. Questions must be answered as to the social structure, outlook of the population regarding industrialization, working habits, and cultural taboos.

Development of a sociocultural environment profile will permit judgments on the managerial and labor requirements and will suggest suitable recruitment, training and personnel programs. It will serve as a guide in predicting the success of the proposed project in the particular locality and will identify needs for an educational program to gain project acceptance.

International Considerations

The PPA must discuss the hazards or benefits to a project that will arise from its international orientation.

Some manufacturing projects will be extremely sensitive to international considerations. The prices and availability of some commodities will be affected by supply conditions (e.g., for copper and nickel -- items frequently in short supply). Exports will be affected by tariffs and quotas, which can have serious effects on marketing possibilities. Sanitary regulations and other constraints must be kept in mind. Regional trade agreements, which are relatively new developments, may create possibilities and constraints that have not existed before. Is the project heavily dependent on imports or exports? Are the necessary assurances present or is the project open to risks from abroad? On the whole, projects heavily dependent on exports, imports, or foreign capital are more hazardous than those that are domestically centered.

National Policies Toward Industry: Tariffs, Taxes, Development Assistance

Most developing countries provide favorable conditions for development of manufacturing industries. The form which the government's aid will take will depend on the government's views on these matters:

- Has it reserved certain industries for state enterprise? If so, which?

- What rules has it laid down for foreign investment and other forms of foreign participation?

- Is it oriented towards import substitution? If so, what are the economic and noneconomic criteria employed?

- Is it oriented towards export of manufactured goods?

- Are special inducements offered to manufacturing enterprises utilizing domestic raw materials or domestically produced intermediate goods?

- Has it expressed a preference for certain types of industries? Labor intensive? Capital goods? Consumer goods?

- Is it seeking industrial development in certain regions of the country?

The analyst should try to examine whether government policies will be helpful or harmful to a project in these respects:

- Tariff protection and tariff exemptions for inputs. Will the government grant tariff protection to the project's product? This generally permits the project to receive a higher price for its output than would otherwise be possible.

- Conditions affecting the ease of importing and the availability of transportation.

- Tax exemptions.

- Guarantees, as for credits required for foreign loans.

There is a large number of ways in which the actions of government can influence the project. The analyst's task is to judge the matters of greatest significance and to seek to convert them into measures of impact on the costs and revenues of the project. Precedents for other projects in the country will provide important insights. The standing and influence of the person organizing the project will also have an important bearing on the matter.

Environmental Considerations

The effect on the environment must be treated as an important factor in the PPA. Beyond a certain point individuals cannot adapt fast enough to environmental changes. Typically, disruption to the ecological balance is caused by pollution -- by solids, liquids, gases, noise or thermal output. Relevant effects can be on air, water, land, buildings, monuments, people, plant life, or fish or animal life.

It is necessary to identify and estimate the kinds and amounts of pollution, their duration, and their probable effects. At the same time, corrective actions to eliminate or minimize the potential damage must be identified. Additionally, the potential environmental damage must be estimated along with the probable cost of alternative actions. Such costs, if available, would be incorporated as an input in computing the NNRR; they may also be an input to the BERR if the project (enterprise) requires preventive or remedial measures.

In some cases, the actual damage to the environment may be tolerable from a single establishment, but cumulative pollution effects caused by a series of manufacturing plants may be alarming. Anticipation of future difficulty in this regard may influence the design of the plant.

A PPA may merely identify the dimensions of the problem and suggest further study, particularly where damage and remedial costs could be important and estimates have a wide range of uncertainty.

III. STEPS IN THE PRELIMINARY APPRAISAL

Project preparation and appraisal consist of the following:

1. Identification of the need of the project, particularly the demand

2. Formulation of promising physical resource flow plans

3. Pricing the project

4. Selection of the most promising alternatives

5. Computation of rates of return

6. Sensitivity analysis of rates of return

7. Evaluation summary

While the above steps can be discussed as discrete steps that will occur in the stated order, it should be recognized that in the course of carrying out these steps, there will be considerable interaction. For example, in carrying out step 4, the analyst may find that other alternatives suggest themselves, so that he may find it necessary to return to step 2.

Determining the Demand for Output

The General Guidelines discuss how one would go about estimating the demand for products.

Since the sales forecast is critical for the project, how soundly based is it? Factors that will help to determine the size of the market of manufactured products are:

. Macroeconomic factors. These have already been discussed.

. Size of market. As a benchmark, has the size of the present apparent domestic market been determined (imports plus local production less exports)? Are special surveys necessary to sample local consumption?

. Division of market. Has the market been discretely divided among classes of customers by income, age, location, etc? If the project is to produce an intermediate good, has the market been identified by the sources of demand?

. Guaranteed market. To what extent is there a guaranteed market (captive user, replacement of imports because of new import restrictions, firm sales contracts with, say, a factory requiring the part or raw material to be produced)?

. Competitive tests. What competitive tests have been made and who are the competitors? Has a comparison been made of the price for the product with prices of imported products, after allowing for transportation and handling charges to different destinations in the country? Brand preference?

. Price-demand schedules. Have these been calculated? How sound is the basis for such calculations?

. Preference for imported goods. Consumers of a developing country often show a strong preference for imported goods. Has the matter of domestic preference been competently addressed in the project?

. Product design. What is the basis for judging the acceptability of the appearance, quality, and technical specifications of the product? Replica of existing product? Produced to customers' specifications? Survey of customers' wishes?

. Stability of market. Are there assured outlets for a given product, or will it require frequent shifts in volume and kinds of output to meet competition?

. Market experience in other countries (particularly those with similar income and population characteristics). What has been the experience there?

. Sales outlets and distribution methods (particularly for export markets). Is a qualified sales force likely to be available, and can agency or other outlets be readily established? Particularly

for the export of manufactured consumer goods, effective ties in foreign markets are extremely important.

A large number of factors will determine sales. The project proposal, particularly if it is in preliminary form, is likely to have covered only a few of such matters. The analyst must determine whether the most indicative factors have been considered adequately. Allowing for miscalculation, he must also determine:

- What margins of safety have been allowed in the calculations

- What alternatives are available if sales should fall below (or rise above) the projected level.

Formulation of Promising Physical Resource Flow Plans

To compare promising alternatives in manufacturing, physical flows must be considered. Ideas for alternative flows will arise from engineering considerations bearing on how the demand for the product(s) can be met. The aspects related to engineering are discussed in appendix A. Ultimately, decisions on alternatives must be based on determining the alternative with the least-cost and/or the most attractive rates of return, using the procedures described in the General Guidelines (see chapter IV).

A common difficulty with manufacturing projects in developing countries is that for a variety of reasons a given investment gives rise to a relatively small output, making the burden of fixed costs excessive in relation to output. Project design can influence this in a number of important ways.

- The scale of the project should be appropriate for the market. Planning for multishift operation is extremely important for heavy investments.

- Where demand for a product is limited, it may be possible to plan for a number of products to be manufactured, using the same plant.

. By planning an export program, it is possible to overcome the demand limitations of the domestic market.

In manufacturing, consideration must be given to promising alternatives involving different raw materials, sizes and scope of project, technology, provision for expansion, phasing of gestation, and location. Because of the very large number of possibilities, the analyst must exercise judgment as to which alternatives are worth pursuing.

Pricing the Project

The business enterprise will calculate its rate of return (BERR) based on market prices for both inputs and outputs.

To obtain the NNRR, inputs and outputs may require the use of accounting or shadow prices if actual market prices do not provide accurate measures of real costs and benefits. This commonly applies to foreign exchange earned or expended, capital employed, and unskilled labor and skilled personnel. The value of output sometimes presents some problems. The opportunity cost of the output is the expected c.i.f. price plus handling charges. Where the output is not a standard product, there may be some difficulty in establishing an equivalence in value. However, an even greater difficulty is the difference in prices, depending on the exporting country, the supplier and the marketing conditions. In general, one should not assume c.i.f. prices that are temporarily depressed because of dumping or other short-term developments. Neither should one assume prices that are high because of unusual circumstances. As a practical matter one may have to resort to averaging of some kind.

Construction of the BERR flow as described in the General Guidelines will yield approximate cash requirements to be supplied by all sources of finance, equity and loan and the potential amounts available for payment of interest and repayment of loan. Normally, the relative importance of different forms of finance will be open-ended at the PPA stage.

More detailed timing of required funds would be undertaken in later project studies when the relative roles of the different forms of financing were more definite. This

would take the form of cash flow projections on a quarterly or monthly basis, detailed by major items, taking into account the specific forms of finance employed.

Selection of the Most Promising Alternatives

While many of the physical alternatives that are possible (see appendix A) can be rejected on the basis of engineering considerations, many of the choices will require a comparison of cost. Where alternatives involve only current domestic costs (for example, raw materials or labor utilization), relatively simple comparisons are sufficient for the analyst to reach a decision. However, where one or more alternatives involve a greater or lesser investment with varying costs over the life of the project, the comparison of their respective value flow is called for, as described in the General Guidelines (see chapter IV).

Computation of Rates of Return

A detailed example for a manufacturing project is given in the General Guidelines (chapter VII). The illustrated tables indicate how one goes about calculating the business enterprise rate of return and the net national rate of return.

The differences between the business enterprise and the net national rates of return can be quite large in manufacturing projects.

The business enterprise rate of return reflects the return on assets employed by the project and is of interest to the owner of the business and to the lender.

Actions to improve a project with an unattractive BERR should be considered if the NNRR is favorable. Changes can be made in training allowances, import privileges, tariff protection and various other types of assistance.

Sensitivity Analysis of Rates of Return

How likely is it that the estimated rates of return will be realized? Are there controllable factors that can have large effects on such rates? What are the effects of the factors that cannot be controlled?

An important tool for determining sensitivity of rates of return of manufacturing projects is the so-called break-even point analysis. By categorizing costs into those that are fixed and those that are variable, it is possible to project profits (or losses) under a variety of conditions. Figure 1 presents a graphic break-even analysis. One can readily trace the effect of changes in price, volume, and variable expense on a yearly basis and convert it into terms of rates of return. For example, if production is scheduled to reach 90 percent capacity by the end of the second year and actual production only reaches 60 percent, in many types of manufacture the effect on profit is very large. One can also test the sensitivity of rates of return to the size of investment and the length of gestation period. These in turn may suggest desirable modifications in implementation or production techniques.

High fixed costs are associated with automatic equipment, and this will tend to be reflected in the need for a large volume of sales. On the other hand, products requiring a high labor input tend to be associated with lower fixed costs; this in turn usually will result in the need for a lower volume of sales to achieve a break-even point. Specific analysis, however, must be performed for given cases; generalizations will not suffice. All factors must be considered, such as the expected volume of sales, the amount and cost of labor, the need for overtime to meet demand, equipment requirements and the like.

Where variables having a large impact can be affected by policies or further study, sensitivity results can indicate the desirability of further study or reconsideration of policies.

Evaluation Summary

In accordance with the General Guidelines an evaluation summary should be prepared incorporating the major findings of the study.

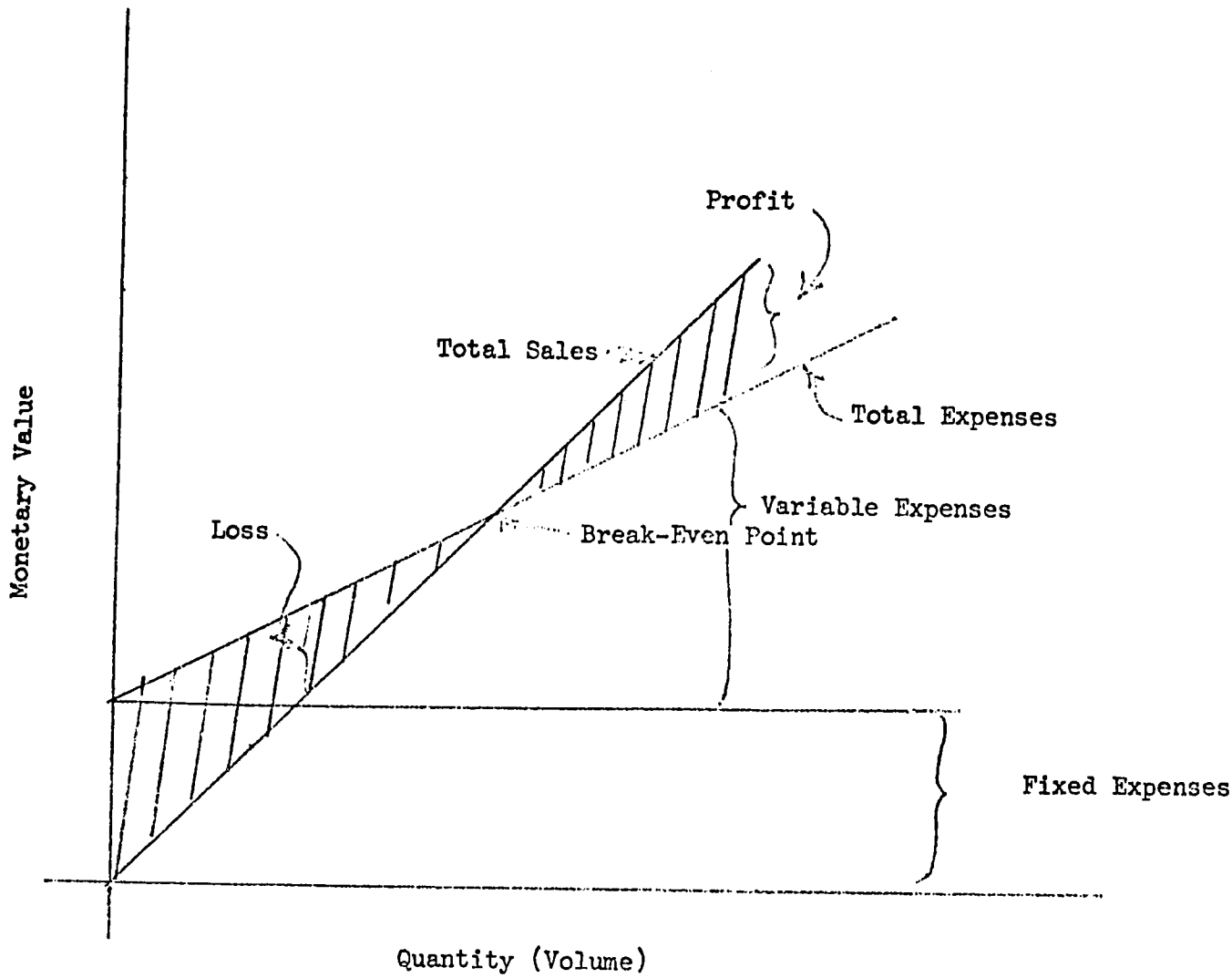

Figure 1. Break-Even Analysis

APPENDIX A. ENGINEERING ASPECTS OF A MANUFACTURING PROJECT

The aspects of engineering variables involved in planning a manufacturing project have to be settled in terms of least-cost alternatives rather than on the basis of absolute engineering standards.

Product Definition and Design

Definition of the product must be clearly specified. First the characteristics of the final product must be determined on the basis of the nature of the market. Second, decisions are required on which materials and parts should be bought and which should be manufactured in the plant.

The plant may be conceived primarily as an assembly plant and all components may be purchased. It may be a deliberate policy of the government to require a certain amount of subcontracting. On the other hand, it may be that some of the components cannot be produced on the outside because qualified vendors are not available; the company may wish to retain and maintain control over the production processes; vendors may not be willing to produce the product due to inadequate profit margin or lack of available open shop time.

Specific factors affecting make-or-buy decisions are the available technology and equipment within the plant, available qualified sources for procurement of needed items on a competitive basis, desire to maintain or develop skills within the plant, company or government policies for developing outside procurement sources, available plant capacity, opportunity costs of rejecting an available alternative, and differences in the foreign exchange burden implied by the decision.

What is the basis of the decision to make or buy? Are the decisions irreversible? Whenever possible, the analyst should seek comparative costs.

The cost of parts to be purchased domestically is likely to be surrounded by great uncertainty, and the preliminary appraisal will have to work with a range of costs. For this reason, it is desirable to consider imports as alternatives, even if on a contingent basis.

It is frequently necessary to modify the product for it to be compatible with available manufacturing equipment. Sometimes the product is modified for production by high-speed specialized production equipment. The converse is also true; that is, a product may be designed for production by general purpose equipment. Thus, it may be necessary to modify the designs to meet available local production equipment. Consequently, in most manufacturing plants, some product design functions are performed.

Definition of Production Methods

The elements that contribute to the efficient production of goods are production equipment, plant layout and assembly operations. The selection of equipment, establishment of assembly operations and the choice of plant layout is governed primarily by the volume of output of a given product. However, where quantities of a product are small, more efficient equipment can be justified if the plant is designed for more than one product.

Plant layout is characterized by the following three basic types:

1. Production line -- where a production line is established to produce a single product. Material flows progressively through consecutive work stations of equipment or assembly operations arranged according to the sequence of operations, such as is characteristic for automotive plants. The advantages of this method are reduced handling of material, reduced material in process, effective use of labor, more effective production control.

2. Process layout -- also known as batch layout or job shop, where all operations are grouped together. That is, all similar equipment will be in one area of the shop. For example, lathes may comprise one area, milling machines another, and welding equipment still another. Similarly, assembly operations will be grouped by like processes in the same area. Advantages of a process-type layout are improved machine utilization, the variety of products that can be produced by lot sizes, and allowance for frequent product changes.

3. Fixed position layout -- where the material or major component remains in a fixed place. Equipment, labor and materials are brought to one location. An example of this kind of layout is the refitting or build-up of a shop in a drydock. Advantages of this type of layout are (a) handling of a large item is reduced or eliminated, (b) changes in product design can be readily incorporated, (c) skilled operators can complete their work at one point, and (d) less total space is required.

A summary of the various types of plant layout is given below:

Type of layout	Characteristics
Production	High volume, single product
Process	Low volume, many products, intermittent demand
Fixed	Large item, prototype, one-of-a-kind product, small working space

Determination of specific equipment to be used is facilitated by outlining the operations and equipment to be used in a manufacturing process planning sheet, such as is shown in table A-1.

Table A-1. Illustration of Manufacturing Process Planning Sheet

Operation Summary Sheet
Part Name: Gear
Part Number: XXXXXXXXXXXX

Operation number	Operation description	Equipment	Pieces per hour
10	Receive and inspect blanks	Bench and Brinnell hardness tester	120
20	Rough turn and cut-off	Monarch engine lathe	20
30	Roll stamp heat code	#25 Schmidt marker	120
40	Break sharp corners, wash and oil parts	Speed lathe, dip tank	50

The type of machines required must be determined and priced. Information on standard machinery is readily obtainable from manufacturers who are listed in the Thomas Register of Manufacturers for the United States or in like references for other countries. The analyst will do well to obtain catalogues from various manufacturers to compare processes and prices. Installation costs can be obtained from engineers or from equipment manufacturers. Through inquiry or by drawing on experience in similar projects and using cost indexes, it should be possible to arrive at approximate costs of installation and equipment, and at the lead time required for ordering.

Production Area

Design of a production area is dependent upon the specific types of product methods incorporated into the overall production plan. The basic point to stress in the design of production areas is the concept of visible production control. This concept is applicable to all methods of production as it emphasizes adoption of work-in-process storage, aisle space, correct material handling and proper flow of goods without backtracking and the like.

To achieve visible production control even in a process-type layout, much can be accomplished to obtain a reasonable straight-line flow of materials. An analysis of the operations will reveal that the various production areas such as lathes, milling machines, drill presses, and other equipment can be arranged with the objective of minimizing backtracking of material through the shop. Also the aisles for moving materials should be wide enough without work-in-process materials stored on the aisles. Likewise, the production equipment work areas can be arranged in proper geometric configurations that will encourage neatness. In an orderly shop, foremen and higher echelons of supervision will be able to walk through the shop and observe that neat, orderly work stations are producing goods without interruptions. On the other hand, work stations with material accumulating by them will provide a signal of potential problem areas, because either the equipment is not performing properly or the operator cannot handle the work to be processed on time.

Supporting Production Departments

In the design of a manufacturing plant, consideration must be given to the proper location and space allocation of the functions that are either directly or indirectly required

in support of production. Typically such supporting functions are maintenance, incoming materials storage, tool rooms and cribs, finished goods storage, shipping, cafeteria service and power plant. Some of these functions, such as the power plant, maintenance shop, or cafeteria, may be located outside the plant. Size of the plant, size of the supporting function, relative importance of the function to the production area, and other related factors contribute to the location and space allocation of supporting functions.

Physical Plant

The physical plant is comprised of: production equipment and the structure containing the equipment, administrative offices, warehouses, maintenance shops, power plants and the like. The size, type and complexity of the physical plant depends upon:

- Scale of operations
- Nature of operations
- Geographical location

Thus, a small manufacturing plant may not require a power plant or may require only a small diesel engine to satisfy its needs. On the other hand, an extremely large automotive assembly plant may require its own power plant if the outside power sources cannot supply power in sufficient quantities.

The nature of operations will contribute to the needs of particular facilities. Even a light electronics assembly plant will normally demand an air-conditioned environment for the manufacturing area.

Geographical location, of course, requires different structural considerations. A warm, humid climate may impose the necessity of an air-conditioned environment to assure an alert, efficient working force. This, in turn, will impose specific building construction to meet these needs.

Supply Logistics

Materials for the production lines, spare parts for maintenance of equipment, water for plant operations, and other supplies must be provided at the right time and in-correct quantities. Initial supplies must be made available

to start the manufacturing plant, and plans must be made to assure continuous flow of supplies to support production.

Thus, it is necessary during the planning phase to identify the following:

- Items to be supplied
- Quantities to be supplied
- Preliminary candidate suppliers, e.g., wholesalers, manufacturers, utilities, jobbers
- Method of payment for supplies
- Cost of supplies and their shipment
- Method of shipping the supplies, e.g., air, water, rail, truck
- Method of inventory control over supplies (quantities to be purchased and stored)
- Unusual constraints in terms of tariffs, money exchange and the like.

A total logistic plan in rough form must be developed to identify the method for acquiring goods to sustain production in an orderly manner. A logistic plan is to be considered an important part of manufacturing planning.

Distribution Needs

Consideration of the adequacy of planning for distribution is essential in overall project appraisal. The analysis of product distribution requirements will reveal basic factors relevant to plant location decisions -- transportation requirements, handling requirements for shipping, warehousing needs -- and will also force clear identification of expected marketing locations. The project should contain a description of:

- Quantity of product to be shipped in a given time interval: day, week, month or year

- Method for shipping the product, such as unit loads, containers, type of packaging, or bulk (as in mining products)

- Available transportation modes, and selection of proper transportation modes

- Kinds of warehousing or storage requirements

- Destinations to which the products will be shipped

- Taxes or duties that must be paid.

Again, the analyst must judge whether these matters have been explored; if so, he must also judge the quality of the supporting data. He will need current information on distribution methods, particularly for analogous facilities in the country and elsewhere.

Plant Location

Analysis of the marketing areas, distribution requirements, and supply logistics will assist in the decision-making for plant locations. Obviously, the ideal is to be close to the raw material and the markets; however, such an ideal condition is not always possible. Many factors will influence a plant location. Some of these factors are:

- Political climate or requirements
- Social demands
- Location of raw materials
- Location of the markets
- Taxation
- Labor costs or labor availability
- Transportation costs (raw material and market)
- Market demand
- Special concessions.

A PPA should quantify the national rate of return flows and the business enterprise flows corresponding to the most promising locations along with other quantifiable and nonquantifiable considerations. This task is made simpler by the fact that the requirements of the facility often narrow the choice considerably (close to port, pool of skilled personnel, etc.). The procedure of finding the least-cost alternatives can be used for choosing among contending alternatives, providing sufficient consideration is given to their quantifiable and nonquantifiable considerations.

Proper plant location analysis must identify all the relevant factors that were considered in locating the plant in a specific locality. This will permit proper evaluation of the merits of the proposed project.

Aesthetic Needs

There is a tendency, in the name of expediency, to disregard aesthetic values of physical structures; this is especially true in many manufacturing plants being constructed

in LDC's. The fallacy of such an approach cannot be overstressed. Examples of shoddy architecture in plant designs are numerous, although economic manufacturing plant can be made appealing at the same cost as an unappealing one. It is only a matter of emphasis. Evaluation must consider the aesthetic qualities of manufacturing plants.