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HANDBOOK FOR PROJECT DESIGNERS

A practical guide to project formulation

Annotated index

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PART IV

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Part I

Introduction

Part I

GENERAL COMMENTS

The introduction is not intended to be an operational part of the Handbook. It is designed to enable the user to obtain the maximum benefit out of it. The introduction will therefore explain what is understood by a project and what are its characteristics and aims in the context of development. It will then review in brief the various types of projects for whose preparation the Handbook will yield good results to the user; it will explain how a project is formulated, from the original conception through its running-in period, defining the position and function of the "project-designer" in that process and the role to be played by other professionals who will also use the Handbook to guide their participation in the development of a project. The introduction will finally describe the general content of the Handbook and how to consult it and use it for operational purposes.

/1. THE PROJECT

1. THE PROJECT

1.1 General definition of a project

1.1.1 Definition

1.1.2 The two major divisions: the economic project and the social project. Artificiality of the distinction but the need to use it. Recognition in the social project of all the basic elements of the economic project. Real or semantic differences? Balance between both types of projects.

1.2 Functions of a project

When a project is formulated, it satisfies the objectives for which it was designed, and also directly or indirectly fulfil other functions; some of these functions are common to all projects and others to a specific group. In this section of the introduction an attempt is made to present these functions in such a way as to bring home to the project designer the importance of considering a project within a broader context than that of the specific objectives assigned to it.

1.2.1 The project as development tool

All projects, public or private, economic or social, make a positive or negative contribution to development, according to whether or not they are successful and how effectively they help to eliminate the obtacles and shortages obstructing development.

In accordance with the importance attached to the basic concepts in Part II, this sub-section will be further divided into:

1.2.1.1 Determinants of development

1.2.1.2 Development policy

1.2.1.3 The project as a development tool

1.2.2 The project in the context of planning problems

Every country has a more or less explicit and consistent development policy deriving from its prevailing legislation, its institutions and the executive powers which the authorities can exercise in certain circumstances. This policy may find partial or global expression through the formulation of a development strategy for specific sectors or areas of the country, or in a general conception which may vary in coverage and method of ensuring compliance.

The development of this sub-section will also depend on the final content of Part II as regards planning. The following paragraphs are suggested:

1.2.2.1 Various development strategies (unplanned development, centrally planned development, indicative planning, sectoral programming, regional programming, public sector planning and performance budgeting, etc.)

1.2.2.2 Project formulation as part of a programme

1.2.3 Some specific aspects of the project

1.2.3.1 The economic project and the social project

1.2.3.2 The national project and the multinational project

1.2.3.3 The project and economic integration

1.2.3.4 The single-purpose project and the multi-purpose project

1.2.3.5 Types of projects

This sub-section will contain a brief summary of the relevant chapters of the Handbook

2. THE PROJECT FROM THE VIEWPOINT OF THE HANDBOOK AND OF THE PROJECT DESIGNER

2.1 Definition of a project in terms of the Handbook

This section will note the differences between projects which follows the normal process of fomulation and those whose characteristics class them as such, but which are studied and executed by methods other than the technical and economic procedures defined here.

2.2 The "project designer" and his sphere of action

An analysis will be made of the functions of a "project designer", the particular techniques which characterize his activities, the essential qualities required in exercising his functions, and the relationship between the "project designer" and the stages preceding and following his work.

3. THE PROJECT AS A MONOGRAPH

This chapter is in some degree a brief summary of the content of a project, i.e., a synthesis of Part IV of the Handbook, and in particular of chapter 4. The following sections are tentatively proposed:

3.1 Analysis and justification of the allocation of resources

3.2 Technical and economic problems requiring analysis

3.3 Methodological information

4. PURPOSE AND CONTENT OF THE HANDBOOK

In the first place, the purpose of the Handbook will be presented in terms of the "project designer's" role in preparing the project, and will essentially reflect the concepts expressed in the document giving a summary explanation of the aims and characteristics of the Handbook. As regards its content, an over-all view is given of the subjects dealt with in the Handbook and the reasons why they were chosen. The main section and sub-sections might be:

/4.1 Purpose

4.1 Purpose of the Handbook

4.1.1 Purposes and characteristics of technical Handbooks

4.1.2 Need for an operational tool of this kind for use by the "project designer"

4.1.3 Other users for whom the Handbook is intended

4.2 The General Handbook and the specialized Handbooks

4.2.1 The reasons for preparing a General Handbook

4.2.2 The reasons for preparing specialized handbooks

The way in which the specialized handbooks will supplement the General Handbook will be explained later and a tentative list will be given of the main specialized handbooks that are considered useful.

4.3.2 The General Handbook and the necessity and form of life continuity over time.

Like all professional handbooks, indeed perhaps more than any other, this Handbook will have to be revised periodically, to keep it up to date and more particularly to expand it, remedy omissions or amend some of the proposed rules. This section will set out some rules of procedure for keeping it up to date and above all for improving on this first venture.

4.3 Content of the General Handbook

4.3.1 General introduction

4.3.2 Basic concepts

4.3.3 Methods

4.3.4 The project, its formulation and analysis

4.3.5 Auxiliary tools

4.3.6 Indexes

/This section

This section will present the over-all content of the Handbook, justifying the content and the linkage of subjects in the same way as the document that gives a general explanation of the Handbook.

4.4 How to use the General Handbook

This section will contain a general explanation of all the purposes of the Handbook and will show how to use it, giving some some simple examples. In various parts of the Handbook, particularly Parts IV and V, fuller examples will be given of how it should be used.

/Part II

PART II

Basic Concepts

Part II

GENERAL COMMENTS

The fact that the study of projects simultaneously covers a wide range of economic problems and technical problems, explains the relative variety and scope of the subjects which will have to be included as basic concepts in the Handbook. The analysis of economic problems and their relationship with financial issues, on the one hand, and its social, political and administrative implications on the other, makes it necessary to study the essentials of the social sciences, including also mathematics and statistics, in addition to the basic concepts and principles of economics itself and financing. When technical problems of different kinds are considered in project-designing, it is necessary to describe the concepts and principles on which an analysis of this type of problem is based, with a view to choosing possible solutions and justifying that choice from the technical and economic standpoints.

The selection of the subjects which should be regarded as fundamental elements in solving this group of problems is based on an inventory of the specific processes for obtaining information and the analytical methods used in formulating projects, followed by an examination to ascertain the methodological concepts and principles governing their use and, lastly, a study to determine what subjects in specific scientific disciplines serve as a bases for such processes and methods. This is the procedure adopted to select the subjects included in Part II of the Handbook. Each subject to be included shall be, without exception, the basis for one of the methods studied in Part III and specifically applied to the formulation of projects in Part IV.

In the annotated index pertaining to this part of the Handbook, as well as in those related to the other parts, it has been thought advisable to cover what is possibly an unduly large amount of material; this fault can be rectified in the drafting stages by eliminating the questions which, upon more careful examination, can be dispensed with in the final text. At this initial stage, it has been deemed preferable to

/err on

err on the side of overabundance rather than to risk omitting some subjects which may be useful for a practical guide for project formulation and analysis.

/1. BASIC MATHEMATICAL

1. BASIC MATHEMATICAL CONCEPTS

The preparation and evaluation of projects involves dealing continually with magnitudes, measures and estimates, so that the "project-designer" is constantly required to grapple with mathematical problems.

In the partial studies that conform a project, problems of this kind are found in three different areas: general mathematics, financial mathematics, and mathematical statistics. The basic concepts of mathematics are presented in this same order in the Handbook.

The chapter on general mathematics will be confined to those points which in some way constitute basic background knowledge for the solution of the practical problems that arise in the preparation and evaluation of projects.

This is the criterion that has been followed in selecting the subjects for inclusion in the chapter on general mathematics: those serving as a basis for the treatment of other mathematical problems as applied to technical or economic problems, or those related to the content of the other chapters on financial mathematics and mathematical statistics. Thus, for example, basic concepts of progressions are included because they are necessary for solving problems of compound interest and discount, notions of linear algebra because of their relation to mathematical programming, and even certain concepts of integral calculus, which are commonly used in statistical theory when it is necessary to include the continuum and discrete in a single formula, e.g., the Riemann-Stieltjes integrals. Moreover, such subjects as maxima and minima or "matrices and determinants" are included because they are directly applicable to economic theory as utilized in the formulation of projects.

As to the essentials of financial mathematics, those which are elucidated and developed in this chapter constitute the basic concepts of interest, discount, annuity, current value and other

/notions which

notions which are applied throughout the preparation and evaluation of projects in establishing financial equivalencies and homogenizing economic values over time. They are also used directly in calculating such coefficients as the internal rate of return, up dated net value, or the rate of return over costs on the basis of specific project data, and are useful for the internal evaluation of the project.

The chapter on mathematical statistics will be developed in such a way that it may help to improve the quality of the partial studies that make up a project. In some of these --market studies for instance-- it may be necessary to use more sophisticated statistical methods because of the nature or importance of the project, the "project-designer" being left to decide on the depth of the study in each case.

Since these are basic concepts, it is reasonable to start with concepts linked to probability and end with problems of statistical inference and decision theory. Nor can the basic concepts of the principal forms of mathematical programming be excluded or those of the major elements of operational research that can be applied in the formulation of specific projects.

In the concepts contained in the three chapters, it was thought best to present a fairly wide range of subjects that might possibly include rather too much material in relation to the purposes of the Handbook. Again, during the final drafting stages it may be decided to eliminate some of those subjects.

1.1 General mathematical concepts

Progressions
Functions
Graphical representation of functions (exponential, logarithmic, etc.)
Free and conditioned maxima and minima
Riemann-Stieltjes integrals
Sums expressed in terms of Riemann-Stieltjes integrals

/Reduction of

Reduction of a Riemann-Stieltjes integral to a Riemann integral
Differential equations
Equations in differences
Linear algebra
Matrices and determinants
Quadratic forms

1.2 Financial mathematics

Simple and compound interest
Current value
Annuities
Financial equivalences

1.3 Mathematical statistics

1.3.1 Probabilities

- Events and probabilities
- Dependence and independence
- Random vectors
- Distribution function
- Discrete and continuous random vectors; conditional and marginal distribution
- Correlation
- Asympthotic limits

1.3.2 Statistical inference

- Random sampling
- Sampling distribution
- Parametric estimation
- Point estimates
- Confidence intervals
- Test of hypothesis
- Linear models (complete range and range of linear approximation)
- Auto-correlation models
- Errors in variables
- Non-parametric estimation
- Random sampling in finite and stratified populations

/1.3.3 Decision theory

1.3.3 Decision theory

- The general problem of decision-making
- The utility function
- Minima solutions
- Bayesian solutions

1.3.4 Programming

- Linear and non-linear programming
- Dynamic programming

1.3.5 Operations research

- Concepts of stochastic processes
- Queuing theory
- Theory of inventories

2. BASIC ECONOMIC CONCEPTS

2.1 Macro-economics

2.1.1 Description of the organization, structure, and operation of the economic system.

This sub-section will begin by defining a number of analytical categories that will be of use in interpreting economic facts. Economic systems may operate under different forms of political or institutional organization (capitalist-socialist) and within each may have different structures.

With regard to the operation of the economic system, the description will make a clear distinction between current functions and capital accumulation functions, and will cover the real and the financial aspects of both types of function. Essentially, this sub-section will deal with such matters as the different types of markets, their purposes and methods of operation, basic concepts relating to price formation, government intervention in enconomic activity, and the relations of a given economy with the rest of the world.

2.1.2 Macro-economic accounting systems

This sub-section will deal with the operation of the economy from an accounting standpoint. It will begin with the physical side of accounting by defining the main economic aggregations, and them look at monetary matters, including the effect of changing the method of valuing physical factors on the results of the analysis.

/2.2 Micro-economics

2.2 Micro-economics

2.2.1 Theory of the supply of goods

This sub-section will study in real terms the most important factors which determine the optimum volume of production for an enterprise in a capitalist economy over the short and the long term, under different market conditions.

2.2.1.1 The factors of production:

- Analysis of the concept
- Complementarity, substituibility, homogeneity and divisibility of the factors of production
- Differentiation between the concepts of productivity and output with respect to individual factors of production

2.2.1.2 The production function:

- Analysis of the concept of the production function and technology
- Basic concepts relating to technological change and progress
- Definition of the concepts of productivity and output with respect to the factors of production as a whole

2.2.1.3 The supply function:

- Analysis of the concept and comparison with the production function
- Analysis of costs and income in the enterprise
- Definition of the concept of the elasticity of supply

/2.2.2 Theory

2.2.2 Theory of the demand for goods

This sub-section will basically analyse the criteria applied by the individual consumer in a capitalist economy when using his purchasing power to acquire given quantities of goods and services and to increase his financial assets as for example stocks and shares and cash reserves.

2.2.2.1 The factors influencing demand:

- Discussion of the major objective and subjective factors
- Selection of explanatory variables useful in analysis, such as income, prices, interest rates

2.2.2.2 The function of individual demand:

- The demand function for a given product, including an analysis of the nature of goods and their complementarity and substituibility
- The over-all demand function
- Basic instruments for demand analysis

2.2.3 Analysis of the factors of production

This sub-section will look at the main aspects of supply and demand in respect of the services of factors of production in a capitalist economy, under different market conditions

2.2.3.1 Labour:

- Main factors influencing labour supply and demand
- Relationship between production and supply functions in respect of goods and the demand for labour

/2.2.3.2 Natural

2.2.3.2 Natural resources

- Main factors influencing supply and demand in respect of natural resources
- Relationship between production and supply functions in respect of goods and the demand for natural resources

2.2.3.3 Investment and capital

- Differentiation of theories relating to investment and capital
- Analysis of the main determinants of the demand for capital goods for investment
- Definition of basic concepts, such as gross return on capital, financial cost of capital, investment rate of return, values of depreciated and non-depreciated capital

2.3 Analysis of economic equilibrium

2.3.1 Partial equilibria

This sub-section will look at the equilibrium of markets for finished goods and for services of the factors of production, including the formation of prices. It will also look at the balance between supply and demand for money, including the establishment of interest rates both within the financial system --in terms of the total sources and uses of funds-- and between savings and real investment.

2.3.2 Over-all economic equilibrium

Formulation of an over-all macro-economic interpretation, based on a study of the partial equilibria in the major sectors of the economy.

/2.4 Economic

2.4 Economic development

Although there is much academic controversy about the actual concept of economic development, owing to differences in approaches to the economic, sociological, political, and cultural factors on which it is based, it can safely be said that the "projects" of a nation or a human society includes the idea of developing the economy, in the sense of changing the structures of production and distribution with a view to raising income levels and also progressively redistributing it. Various operational instruments to promote economic development can be derived from an over-all policy, including specific economic policy measures, decisions on investment or other types of action taken through the formulation and analysis of projects.

The project is, then, a tool for economic development which helps to translate development policies and decisions into actual units for the production of goods or services, not only in the strictly economic areas but also in those that are predominantly social.

In a Handbook designed to be an operational guide for the preparation and evaluation of projects, a few pages must therefore be devoted to analysing economic development, and to clarifying the concept itself, the theories that have been built up around it and the most significant variables affected by the development process. The subject will be broken down as follows:

2.4.1 Evolution of the concept of economic development

- 2.4.1.1 Historical background
- 2.4.1.2 Economic development and economic growth

2.4.2 Theories of economic development

- 2.4.2.1 Historical environment
- 2.4.2.2 Principal schools of thought

/2.4.3 Some

2.4.3 Some significant variables in theories of economic development

2.4.3.1 Capital formation

2.4.3.2 Labour productivity

2.4.3.3 Entrepreneurship

2.4.3.4 Real demand and the level of employment

/3. BASIC

3. BASIC FINANCIAL CONCEPTS

This chapter will describe the concepts, institutions, and instruments that make up the general context of project financing, at both the national and the firm levels. The financing needed to implement and operate projects, its sources and the mechanisms for obtaining it, and the use to which it is put in the normal course of investment, will be analysed with a view to clarifying the reasons underlying the problems dealt with elsewhere in the Handbook in connexion with the operational side of project financing.

The chapter will begin by looking at the financial system and its basic monetary instruments, and then discuss the financial aspects of the national economy and the economy of the firm, systematically analysing the basic concepts in the following sequence:

3.1 Analysis of the financial system

3.1.1 Main characteristics of the financial system

3.1.1.1 Basic concepts:

- The various types of financial assets
- Intermediate and final sources and uses of funds
- Relation of sources and uses of funds to real savings and investment
- The financial agent or intermediary and his functions
- Principal factors determining supply and demand in respect of financial assets

3.1.1.2 Financial institutions:

- Capital markets
- Banks
- Stock exchanges

/3.1.2 Money

3.1.2 Money as the basic element of the financial system

3.1.2.1 Concept of money and its functions

3.1.2.2 Money supply. Processes whereby means of payments are created and destroyed

3.1.2.3 Analysis of the demand for money

3.1.2.4 The role of money as the basic means of economic transactions

3.1.2.5 Money as an element that integrates the real and the financial mechanisms of the system.

3.2 Financial aspects at the national level

3.2.1 Fiscal policy

3.2.2 The budget

3.3 Financial aspects at the level of the firm

3.3.1 Accounting

3.3.2 Sources and uses of funds of the firm

/4. THE ENTERPRISE

4. THE ENTERPRISE

This chapter will identify and analyse the problems affecting the relationship between projects and the types of enterprise capable of carrying them out with a reasonable chance of success. Taking the enterprise as the production unit in the economic system, the chapter will attempt to classify the enterprises within the major sectors of the economy, using as basic criteria such factors as size and forms of ownership and management. It will also describe the various types of enterprises, classifying them, in the agricultural sector, for example, according to whether they are family, capitalist-type, co-operative or collective; in the industrial sector, according to whether they are artisan-type, capitalist, state-owned, or managed with some degree of labour participation; and, in the case of commercial or service enterprises, according to the various types of participation in ownership and management. The chapter will then consider the role of the enterprise in co-ordinating the use of the factors of production, in the light of the analysis of the concept of the production function. It will also analyse the motivations of the decision-maker in deciding about the setting up and the future development of his enterprise.

It will then show, in the context of a given economy, that, since enterprises are continually starting up, growing and disappearing, the enterprises actually in operation at any given period of time follow a certain pattern in terms of size and objectives. In addition, it will consider the contribution of the enterprise to the economic development of the area in which it operates, with special emphasis on the role of the public enterprise in underdeveloped economies.

A typological inventory of enterprises will then be made in terms of size, methods of organization, levels of competition and forms of ownership and administration, in order to stress the growing

/importance of

importance of management in the increasing number of enterprises in which ownership and administration have been separated. The chapter will conclude with an analysis of the adaptation of each enterprise for different projects dealing respectively with the establishment of new production or service units, the expansion of existing ones, the merger of consolidation of enterprises, and public or semi-public enterprises.

The chapter will be set out as follows:

4.1 The enterprise as a productive unit

4.1.1 Classification of enterprises according to different criteria

4.1.2 Co-ordinated use of the factors of production; the production function

4.1.3 The usual motivations of the decision-maker and the factors affecting the development of enterprises:

- Use of capital and profits
- Innovation and technology
- Capital accumulation and expansion and their problems

4.1.4 Establishment, growth and disappearance of enterprises:

- Factors promoting progress or causing enterprises to shut down
- Distribution of enterprises by size and branch of activity

4.1.5 The enterprise and the development of the economy

- Private and social objectives
- The public enterprise in under-developed economies

4.2 Types of enterprise and their characteristics

4.2.1 Size

4.2.2 Methods of organization

/4.2.3 Level

4.2.3 Level of competition

4.2.4 Ownership and administration

4.2.5 The growing role of the manager in the enterprise

4.3 Adaptation of the enterprise to a project

4.3.1 Project for a new production or service unit

4.3.2 Project for the expansion of an existing enterprise

4.3.3 Project for the merger or consolidation of enterprises

4.3.4 Projects relating to public enterprises

/5. ORGANIZATION

5. ORGANIZATION AND CONTROL

This chapter deals with the basic concepts currently used to regulate and guide the organization of enterprises in general. The methods for their application are presented in other parts of the Handbook.

Since the Handbook is not aimed at the specialist in organization and since its immediate objective is the preparation and evaluation of projects, it must naturally describe and define the most basic concepts.

This chapter will indicate the fundamental principles and concepts on ehich the scientific organization of work is based, giving the necessary definitions and outlining common forms of organization, both from the legal and from the technical and administrative standpoints. In view of the differences between the legislation of the various countries, it will present only those rules or organization that are most commonly used. The setting up of corporations, partnerships and co-operatives, for instance, is generally regulated by legislation that is very similar in all countries, and this is also true of arrangements by public or private enterprises for securing bids, contracting and building.

Since the principles governing organization are of a more general nature, they can be spelled out in more detail, but here too the purpose of the section in presenting the basic principles and describing certain functions of the enterprise is simply to define the organs that should carry out such functions and for which provisions should therefore be made in the project.

The basic concepts presented would be confined to those most widely used and easiest to apply in the standard types of organization, so as to cover all the different types of project dealt with in the Handbook.

/The chapter

The chapter will have the following scheme of presentation:

5.1 Basic definitions

5.1.1 Purposes, functions and activities of the enterprise

5.2 Methods of work allocation

5.2.1 Authority and responsibility

5.2.2 The line and staff organization

5.3 Over-all models of planned organization

6. DESCRIPTION OF THE MORE FREQUENT TECHNOLOGICAL PROCESSES

The purpose of this chapter is to provide the professionals in various disciplines who take part in the project with the basic concepts which may enable them to gain a clear understanding of its technological aspects.

Within the broad conception of the Handbook, the technology which must be examined covers that applicable in both production and social projects.

To fulfil this objective successfully it is necessary to tackle the problem of how to describe with adequate depth and scope the many existing technological processes. One of the most difficult problems is to limit the extent of the description of technological processes, in view of the wide coverage of the Handbook. A common characteristic of most of the technological processes in use, however, is that they combine a few elementary techniques in many different ways. It is therefore possible to reduce the number of cases reviewed without altering the conceptual coverage of the chapter.

There are far greater possibilities of limiting the depth or level of disaggregation and detail. One way of restricting the depth of the study of the various technologies would be to determine the type of professionals for whom the information is intended. Another way would be to limit the desired objectives strictly in terms of the particular functions of these professionals in the project.

As regards the first restriction, it is assumed that this information is intended for professionals who are not specialists in the technological aspects of the projects; thus the descriptions may be confined to basic principles which explain the nature and essential functioning of the technological processes in terms which can be understood by persons with university training who have not specialized in the subject.

/As regards

As regards the second way of limiting the description of technologies, it must be borne in mind that the basic objective of this chapter is to allow and facilitate the interdisciplinary work which is indispensable in the various phases of project formulation, without the need to consult sources of information other than the Handbook. It will not always be possible to achieve this objective to the extent of self-sufficiency, since the degree to which the various professionals are involved in the technical issues will vary. The basic information should therefore be supplemented by an appropriate specialized bibliography for each of the technical fields covered.

The objective to be aimed at may be itemized as follows:

- The chapter would provide and over-all knowledge and understanding of the technical questions involved;
- It would enable the non-technical professional to evaluate the relationship between his own work on the project and the technological aspects of the project as a whole;
- It would prevent the general technical solutions adopted from being evaluated exclusively by specialists who might lack an over-all view of the problem;
- It would facilitate the interdisciplinary contributions that would ensure the best possible technical solution to the problem.

Within these bounds, the problem of describing the technological processes will be dealt with in three sections:

a) Basic definitions
b) Basic principles for the description of processes
c) Classification and description of unit processes

In the first section an attempt will be made to define the basic concepts; the second section will give a systematic description of the most important aspects of a process; and the third section will present a systematic classification and description of the unit processes, with bibliographical references.

/By way

By way of example, the following is the suggested layout for each of those sections.

6.1 Basic definitions

In order to establish communication or exchange interdisciplinary information, it is essential to clarify the meaning and scope of the terms that are to be used, since it often happens that the terms used in one professional discipline are used in another to define different concepts.

This is true, for example, of the terms for operations and unit processes in the chemical industry compared with the broader meaning of those terms in process engineering.

6.1.1 General process

The following definition could be a tentative point of departure:
A process is taken to be the systematic set of activities needed to attain final results or proposed objectives by transforming certain initial conditions within a given period, and which can be reproduced under similar conditions. It must be emphasized in this definition that, for purposes of the project, the process is identified or characterized by the final conditions.

6.1.2 Unit process

This may be defined as the smallest subdivision of a general process, in which there are no typical or reproducible intermediate stages or events.

6.1.3 Continuity of the processes

The differences between continuous and discontinuous processes would be established here.

/6.1.4 Pure

6.1.4 Pure alternative processes

This type of processes will be defined as those that starting with the same initial conditions, and using a different set of measures or a different arrangement of unit processes, reach the same final results.

6.1.5 Secondary alternative processes

These are processes in which there may be certain differences in both the initial and final conditions.

6.1.6 Alternative processes conditioned by the production function

The above definitions consider only the actions but not the other factors that form part of or characterize each process. In both the simple and the secondary alternative processes, there may be different combinations of factors of production which give rise to other alternative processes.

It is particularly interesting here to consider the alternative techniques deriving from the intensity of the use of the labour and equipment (capital) factors and from specific automation solutions.

6.1.7 Alternative processes conditioned by size.

6.2 Basic principles for the description of processes

Once the interdisciplinary "idiom" outlined in the previous section has been established, an attempt will be made in this section to determine the main features common to all processes in order to describe them systematically.

The principal aspects of the process could be divided into three groups:

a) Essential technical

a) Essential technical features of the process
b) Relationship between the process and the environment
c) Information required on the environment

The process, in turn, would consist of three stages:

a) Initial state or condition
b) Transformation process (solution or alternative solutions to the problem)
c) Final result or stage..

This way of describing a process is directly related to the general methodology for the solution of problems, in which the initial and final stages, with their respective limitations or slacks, are considered to be the basic elements for a description of the problem, and the alternative transformation processes to be possible solutions.

6.2.1 Final stage

Since the process is determined by the final stage, this phase will be taken as the point of departure. The definition of the final stage will be taken as a datum in this section but it will be analysed (as a specific solution for a given need) in the chapter on markets, in the section concerned with the specifications of the product.

i) Specific features
   a) Quantity
   b) Quality

ii) Relationship with the environment
   The relationship with the environment will be determined by the slacks or rigidities revealed by the market study, mainly in the form of:
   a) Slacks in regard to quantity (or level of supply)
   b) Quality margins
   c) Cost margins.

/6.2.2 Initial stage

6.2.2 Initial stage

In general, this stage relates to the situation or object to which the transformation process will be applied and whose characteristics condition the final result, although it must not be confused with an analysis of inputs. Thus, for example, in an educational process, where the final result is defined as a certain number of persons with a particular educational level, the initial stage is the description of the persons who are entering the educational process and not of the pencils, books, teachers or schools, etc.

In some final stages, as for example, certain chemical products which result from the combination of very different elements or compounds, this definition is not clearly apparent, and consequently it will be necessary to identify the physical or chemical laws ruling both the initial and final stages in order to define the former, but still without reference to the whole group of inputs required to bring about the change.

To consider some of the inputs as the initial stage, would make it impossible to present the problem clearly and comprehensively; it may also lead to restrict the number of alternative processes in line with the strict specification of their characteristics. For example, the initial stage in the manufacture of sulphuric acid (H_2SO_4) is not the existence of particular compounds, such as pyrites, gypsum or deposits of a certain quality of natural sulphur (defined by the techniques in use), but the existence of sulphur and water. Thus, from this initial stage to the final stage every possible process is contemplated, including the well-known and proved industrial techniques, those tested in pilot projects, feasible techniques at the laboratory level and those which give rise to research projects.

/i) Specific features

i) Specific features
   a) Quantity
   b) Quality
ii) Relationship with the environment
   a) Spatial distribution
   b) Physical, economic and social rigidities

6.2.3 Process

The description or specification of the initial and final stages is merely the presentation of the problem. The description of the intermediate phase or process proper corresponds to its technical solution.

The main characteristics which are to be included in this description would be selected with a two-fold purpose: first, to present a synthesized picture, as complete as possible, of a qualitative and quantitative nature; and, secondly, to provide the elements of comparison for the choice of techniques dealt with in Part III, chapter 3.

i) Characteristics of the process
   a) Productivity (the different concepts of productivity should be explained here)
   b) Speed of the process
   c) Relationships of productive scale
   d) Analysis of inputs
   e) Security of operation
   f) Security of the human factor (environmental conditions, physical safety of the workers)
   g) Simplicity (relative analysis of simplicity)
ii) Relationship with the environment
   The following are the main two-way relationships between the environment and the process which would be reviewed:

/a) Effects on

a) Effects on alternative processes in use. It must be emphasized here that this part of the analysis is purely descriptive, since the evaluation of the effects must take place after the criteria for assessing them have been defined. Special reference will be made to the way in which new technologies may replace those existing in the environment (horizontal relationship);

b) Compatibility with existing processes. This section deals with the effects of a vertical relationship, especially the use of inputs or the manufacture of semi-processed products which has a favourable or unfavourable effect on the existing system;

c) Adaptability. A review will be made here of the way in which the processes may adapt or be designed to adapt to environmental changes, on the side of both inputs and demand;

d) Continuity in the face of technical obsolescence. This section, while closely related to section (c), will emphasize the speed of adaptation and the rigidity of the means used vis-a-vis the speed of technological progress.

iii) Information required on the environment

By way of supplementing the previous analysis and completing the background data for the choice of alternative techniques, the type of information that must be obtained concerning the environment in which the process in question is to be used must be presented systematically.

This data might include:

a) A description of alternative techniques available in the environment (which can amount to only a small proportion of the total number of possible techniques)

/b) Existing technical

b) Existing technical standards and limitations in regard to their modification

c) Present stage of technology in relation to the process, both in general, and specifically in relation to the limited environment in which the process is to be applied

d) Present and probable foreseeable advances at the industrial level

6.2.4 Some graphical means for the description of processes

The basic elements of flow diagrams and their usual symbology could be indicated here.

6.3 Classification and description of unit processes

After defining the basic elements that facilitate a common interdisciplinay language and presenting the basic principles of the processes, the bulk of the present chapter will centre on a description of the unit processes as elements of technological knowledge at the level of the non-technical professionals taking part in the project.

An attempt will be made to limit these descriptions, as well as the classification for their systematic presentation, in line with other sections of the Handbook on this particular subject.

PART III

Methods

Part III

GENERAL COMMENTS

This part of the Handbook will deal with the methods most commonly used in project formulation and analysis.

The idea is to present systematically in one part all the procedures more generally used that may be utilized as instruments in the wide range of projects covered by the Handbook. This would make it possible to shorten Part IV, which will be the section most used; the methods required could simply be mentioned in this part and would be fully developed here.

In principle, Part III will include only general methods in widespread use, which will not in this part be grouped according to the typology of projects adopted in the Handbook.

Although these methods are in widespread use, at this stage of preparing the index, before all the subjects have been thoroughly developed, it is not possible to foresee the full coverage of methods that will ultimately be required. It may also happen that some of those now included will be omitted from the final version.

In general, the subjects included constitute a methodological supplement to Part II and the methodological basis for Part IV.

Although, strictly speaking, this part should deal exclusively with methods, a number of theoretical explanations are added in order to provide some guidance when there is no corresponding theoretical section in Part II.

/1. MATHEMATICAL

1. MATHEMATICAL METHODS

This chapter contains the methodology that corresponds to basic concepts of mathematics included in Part II.

It will cover all the methods which are considered necessary for the various phases of project formulation and analysis.

Again, since these are methods in general use, it is not possible at this juncture to prepare a complete list that would be exactly in line with the foreseeable requirements of the Handbook, before a more thorough study is made of the related subjects for which these methods are required. Therefore list of subjects set below is not exhaustive, and some of the methods now included may be omitted from the final version of the Handbook.

1.1 General mathematical methods

- 1.1.1 Determination of maxima and minima
- 1.1.2 Matrix operations
- 1.1.3 Classification of quadratic forms

1.2 Financial mathematical methods

- 1.2.1 Construction and use of tables
- 1.2.2 Interest and discount
- 1.2.3 Current value and financial equivalences
- 1.2.4 Annuities and amortization
- 1.2.5 Construction and use of tables

1.3 Statistical methods

- 1.3.1 Methods for data compilation, processing and analysis (from a descriptive angle)
- 1.3.2 Methods of indexes determination
- 1.3.3 Methods of parametric estimation
- 1.3.4 Methods for testing hypotheses
- 1.3.5 Methods for experiment design and analysis
- 1.3.6 Sampling methods
- 1.3.7 Programming methods
- 1.3.8 Operations research methods

/2. MARKET

2. MARKET ANALYSIS METHODS

It is intended that the "project designer" should find in this chapter all the necessary methods for carrying out the consecutive stages of the market study that are required ror the various types of projects considered in the Handbook.

The type of subjects to be included in this chapter are shown in the following outline:

2.1 Analysis of past and present demand

- 2.1.1 Statistical series on prices
- 2.1.2 Statistical series on physical quantities (production, imports, exports and changes in stocks)
- 2.1.3 Statistical series on population and economic matters (population and income)
- 2.1.4 Methods of analysing production and consumption cycles
- 2.1.5 "Marketing" analysis methods
  - i) Transport and storage
  - ii) Presentation and technical assistance
  - iii) Government action
- 2.1.6 Methods of research on products of a similar kind, complementarity and substitution

2.2 Analysis of present supply and its trends

- 2.2.1 Measurement of level of competition
- 2.2.2 Measurement of installed, utilized and idle capacity
- 2.2.3 Analysis of current production costs

2.3 Estimation of future demand

- 2.3.1 Methods of projecting trends
- 2.3.2 Usual technical coefficients
- 2.3.3 The utilization of international comparisons
- 2.3.4 Econometric methods

/i) Price-elasticity

i) Price-elasticity coefficient
ii) Income-elasticity coefficient
iii) Demand, price and consumer income
iv) Projection of prices and inflation

2.3.5 Methods of projection without statistical data

i) Analysis by sector of use
ii) Consideration of development objectives
iii) Consideration of political factors

2.4 The problem of uncertainty

2.4.1 Introduction of uncertainty into the estimation of past and present demand

2.4.2 How to insert uncertainty in the forecasting of future demand

2.4.3 Correction of assumptions regarding the future evolution of demand and supply

3. ANALYSIS OF TECHNICAL ALTERNATIVES

This chapter will deal with the methodological aspects of devising a technical solution for the project in the three stages covered by the Handbook [1/] (identification of the idea and exploratory design; preliminary design and final design).

It should be indicated here what type of problems are involved in the design of technical solution and which of them directly affect the "project-designer". The scope of this chapter will thus be more clearly delimited.

In order to define the question of design in the context of the project (in the terms laid down in the Handbook, the specialized technical "agents" should be considered separately from the interdisciplinary group covered by the term "project-designer". Thus, the question of design is limited to three active factors or "agents": the "decision-maker" (in the broadest sense of the term), the "project-designer" and the "technician" (representing the specialized group); and a passive factor constituted by the "environment" (a context defined by cumulative and accessible information, and geographical, political, social, economic and cultural variables).

The distinction between the "project-designer" and the technician is purely conceptual, since in practice the "project-designer" may be an enterprise which has all the specialized technical agents at its disposal.

From the time the basic idea of the project is born (decision-maker) to the completion of the final design (project-designer), the technical solution goes through a continuous process of evolution and

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1/ These main stages and their composition are described in Part IV of the Handbook (3.1.1, 3.1.2 and 3.1.3).

/improvement in

improvement in which the four factors referred to above take part. This process (which will be described in Part IV of the index) consists of the interaction of the four factors which, in a series of approximations from the general to the particular, establishes a sequence of phases of intermediate decision-making or partial solutions until the optimal solution is reached.

The purpose of this chapter is to provide the "project-designer" with the methodological elements required to facilitate the interaction of these four factors in each of the stages of decision-making.

Broadly speaking, the design of a technical solution comprises the following stages: the idea, the formulation of the problem, the search for solutions and the evaluation and choice of solutions (and a possible additional stage of revision or improvement of the chosen solution). This design process is repeated partially or completely a number of times, in increasing depth, from the inception of the project to the stage at which the optimal solution is worked out as the basis for the formulation of the final design. It often happens that the original design raises secondary design problems or subprojects, for which the same process of formulation is followed.

Since the technical objective of the project is to find the best possible solution, it is necessary to establish the means of communication that will enable the "project-designer", as the individual responsible for the optimization of the project as a whole, to co-operate with the other project agents, particularly the specialized technicians, in seeking the optimal solution. Otherwise, the "project-designer's" activities will overlap with the decisions already adopted by the technicians, and his work will be confined to improving or evaluating the effects of the latter's decisions, thus limiting the quality of the final solution to that of the solution worked out separately by the technicians.

/The "project-designer"

The "project-designer" must therefore take part in perfecting the solution from the very beginning.[2/] If he is involved from the moment the idea is first conceived it will be possible for the final design - as a monograph - to contain a synthesized list of the solutions explored and the justification for their choice or rejection in the stage of technical formulation.

The process of design within a project is combined technical and economic approach in which there is no strict separation between the fields but only a gradual change of emphasis. It may happen that even if the problem is presented in purely technical terms, the "context" and the interests of "decision-maker" will provide the economic approach. What the Handbook aims at is to ensure the smoothest possible transition from a technical to an economic slant. In short, the problem which the Handbook will try to solve in this chapter will be conditioned by the following factors:

a) Need for joint action by the "project-designer", and the other project agents.
b) Desirable participation of the "project-designer", which could be extended to the source of the idea.
c) The chosen technical solution is reached through repeated decision cycles.

The first two factors tend to broaden the "project-designer's" sphere of action and thus increase the part he plays in the design of the technical solution. The third factor, however, is what makes this problem really manageable, since it enables the systematic analysis of each decision cycle.

The methodological analysis of a typical decision cycle will help to enrich project formulation techniques with contributions from such branches of knowledge as logic, systems engineering, methods engineering, scientific method; decision-theory, etc.

2/ The introduction to Part IV, chapter 1 comments on different types of decision-makers and the greater or lesser extent to which they require the "project-designer's" assistance.

The design cycle will be dealt with under the following phases:

- Problem formulation
- Search for solutions
- Technical evaluation and choice of solutions
- Revision or improvement of the chosen solution

3.1 Problem formulation

The point of departure of the design process could be defined as the situation when the "decision-maker" feels or forsees a need whose satisfaction —or the action required to meet this need— enables him to live up to his own "values", This is the conception of the idea. This concept must be limited, so far as projects are concerned, to ideas which are confronted by a problem situation that has to be solved through the action of the "project-designer" (the degree and form of relationship between the "project-designer" and the different types of "decision-makers" are analysed in Part IV, chapter 1).

At his point the idea must be translated into the "problem formulation". Emphasis should be given hereto the optimum problem formulation, since to a large extent this logical analysis of the situation contains the germ of the solution. Obviously, sound solutions of the problem cannot be reached unless the problem is properly formulated.

A "problem situation" is defined by a minimum of five necessary and sufficient conditions:3/

i) An individual who has the problem and makes the decision ("entrepreneur");

ii) An objective that is desired by the entrepreneur, and which has positive value within his scale of values;

3/ The proposed definition is based on Russell L. Ackoff, Scientific Method (New York, John Wiley and Sons, Inc., 1962), p. 30.

/iv) A "state

iv) A "state of doubt" in the "decision-maker" as to which choice is best;

v) The "context" of the problem or the set of factors which can favourably or adversely affect the goals desired and which are not under the "decision-maker's" control.

Implicit in the "idea" itself there are nearly always real or fictitious conditioning factors which distort the statement of the problem. The "project-designer" should be able to translate the decision-maker's idea into the real terms of the problem, endeavouring to come as close as possible to the minimal conditions for defining it by eliminating the fictitious constraints. The "technicians" may be required to begin participating in this part of the process in addition to the "decision-maker", and a preliminary study may be needed of the "context".

3.1.1 Definition of the final stage (in relation to these definitions, see Part II, chapter 4);

Analysis of the final product or stage with its constraints in terms of:

i) Quantity

ii) Quality, time or speed of the process

3.1.2 Analysis of the range of flexibility of the constraints in the final stage.

The "technical elasticity" of the solution will be examined here, possibly to the extent of formulating alternative final stages, on the basis of which it would be possible to reformulate and come to a decision on the problem at more advanced stages of the analysis. In analysing an education problem, for example, the quantity factor will appear as the alternative numbers of students

/and the

and the quality factor as the levels or types of education, which would make it possible later to choose partial combinations of the two factors in line with the factors subsequently conditioning the project.

3.1.3 Definition of the initial stage: possible alternatives

3.1.4 Constraints connected with the environment

3.1.5 Constraints connected with the "decision-maker"

3.1.6 Optimization criteria

3.2 Search for solutions

Once the problem has been accurately defined, the next step is to seek adquate solutions. This will be the design stage, which should in itself be eminently creative and cannot be reduced to the simple terms of a method or mechanical system. Nevertheless, some rationalizing is possible. The following definition can be taken as a point of departure: "A solution is a synthesis of component elements which hurdles the obstructing difficulties and, neither exceeding the available resources nor encroaching on the limits set by the constraints, accomplishes the prescribed goals".4/

Several concepts may be distinguished in a solution:

a) The concept of "universal information" or comprehensive knowledge (of the component elements)

b) The capacity to synthesize the component elements and to organize them in a way that will fulfil the conditions of the problem

c) A complete knowledge of existing solutions to the same or similar problems and the ability to adapt them to the problem concerned

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4/ Morris Asimow, Introduction to Design (Englewood Cliffs, N. J., Prentice-Hall, Inc., 1962), p. 45.

/d) The

d) The whole set of limiting factors

e) The objective

The first three concepts define the action of the "technical agents" or specialists in a given discipline, while the last two largely make up the "project-designer's" sphere of action.

The dialogue between "project-designer" and technician should aim at getting the proper answers for the following problems:

i) To assure the "project-designer" --responsible for the overall solution-- that the three conditions to be fulfilled by the "technical agents" will be accomplished within the framework of the project;

ii) That the process of designing the technical solution will be efficient in relation to the resources allocated to it.

The following steps would be necessary to achieve these objectives:

3.2.1 Determination of the area of acceptable solutions

Ideally, the search should be complete, but since this would be very costly in time and resources, its coverage must be limited from the earliest phases of the analysis. Once the initial and final conditions and their respective alternatives and margins of flexibility have been determined, the set of possible solutions can be limited by defining the area in which the process of seeking acceptable solutions should be concentrated. This group will include both the proved solutions, and those not yet established, which could give rise to research projects.

3.2.2 Process of seeking solutions

The possibility of designing a solution depends, in general, on two factors:

/a) The

a) The resources that can be allocated to the design, in terms of time, talent and material resources;

b) Scientific evidence that the final stage or proposed target can be reached within the bounds of present scientific knowledge.

In every case the resources are limited and the formulation of projects involves the establishment of a time-table and relations with a "context" that is also variable in terms of time. Consequently, the necessity of applying the criterion of economic feasibility to the search, conflicts in some degree with the criterion of comprehensiveness that is desirable in order to cover all possibilities; hence, these criteria should be applied within the area of acceptable solutions.

It is possible that the limited time and resources available will hinder the determination of all the alternatives (which would include the optimal solution), and the process would merely result in the establishment of a subset of feasible solutions (which might not include the optimal one).

3.2.2.1 Subdivision of the area of acceptable solutions

In order to avoid concentrating the search unintentionally in a limited sector of the area of acceptable solutions, it is advisable to subdivide this area. It would then be possible, at the same time, to fulfil the condition of economic feasibility, since the search could be deliberately concentrated in one of these subsets in which it is assumed that feasible solutions could be obtained most economically.

/The area

The area might be subdivided as follows:

i) Alternatives tested at the industrial plant level;
ii) Alternatives tested at the pilot plant level;
iii) Alternatives tested in the laboratory;
iv) Alternatives which have not been tried out but whose components have already become a part of scientific knowledge.

Each of these subdivisions might, in turn, be divided into two parts:

a) Inventory of existing alternatives;
b) Historical scope (changes in the context over time and disparities at a point of time between countries at different stages of development tend to reintroduce alternatives that had previously been discarded with the advent of new conditions: the electric automobiles, for example).

3.2.2.2 Establishment of priorities or deliberate search for solutions

The "project-designer" jointly with the technician, must establish priorities among the various divisions in the area of acceptable solutions, with the purpose of obtaining the first feasible alternatives as soon as possible and at minimal cost. Top priority might be given to reviewing alternatives tested at the industrial plant level, then those tested at the pilot plant level, etc., the inventory of existing alternatives being examined first, followed by the historical scopes. It is even possible to improve the efficiency of the process within each of these

/subdivisions by

subdivisions by concentrating attention on those solutions which best fulfil the conditions for optimizing the project: for example, the search for labour-intensive solutions or solutions which may minimize fuel consumption, etc. Again within these internal limitations of priorities and optimization criteria, it is necessary to introduce the criterion of comprehensive coverage in relation to the type of alternatives (see Part IV), examining first the alternative processes and the alternative scales of these processes, and then in the more elaborated decision cycles the alternative locations, technical time-tables and physical works.

3.3 Technical evaluation and choice of solutions

In this stage the general criteria for evaluating the project will be translated into technical terms, which will enable the specialized "agents" to perform their role in the evaluation of technical alternatives within the framework of the project.

3.3.1 Evaluation of alternative processes

In this section the process analysis developed in Part II, chapter 6, will be translated into applicable methods. Since the final stage of a process is the point which characterizes or defines the solution, the analysis will focus on the initial stage and the process itself.

3.3.1.1 Analysis of the initial stage

i) Analysis of special distribution (in the terms set forth in Part II, chapter 6);

ii) Analysis of physical rigidity.

/3.3.1.2 Evaluation

3.3.1.2 Evaluation of alternative processes

The project criteria will be stated here in terms of:

a) Productivity (efficiency analysis)
b) Speed of the process
c) Analysis of production scale
d) Input analysis
e) Security of operation
f) Manpower safety
g) Simplicity (relative simplicity analysis)

3.3.1.3 Evaluation of their relation with the environment

a) Effect on alternatives in use
b) Technical compatibility with existing processes
c) Adaptability
d) Behaviour in the face of technical obsolescence

The dialogue between "project-designer" and technician will still have to be systematized methodologically in regard to:

3.3.2 Alternative physical works

3.3.3. Alternative time-tables

3.4 Revision or improvement of the chosen solution

Design activity in the project (with its partial solutions for each decision cycle) is part of a network of simultaneous activities which yield data whose quality and quantity improve over time, and this makes it necessary to reappraise the chosen solution periodically.

This section will analyse in detail the various ways of applying the method of successive approximation, or concentric decision cycles.

4. METHODS OF COST BUDGETING

In the progressive stages of project formulation and analysis, decisions must be taken concerning the costs of alternative solutions, or the effects of specific solutions must be evaluated. It is important for the "project designer" to have the necessary tools and information for calculating costs, which may be used either in the form of processed data or as elements for estimating them, from the earliest stages of the project.

For the purposes of the Handbook, the group of elements required for estimating costs will be divided into three groups: the first group will be composed of general data on costs and its variations, which are applicable to most of the types of projects to be included in the supplementary material in Part V; the second group will comprise more specific data which will form part of the future specialized handbooks; and the third group will consist of the methodological elements. This last group forms the subject of the present chapter, which attempts to present the various methods systematically, from those required for approximate assessment in the early stages of the project to the more sophisticated methods required in the closing phases of evaluation of the final design.

By way of example, an outline is given of the type of subjects that would be included in the presentation of methods:

4.1 Classification of expenditures and costs - direct and indirect expenditures

4.2 Estimation of investment expenditures --investment items-- valuation of investment

4.3 Estimation of operational costs and income

4.3.1 Single product

4.3.2 Various products or by-products

/4.4 Income

4.4 Income and expenditure budget

4.4.1 For installation

4.4.2 For operation

4.5 Methods of data compilation

4.5.1 Analogy with other projects

4.5.2 Data furnished by suppliers

4.5.3 Direct estimation

4.6 Cost and price projections

5. METHODS OF ORGANIZATION AND CONTROL

For a project to be succesful, there must be, during the phases of installation and operation, an "enterprise", in the widest sense of the term, to set it up and operate it.

This means that the "enterprise" has a number of special functions that can be subdivided into those relating to organization and those relating to control.

This is why the present section is included in the part of the Handbook dealing with methods. In this section the methodological aspects of these functions will be systematically discussed. In other words, it will describe those components of the project which are designed to solve problems in these two areas — organization and control— and in this way identify the variables involved in the different approaches and solutions so that the project will prescribe the measures appropriate to each individual case.

Organizational problems arise in two different areas: the legal and the technical-administrative, the latter being of special importance during the process of establishing the enterprise and its subsequent operation. Problems of control can be broken down under the following headings: quality control, quantity control, time control, financial control and product cost control.

Each of these topics will be dealt with in the Handbook in as detailed a manner as is necessary to be in line with the study of the various stages of project formulation at the level of the "project-designer". Clearly, the final detailed and complete proposal will be made after the final design has been prepared.

The subject will be discussed according to the following plan:

/5.1 Organization

5.1 Organization

5.1.1 Organizational tools

- monograph
- organizational charts
- flow charts
- other organizational tables and diagrams

5.1.2 Legal organization

- legal structure of public and private enterprises
- corporations, partnerships and co-operatives
- legal requirements for the setting up and operation of enterprises
- systems of relationships between the public and the private sectors

5.1.3 Technical-administrative organization

i) setting up of an enterprise

- arrangements for securing bids
- methods of organization for building and assembly
- ways of contracting for work and arrangements for carrying out the work

ii) Operation of an enterprise

- methods of analysing the objectives, functions and activities of an enterprise
- identification of activities and needs for advisory services
- model organization of the enterprise
- organization at the office, workshop and production unit levels
- the usual functions of the enterprise and their organization (finance, production, engineering, sales, legal, human relations, etc.)
- analysis of systems of internal incentives

/5.2 Control

5.2 Control

5.2.1 Need for control and areas of application

5.2.2 Quality control and the bodies responsible for it

- factors affecting the quality of a product
- the function of inspection
- acceptability standards and testing methods
- statistical methods of quality control
- organization for quality control

5.2.3 Quantity control and the bodies responsible for it

- input control
- output control
- physical yield control
- inventory control and stock management
- organization to control inputs and final product quantities

5.2.4 Time control

- building and production schedules
- working-time control

5.2.5 Financial controls

- ratios and other indicators

5.2.6 Cost control

- cost determination of inputs
- cost structures and their evaluation
- statistical analysis of cost trends

5.2.7 Co-ordination of control bodies

5.3 Network analysis

5.3.1 The basic concepts

/5.3.1.1 The

5.3.1.1 The project as a sequence of activities and events

- the multiple linkage of activities
- successive and simultaneous activities. The graph or activities network

5.3.1.2 Time control of the project. Descriptive and analytical control instruments. Estimation of the time duration for each activity. Time duration of the various sequences. The critical path. The characteristic times of events. Earliest "possible" and lates "permissible" times. Slacks or floats. Critical events. Initiation and termination times of activities. Time margins or surpluses. Critical activities.

5.3.1.3 Time durations matrix in simplified form

5.3.2 Compilation of data and preliminary operations

5.3.2.1 Listing of project tasks or activities

5.3.2.2 Estimation of the time duration of activities

a) The single time-estimate of the critical path method (CPM)

b) The three time-estimates of the PERT methods and calculation of expected duration

5.3.2.3 Tasks ordering and identification of sequences. Determination of event common to two or more sequences. Final assembly of the network. Presentation of the network in the form of diagrams and matrices.

5.3.2.4 Data organization for processing by high-speed computers

5.3.3 Final operations and revisions

/5.3.3.1 Calculation

5.3.3.1 Calculation of the characteristic times of events

5.3.3.2 Analytical table of events and activities and determination of the critical path.

5.3.3.3 Organization of the project schedule.

5.3.3.4 Introduction of direct and indirect costs and analysis of their variations in terms of the duration of each task.

5.3.3.5 Programming the project for the minimum total cost.

6. METHODS OF EVALUATION

This chapter will include the methods of evaluation required to develop this phase of the analysis for the various types of project covered by the Handbook.

This will be only an intrumental Chapter, presenting a systematic account of the tooks of evaluation currently in use. How to use these material in different projects or stages will be dealt with in Part IV.

6.1 Productivity of each resource

6.1.1 Net return on total and owned capital
6.1.2 Added value per unit of capital
6.1.3 Rate of turnover of capital
6.1.4 Capital intensity
6.1.5 Ratio of labour to unit of capital
6.1.6 Marginal social productivity of capital
6.1.7 Labour productivity

6.2 Productivity of input resources

6.2.1 Cost-benefit analysis

6.3 Measurement of the effects of the project on the economic system

6.3.1 In the framework of development and planning strategies
6.3.2 In the framework of partial economic policies

6.4 Analysis of economic integration projects

/Part IV

PART IV

Formulation and evaluation of the project

Part IV

GENERAL COMMENTS

The mechanism of project formulation, and the operations involved in project evaluation, require not only an analysis of the steps to be taken in project preparation proper, but also the consideration of certain additional elements, such as the way the "project-designer" work should be organized, the various types of projects, etc.

This part, therefore, will begin by describing the minimum organization that is needed for project formulation, bearing in mind the fact that two aims will be sought: (a) To assist in the organization of a project office, in this case being of direct use to the "project-designer"; and (b) To help the user of the "project-designer's" services to employ such services in the most efficient manner.

Both these aims, and especially the latter, will be carefully borne in mind throughout the chapter, since experience in Latin America shows that so far a lack of knowledge and inadequate bargaining power have led on several occasions to results that are far inferior to what might have been expected, given the cost of the work done and the intellectual calibre of the "projec-designer's" involved in it.

In order to develop the mechanics of project formulation, it will be useful to begin by breaking down the formulation process into its various stages.

This breakdown will centre around the role of the "project-designer" and the stages to be considered will be those preceding the sphere of action of the "project-designer", i.e. from the identification of the original idea to the initiation of project design; those in which the "project-designer" is more directly involved, i.e. the preliminary design and the final draft project; and those occurring afterwards, i.e. the detailes project engineering stage and the implementation and operation of the project. Although these last stages will not constitute an operational part of the Handbook, they will be described in this chapter so that the "project-designer" may know the nature of the work that follows his own up to the completion of the project.

/The fourth

The fourth chapter of this part will contain the actual description of the operations of project preparation and evaluation, based on a description of the work involved in formulating a final design specially applicable to the industrial sector.

It will describe what needs to be done with respect to market research, the technical economic studies on the basis of which options relating to processes, locations, scales of production, etc., can be analysed, rejected and eventually adopted and the implications in terms of investment costs and operational costs and income. It will also outline the operations required to arrive at feasible solutions in terms of financing and organization.

The different ways of evaluationg the effects of a project, although they are in fact operations to be carried out by agencies other than the "project-designer", will be provisionally included in this chapter.

This part of the Handbook will end with a chapter describing how to prepare projects for sectors other than the industrial sector, following the classification mentioned above. This particular chapter will discuss the various stages of project formulation, with special emphasis on aspects that are not common to all types of project and consequently need special treatment.

1. ORGANIZATION FOR PROJECT FORMULATION

Within project formulation, emphasis must be placed on the way in which of the "project-designer's" work is organized. Hence, the first chapter of this part of the Handbook, which basically focuses on ways and means of carrying out the project, will describe the different methods of organizing the "project-designer's" work with two aims in mind.

a) To help in the organization of a project office or department, describing the experience acquired in both developed and developing countries.

/b) To

b) To show, for the benefit of the user of the "project-designer's" services, how to make the most efficient use of such services, presenting a systematic account of the experience acquired in this field.

These two objectives involve determining which will be the potential users of such services and the possible forms of "project offices".

Generally speaking, there are at least four possible alternatives with regard to the individual or agency responsible for the decision to study a project (the "entrepreneur"):

i) The entrepreneur does not have the capacity to specify the details of the project, i.e. to define precisely - as may be required - the work to be done by the "project-designer". In other words, the entrepreneur cannot translate the idea which is to be developed in the form of a project into proper instructions for its development, without a considerable number of error, guesswork, difficulties, consultations, and contractual problems that will jeopardize the result.

ii) The entrepreneur does have the capacity to specify the details of the project but not to formulate it. In other words, he has the capacity to know exactly what he expects from the "project-designer", but not to formulate the project up to the stage of the final design and even less to that of the complete project (including the detailed project engineering phase). This is often the case with enterprises that have engineering departments to deal with the problems that normally arise in the operation of an enterprise; they are capable of studying and investigating the possibilities of new products, but they have no real need for a project formulation capability that would be used very seldom and at fairly long intervals.

/iii) The

iii) The entrepreneur has the capacity to specify the details of and to formulate but not to implement the project. This is generally the case with organizations that have the technical capacity to specify the details and to formulate the project up to the final design level, or even, in some cases up to the complete engineering level, but which do not have the organization to implement it. Their capacity to formulate a project may be deficient because of the nature of their normal work; however, the implementation of investment is not part of their normal work, and therefore there is no point in their maintaining a permanent capability for a task that is outside their particular field.

iv) The entrepreneur has the capacity to specify the details of, formulate and implement the project. In this case he has all the necessary flexibility to carry out the project as he sees fit.

It will be seen from this brief description that in cases (i) and (ii) the entrepreneur depends basically on independent consultants, "project-designer's", and engineering offices for the formulation and implementation of projects. On the other hand, in cases (iii) and (iv) the organizations concerned possess genuine project designing offices and even complete engineering facilities. They may be large private enterprises, public agencies or government institutions. In all the cases it is clear that there is no one way of formulating a project, which depends on such diverse factors as specializations, size of the country and its level of technological development, the existence of laboratories and independent consultants in specific fields, etc.

1.1 Selected systems of work in project offices

The study of a project, at least at the level of the "projec-designer" (it may be noted that something similar happens at the project engineering level) undergoes a continual process of successive

/approximation during

approximation during which all the components of the project change until they are stabilized or fixed at avrious stages of the process, which differ from one project to another, even when they are of the same type.

The systematic treatment of these components, the intermediate controls that have to be exercises during project formulation, and the relationship that has to be established between the project, its construction and its operation, involve sets of procedures dealt with by project offices in different ways. Similarly, there are special techniques that reflect the way in which the office accumulates experience, the mode of data presentation, the conception of the preparation of the project as the product of the office itself and the preparation of proyect budgets covering consumption of resources and the project costs.

This section will be developed on the basis of consultations with reputable project-designing and engineering offices in developed and developing countries, both specialized and general, private and public, large, medium-sized and small, in order to suggest guidelines for the systems of work that seem most suitable. Appropriate rational procedures have to be applied to what is really a project factory similar to those used for the study of any investment project which the office itself may wish to formulate.

1.1.1 Organization of private project offices

Using the same approach and procedures outlined above, this subsection will describe - on the basis of the experience of highly reputed project offices - the systems of organizations the type of work done, the use made of external consultants, laboratories, experimental and inspection institutes, etc.

/1.1.2 Organization

1.1.2 Organization of project offices in public instituions

This sub-section, similar to the above, will study the organization of project offices in Ministries of Public Works or state agencies capable of project formulation, giving special emphasis to the model systems presented to the size of the country concerned and its level of development.

1.2 Project offices at the national or state level

If a country or a federal state is developing a plan or programme or even if is simply has a programmed investment budget, the need has been felt for a national or state project office, to promote projects in certain fields, to evaluate given projects, or to fit them in to the programme or the over-all budget, etc. Although the actual type of organization and the responsibilities will differ depending on national circumstances, the main aspects and problems that must be borne in mind in organizing a project office of this kind will be outlined in this section. The "project-desinger", as defined in the Handbook, will probably be excluded from such office, but will maintain a close working relationship with it.

1.3 Client-consultant relationship[1/]

This will be a particularly important part of the Handbook in view of the fact that in the cases (i) and (ii), at least the entrepreneur or client is basically dependent on the consultant. In the other two cases there is also a relationship between the entrepreneur and the consultant, since even the largest enterprises have to use consultantes, but here the client is less dependent on the consultant than in the first two cases.

1/ The term consultant is used in a wider sense than that of "project-designer" and covers both specialized advice and participation in the implementation phases of the project. This term is used throughout this chapter because the concepts discussed involve aspects that have to be dealt with by consultants in a broader context.

/Taking as

Taking as a tentative model The Manual on the use of consultants in developing countries[1/] prepared by UNIDO, the index of this section might be as follows:

1.3.1 The role of the consultant and the sources of consulting services.
(Individuals, consulting firms, research institutes and universities, government agencies and external assistance, suppliers of equipment, engineering designers/constructors, etc.)

1.3.2 The selection of consultants, terms of reference of consultant's work and consulting fees.
This sub-section will place special emphasis on procedures and specifications for contracting consultants; definition of the project, responsibilities of the consultant with a precise definition of his tasks, work schedule to be maintained, personnel to be supplied and their qualifications, responsibilities of the client, duration of contract, financial provisions, general provisions such as legal jurisdiction, arbitration procedures, etc. There will also be an analysis of the various systems for remuneration: lump sum, cost plus percentage or fixed fee, etc.

1.3.3 Consulting services in the developing countries.

1.3.3.1 National consultants
1.3.3.2 Foreign consultants
1.3.3.3 "Joint-ventures" in consulting
1.3.3.4 Technical assistance at the goverment level
1.3.3.5 Taxation and other problems that may arise

1.3.4 Special consulting services related to, but not part of, project consulting

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2/ The Manual (United Nations Publication, Sales N° E68.II.B.10) was prepared for industrial consultants. This chapter endeavours to cover a wider field.

1.3.4.1 Technological services

1.3.4.2 Economic services

1.3.4.3 Services relating to administrative, industrial, and commercial organization

1.3.4.4 Management services

1.3.4.5 Training services

1.3.4.6 Other services

2. TYPOLOGY OF PROJECTS

As indicated in the introduction, this Handbook is designed to provide general guidelines for the formulation and evaluation of projects, without going into the special methods of formulation and evaluation required for specific types of projects, such as projects relating to the iron and steel industry, the timber industry or the construction of a medical centre, for example. It is possible, however, to break projects down into fairly homogeneous groups, in each of which a common pattern of design can be found, even though there are, may be, wide differences from group to group. Both these elements —i.e., what projects have in common and the most obvious differences between them— will be discussed and explained in the present chapter on the typology of projects.

2.1 Classification by activity

2.1.1 Economic development

- 2.1.1.1 Research projects
- 2.1.1.2 Infrastructure projects
- 2.1.1.3 Projects relating to primary and secondary production
- 2.1.1.4 Projects relating to services

2.1.2 Social development

- 2.1.2.1 Research projects
- 2.1.2.2 Infrastructure projects
- 2.1.2.3 Projects relating to production
- 2.1.2.4 Projects relating to services

This classification will include a description of the general features of each type of project, endeavouring to show the most characteristic features which can help to determine the differences in the formulation of the projects concerned. This aspect will be covered in chapter IV-5 (Methods for the preparation of different types of project).

/2.2 Classification

2.2 Classification by degree of complexity

2.2.1 Single-purpose projects

2.2.2 Multipurpose projects

Although chapter IV-5 will focus specially on the classification given in section 2.1, the types of project to be considered under the present section have special characteristics that are of importance in project formulation, and these will be given the greatest emphasis in this and the following section.

2.3 Classification by geographical and political coverage

2.3.1 Local

2.3.2 Regional

2.3.3 National

2.3.4 Multinational

2.3.5 International (integration projects)

3. STAGES OF A PROJECT

This chapter has several purposes. First, it will establish the stages that make up a project, from the moment of its original conception to the implementation, operation and exploitation stages, including the wind-up stage at the end of the project's useful life.

Secondly, this chapter will make a detailed examination of the operations that are carried out before the "project-designer's" work begins, starting with the identification of the original idea and ending with the initiation of project design work. As indicated in chapter IV-1, the "project-designer" may or may not be involved in identifying the original idea, and even if the stages and operations that have to be carried out are similar in character to those of a project, the methods and techniques used are so much less rigorous than those required in project formulation proper that they can be and in practice are applied by persons who are often very little connected with the "project-designer's" work.

After the identification of the original idea comes the stages of the project which are properly the province of the "project-designer" and which yet precede the formulation of the final design. These can usually be lumped together under the heading of "preliminary design" of a project. The various stages of the "preliminary designs" will be described in detail in this chapter, according to the same plan as that used in chapter IV-4 and IV-5 to discuss the final design, but accompanied by an explanation of the simplified methods that should be used, the degree of precision that should be sought in considering alternative solutions, and the answers that should be obtained from the preliminary analysis before the decision-maker comes to a decision about initiating work on the final design.

This section will not deal with the final design, which will be covered in chapter IV-4, but it will describe --for the information of the "project-designer"-- all the stages subsequent to the formulation of a project which do not come directly within his field of action.

/PLAN OF

PLAN OF THE CHAPTER

The chapter will be set out as follows:

3.1 Stage preceding the "project-designer's" work. Concept identification and exploratory design.

"The starting point of a design project is a hypothetical need which may have been observed currently on the socio-economic scene. It may be phrased in the form of a primitive statement resting on untested observations; or it may have been elaborated into a sophisticated and authenticated statement based on market and consumer studies. The need may not yet exist, but there may be evidence that it is latent, and that it can be evoked when economic means for its satisfaction become available. The need may be suggested by a technical accomplishment that makes the means of its satisfaction possible. In whatever way the need has been perceived, its economic existence, latent or current, must be established with sufficient confidence to justify the commitment of the funds necessary to explore the feasibility of developing the means satisfying it".

The above quotation would seem to be an adequate definition of the idea of a project and of what is understood by its identification. It is clear that the idea can originate at any level; its identification requires a minimum of analysis to establish the existence of a need (identification of the idea) and the possibility of satisfying it, on the basis of very provisional data (feasibility of the idea) and thus convert it into the idea for a project.

This section will discuss the types of research, analysis and preliminary feasibility studies that can be done in a practical way to achieve the desired results.

/Each of

Each of the sub-sections will describe the operational procedures, shortcuts and the basic minimum of data required to give the person who has to decide whether or not to go ahead with the study of the idea a reasonable chance of developing a preliminary design which prima facie would appear to be feasible.

3.1.1 Description of the need (product) to be satisfied

3.1.2 Preliminary investigation of actual and potential markets, future trends, possible competition, social, political and economic pressures that may affect the market

3.1.3 Existence of raw materials, inputs, and other elements required for the project.

3.1.4 Preliminary engineering studies of possible processes (minimum economic scale, amount of investment needed, cost of production or operation, etc.).

3.1.5 Technical and economic pre-feasibility

3.2 Stages within the province of the "project-designer". The preliminary deisgns

As indicated above, the stages within the province of the "project-designer" correspond to the preliminary and final designs or draft projects. The latter are discussed in full in chapters Iv.4 and Iv.5. This section will therefore be confined to examining the practical procedures applicable to the formulation of preliminary designs.

In formulating a project, it may happen in practice that there are several preliminary designs, if the various solutions are so different from each other that they cannot be considered to be variations on a single process but rather totally different ways of solving the same problem. These preliminary designs must be detailed enough to allow making a choice between them, as they are different methods of achieving the same idea.

/A detailed

A detailed scheme of this section is not necessary since it will follow the presentation used in chapters IV.4 and IV.5, as appropriate. Each section in chapter IV.4, for example, will be matched with a description of one or several simplified procedures for the corresponding preliminary design. So the market study will be developed far enough to show that there is a sufficient, current, potential and/or future market to demonstrate the economic feasibility of the project without going into more extensive research on the basis of which the optimum size and shape of the project can be determined.

Similarly, once it has been established that there are feasible alternatives in terms of processes, dimensions, location, and costs, no attempt will be made to give an exhaustive description of all the possible alternatives; this will be left for the final design.

With respect to evaluation, too, the section will endeavour to describe the simplest procedures which can be used to test the technical and economic feasibility of the project, so that the in-depth analysis at the final design stage can but improve upon the minimum results guaranteed by the preliminary design. This will provide the "decision-maker" who decides to go ahead with the project with an adequate safety margin.

It is therefore apparent that most of the aspects that will be studied during the formulation of the final design will probably not need to be considered during the preliminary design stage. All such simplifications of the procedures will be pointed out in this section.

3.3 Stages of the project after the "project-designer" has completed his work

This section will provide enough information for the "project-designer" to be acquainted with the nature of the work during the period which follows the completion of his own work and extends up to

/the completion

the completion of the project. It will lay special emphasis on tasks which, although not his responsibility, may have a bearing on his decisions with respect to the preliminary design and appreciably modify some of his economic and financial calculations. Generally speaking, these tasks entail participation by the "project-designer" to some extent in the work of the engineering office (or in the case of other professions, in the work of the person responsible for the project as a whole). Hence, a knowledge of such matters is not merely useful to the "project-designer" as background information, he also needs it to get a better perspective on his task and carry it out better.

3.3.1 Complete project

3.3.1.1 Detailed engineering design, specifically of buildings and equipment

3.3.1.2 Planning the production process

3.3.1.3 Planning for distribution

3.3.1.4 Final design of planning for consumption (product engineering during the production process)

3.3.1.5 Preliminary design on changes in the run of the business, technical obsolescence, and disruptions in production in so far as they influence the project

3.322 Project implementation

All the stages corresponding to contracting for building and equipment, inspection and acceptance of building and equipment, initial tests, etc.

3.3.3 Operation of the project

3.3.3.1 Entry into operation of production and distribution plans

3.3.3.2 Planning for consumption

3.3.3.3 Final design relating to future changes in business or activity.

3.4 The morphology of the project [1/]

Each project has an individual history. Nonetheless, as it is initiated and developed, a sequence of events unfolds forming a pattern which, by and large, is common to all projects. Depending on the type or family to which it belongs (see chapter IV.2), the sequences of a project may be more or less pronounced, and, some may disappear because it is unnecessary to make them explicit, although the general pattern of a project is common to all of them.

This section will make an over-all appraisal of all these sequences, indicating their interrelationships, the moments when decisions are up to the "project-designer" and when they are not up to him but to the client, so as to have a comprehensive view of the process and of how the "project-designer" fits into it.

1/ Although the outline proposed here does not follow the stages or sequences suggested by Morris Asimow in the book already mentioned, the analytical method used will probably be very much the same as the one he uses.

4. THE FINAL DESIGN

The analysis in this chapter will centre on the formulation of the project, particularly in relation to the "project-designer's" sphere of action. Since there is a logical sequence 1/ of activities in formulating the project, these chapters will present the steps to be taken in each of these activities until their possibilities have been exhausted as elements justifying the decision to be adopted, whether positive or negative.

One point which must be emphasized in order to understand the outline, and particularly the content, of this chapter is that, as distinct from other existing project manuals and texts, it does not include a discussion of the specific methods for each subject. Methods of projecting demand, of comparing technical alternatives, and of updating successive values over time are some examples of specific methods. On the subjects dealt with in this chapter, reference will be made, wherever necessary, to the most appropriate method, whose mode of application will be found in the pertinent chapter in Part III on Methods.

Therefore, this chapter will be confined to an explanation of the manner in which each subject should be developed, and how far and at what point it may be regarded as exhausted, which will necessarily involve a conclusion concerning it. In fact, its purpose, together with that of Part III, is to provide the mechanical elements for the formulation of a project, so that if the sequence presented here is followed, and the methods referred to are intelligently applied, it will be reasonably certain that the project itself will include the

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1/ Needless to say, a logical sequence does not necessarily mean a time sequence, since the main feature of the project formulation process is the two-way flow or iteration between the various points of the project.

/necessary elements

necessary elements for adopting a final decision on its execution.

The outline for this chapter has been developed on the basis of a final design in the industrial sector, first, because greater experience has been built up in classifying the component elements of such projects and, secondly, because they contain practically all the elements found in other types of project. The following chapter on methods of preparing different types of project will deal with the points at which substantial differences exist between the formulation of projects for industry and other types of projects.

Lastly, it should be noted that evaluation will be one of the subjects dealt with in this chapter. It has not yet been finally decided whether it should remain in this group, since it may well be considered to merit separate consideration. In either case, however, it would be developed in a similar way, so it has tentatively been left in this chapter.

4.1 Market research

The market study will hinge mainly on the choice of a desirable methodology (or methodologies).[1/] The first step will be to analyse ways of defining the desired product with precision; the definition may sometimes be obvious, but in many cases studies in depth are required.

The foreseeable uses of the product and those provided for under the project are simultaneously auxiliary elements for arriving at correct specifications of the product and the result of the particular slant of those specifications. The Handbook will also stress their importance in demarcating the market to be studied.

1/ It is not out of place to stress that, under different headings in the various subjects dealt with in this part of the Handbook, special attention will be paid to the stage involving the choice of methodologies.

/Proper specification

Proper specification of the product also facilitates the analysis of alternative, substitute and supplementary products, once the possible fields of application have been established.

These elements, combined with the identification of a suitable market (that will be partly a result of the previous analyses), will provide a basis for the choice of methodology, that is, they will provide the criteria for selecting the best instruments for analysing the probable volume of demand for the product.

On the basis of this choice, the next step will be to formulate the study of additional elements (type of consumer, elements liable to distort the methodological analysis, such as the effects of economic policy, etc.), an attempt being made to explain the past evolution of demand and project future supply and demand, and thus determining the potential volume of demand to be satisfied by the operation of the project.

4.1.1 General statement of the market problem in relation to the project

4.1.1.1 specification of the product known and foreseeable uses

4.1.1.2 possible substitute products that already exist in the market or could be produced

4.1.1.3 identification of the appropriate market

a) local
b) national
c) multinational (within the area)
d) other parts of the world

4.1.1.4 Choice of methodology

4.1.2 Determination of past and present demand and analysis of its conditioning factors

/4.1.2.1 types

4.1.2.1 types and characteristics of consumers

4.1.2.2 effects of economic policy on the market for the product (rates, tariffs, subsidies, price controls, rationing, etc.)

4.1.2.3 conclutions

4.1.3 Determination of future supply and demand

4.1.4 Determination of the potential market

4.2 Technical studies

The evaluation of a project, in the sense of an intelligent operation whose final result leads to the acceptance, rejection or classification of a project within an order of priorities is not undertaken only after the project is completed, but is carried on throughout the various stages of formulation. Therefore, the final result referred to in the above definition of evaluation is arrived at after a number of partial results have been reached in connexion with different elements of the project. This concept of evaluation will be underlined along the Handbook, particularly in this part where attention is focused on the development of project formulation.

The above remarks are necessary in order to explain the structure of the present chapter, which will begin with a discussion of the concept of alternatives. In this discussion, special emphasis will be placed on the approach presented in Part III, chapter 5 (Methods of analysing technical alternatives) in relation to the dual process which the project undergoes during its development: a) the analysis by successive approximations, which involves constant reconsideration of the various components of the project, and b) the dialogue between the "agents" through whom the project takes shape ("entrepreneur", "project-designer" and technicians).

/This dual

This dual process would be meaningless if the development of the project followed a linear course, but it is completely justifiable if there is more than one form (technical and economic alternatives) of carrying out the original idea. And this is always the case with projects. The existence of more than one form or alternative should be studied from specific angles. Hence, the Handbook should analyse the following types of alternatives: process, scale, location, physical works, financing, organization and time-table. This form of analysis means in some degree artificially breaking down a single problem,[1/] but it has the advantage of facilitating the simultaneous study and comparison of the same aspects under different alternatives and of speeding up the selection process.

It should be noted that, in both the technical and the economic alternatives, the guiding criterion or criteria for choosing between them must be clearly indicated. Undoubtedly, such criteria always exist, but it is easy to see that, unless they are clearly set out there will tend to be errors, inexplicable changes in the course of the studies, insufficient explanation of the reasons for preferring a given alternative, etc.

Special importance will therefore be given to the development of criteria for choosing between alternatives, as a prior step to the sequences that will finally lead to the best choice.

4.2.1 Concept of alternatives

4.2.1.1 Technical and economic need to consider alternatives

1/ Because it may be argued that any alternative way of giving practical form to the original idea itself involves a definite choice, not only of process but also of scale, location, etc.

/4.2.1.2 Possible

4.2.1.2 Possible alternatives - process, scale, location, physical works, organization, timetable

4.2.1.3 Criteria for choosing between alternatives

a) profitability
b) foreign exchange
c) employment
d) regional development
e) institutional framework
f) immediate indirect effects

4.2.2 Choice of alternatives

4.2.2.1 Choice of production process

a) methods of selecting the process
b) methods of selecting the machinery and equipment
c) requirements in terms of plant, equipment and supplies

4.2.2.2 Choice of scale of production

a) Technological economies of scale - analysis of cost diferences according to scale:

- raw materials
- energy and fuels
- labour
- capital expenditure

b) Economies of scale in overhead costs - analysis of the differences, according to scale, in the overhead costs, for:

- research
- the purchase of inputs
- marketing
- maintenance, tools and repairs
- obtaining credit
- management

/c) Constraints

c) Constraints relating to size, market, financing and inputs

4.2.2.3 Choice of a proper location

a) supply of factors of production
b) spatial distribution of the market
c) location according to institutional factors

4.2.2.4 Choice between alternative physical works

a) micro-location and general design
b) construction techniques

4.2.2.5 Choice of organization

a) for construction and assembly
b) for operation

4.2.2.6 Choice of timetable

a) technical timetable
b) financial timetable
c) compatibilized sequence of activities

The treatment of the next two sections (4.3 and 4.4) will be different from that given to section 4.2 (technical studies), although following the general orientation of the Handbook. This section indicates the need for certain analyses that are similar in form to those dealt with in sections 4.3 and 4.4, such as variations in costs according to scale, the choice of financial timetable, etc. But while in the section on Technical Studies the analyses will necessarily not be too detailed, i.e., they will only go far enough to make comparisons possible, the following sections will deal with the economic and financial aspects of the final choice, which means that the studies will be more concentrated and made in greater depth.

/4.3 Estimation

4.3 Estimation of investment expenditure and operational costs and income

4.3.1 Investment analysis - items, classification, geographical origin

4.3.2 Analysis of operating costs

i) costs when in normal operation

ii) costs when the installed capacity is partially utilized

iii) estimated period required to attain a normal rate of production

4.3.3 Prices and income

4.3.4 Annual cost and income budget

4.3.5 Conclusions regarding costs and income

4.4 Study of financing

4.4.1 Investment financing

i) in domestic and foreign currency

ii) financing timetable

iii) with own capital and with credit

iv) administrative measures affecting financing

- taxes, customs regulations, accelerated depreciation schemes, subsidies, specific terms, and external economies

v) price and cost variations (conjunctural and long-term trends)

4.4.2 Financing of the operation

i) period of entry into operation

ii) period of normal operation

4.4.3 Final table of sources and uses (flow) of funds

4.4.4 Conclusions and recommendations on financing

/4.5 Most

4.5 Most frequent errors

In the comments on the chapter dealing with the final design it was stated that the general purpose of the chapter is to present the operations and studies which the "project-designer" must carry out in order to produce a document that will contain sufficient elements for a sound decision to be adopted by the appropriate authority concerning the execution of the project. It is hoped, therefore, that this chapter will lack none of the necessary elements for adopting such a decision and that, in addition, it will indicate the depth in which each study should be carried out to achieve satisfactory results.

A separate section on the most frequent errors has nevertheless been added. Experience in project formulation and evaluation shows that there is a recurring tendency to fall into certain types of errors and omissions in formulating a project, which seriously impair the quality of the study and may even lead to erroneous results owing to ill founded decisions.

Accordingly, this chapter will lay special stress on such errors and omissions, even though they have been taken into account in the systematic development of the project analysis.

It is very likely that in subsequent discussions the type of errors and omissions that should be included in this section will be increased over and above those included in the present index; the important point now is to indicate why this section is necessary and the general pattern it will follow.

4.5.1 In market research

i) uncertainty in the estimation of existing demand

ii) uncertainty in the method of projecting future demand

/4.5.2 In the

4.5.2 In the technical formulation process

i) too little importance attached to secondary factors

ii) failure to consider the real operating conditions

iii) failure to examine the possibilities of expansion and future foreseeable requirements

4.5.3 In structuring costs

i) adoption of catalogue prices without analysis

ii) failure to consider the cost of running-in period

4.5.4 In the financing study

4.6 Evaluation of the project

In referring to the section on technical studies, stress was laid on the continuing nature of project evaluation, which is carried out virtually parallel to project formulation, since it accompanies each of its stages.

It should be recognized, however, that the concept of evaluation in economic literature is more limited; it relates to the analysis of a completed project, with a view to determining the degree of "efficiency" of the allocation of resources which the project entails.[1/] It is in this sense that the present chapter will deal with evaluation, and some explanatory comments must therefore be made.

First, acceptance of the limited concept of evaluation in this chapter does not mean that the process of analysing alternatives which must continue throughout the development of the project is to be left out. Rather, a distinction is made between those responsible for the two types of evaluation; while the "project-designer" himself must perform the evaluation throughout the development of the project,[2/] the evaluation

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1/ There are, of course, different criteria for measuring this "efficiency", and they should be defined before the evaluation process begins.

2/ This point has been stressed throughout the present document, especially in the chapters on Methods of analysing alternatives and on Technical studies.

/in its

in its more restricted sense is carried out by an individual designated as "the evaluator", who may be either a government official responsible for deciding whether the time is ripe for undertaking the project, a banker from whom financing has been requested, or the "entrepreneur" himself, who must decide whether or not the project is to be executed, etc.

Secondly, emphasis must be laid on a fact which, perhaps because it is so well-known, tends to be overlooked. Evaluation in its strict sense in based on the assumption - which unfortunately is not always borne out - that the project contains all the information needed for evaluation and that the information has been correctly assessed. In other words, there is no questioning of what the project affirms; the evaluation hinges on the way in which the project makes for the fulfilment of certain predetermined objectives.

Anyone who has had occasion to take part in the evaluation of projects, however, knows that a good deal of spade work is required before the process of evaluation proper can be started. This preliminary work is generally a matter of reviewing, checking and correcting data, and may also include the collection of additional data before one is ready to begin the actual evaluation.

It is to be hoped that, if the rules laid down in the present Handbook are observed, this preliminary work will be contained in the final design, together with the necessary description of the steps followed in choosing among (evaluating) alternatives, and therefore that the evaluation performed by the "evaluator" may be considered to be based on reasonable assumptions, if in turn the accuracy and depth of the "project-designer's" work are considered acceptable.

/The present

The present chapter will be developed along the following line of reasoning. Two opposite positions may be adopted in evaluating a project:

a) When the objectives, which the "evaluator" considers that the project should achieve, coincide with those considered by the "project-designer" in formulating the project;

b) When the "evaluator" tries to determine how far the project can achieve or help to achieve certain objectives which are different from - although not necessarily in conflict with - those considered by the "project-designer" in formulating the project.

In the first case, for example, the evaluation can be performed by the "enterpreneur" who has himself established the criteria guiding the "project-designer's" work. In the second case, officials of a government development bank - operating within the framework of a development plan - evaluate a project prepared for a private enterprise.

Combinations of these two extreme cases may, and probably do, exist. Nevertheless, the treatment in this chapter will be based on the situations described above, from which other combinations can be derived.

In situation (a), the actual aim is to carry out a kind of "auditing" of the conclusions in the final design, while in situation (b) the evaluation will consist in measuring the project's effects, in the light of a prior definition of the principal effects to be quantified.

In both cases a description of the appropriate procedure will be given, ending with the report which will contain the results of the evaluation.

The outline for this section is as follows:

/4.6.1 The evaluation

4.6.1 The evaluation as an "auditing" of the project conclusions

4.6.1.1 Analysis of the conclusions contained in the final design in connexion with:

- Profitability
- Period of recovery
- Financing timetables
- Effects on the economy as a whole or in the sector affected by the project

4.6.1.2 Consideration of the risks

- Sensitivity analysis applied to profitability
- Sensitivity analysis applied to lags of financing
- Break-even points.

This sub-section will describe the sequence of operations when the evaluator considers the desirable objectives for the project to be the same as those adopted in formulating it. Therefore, the operations will basically comprise an analysis of the conclusions concerning those objectives, with special emphasis on an assessment of the project's sensitivity in response to modifications in its component values within the probable range of variation in those values. The analysis of the break-even point, will be treated in a similar way, involving the formulation of certain realistic hypotheses on the evolution of costs and income.

4.6.2 Evaluation as a measurement of the project's effects

4.6.2.1 Criteria for grading the importance of the effects

i) Sources of the criteria

- Development plans
- National policies
- Regional policies
- Sectoral policies
- Entrepreneurial policies

ii) Weighting of the criteria

/4.6.2.2 Bases for

4.6.2.2 Bases for the selection of methods for measuring effects

i) Number and importance of the effects to be considered

ii) Availability of comparative data

4.6.2.3 Range of validity for the measurement results

i) Analysis of the sensitivity of results

ii) Setting of limits of tolerance.

When the evaluation is designed to measure the effects of the project in relation to certain objectives not classified by the "project-designer" according to their importance, the basic task will comprise a precise and systematic classification of those objectives and, therefore, of the criteria for dealing with and measuring the relevant effects.

The sub-section will discuss the sources of those criteria, ways of expressly stating them and their operational value. It will also establish the bases for selecting the working methods, which are described in Part III.

4.6.3 Report on the evaluation

4.6.3.1 Form and content

i) The evaluation as an "auditing"

ii) The evaluation as a measurement of effects

iii) Cases combining the two situations.

Special care must be taken in preparing the "evaluator's" report, particularly when he is acting on behalf of the person or agency who is to take the final decision regarding the execution of the project, because of the ways in which the presentation of the conclusions may be interpreted.

As indicated in the index, three types of reports will be presented, and in developing them advantage will be taken of the fund of experience gained, in particular, by national and international development agencies, planning institutes, firms of consultants, etc.

/4.7 Conclusions and

4.7 Conclusions and recommendations relating to the project

(sequence of activities in the event that the final design is approved)

i) Authorization to exercise industrial operations
ii) Legal constitution of the enterprise
iii) Problems connected with obtaining capital
iv) Import permits
v) Design and construction of the production unit
vi) Staff recruitment and training
vii) Contracts
viii) Direct relations with the public sector
iv) Other provisions.

The "project-designer" must present not only conclusions on the project itself but also certain recommendations for implementing the project - resulting from the studies undertaken, from the knowledge obtained about the projet's sphere of activity, and from his own experience - in the event that, a decision to execute it is taken on the basis of the final design. This section will contain a list of probable recommendations and will analyse how they should be oriented.

5. WAYS OF PREPARING DIFFERENT TYPES OF PROJECT

The chapters of the Handbook which describe the operations to be performed in order to arrive at the final design will be based, as already stated, on the fund of experience built up in the formulation of industrial projects. However, in view of the proposed scope of the Handbook, it is also necessary to analyse the operations to be carried out in the preparation of projects for other sectors and to indicate the specific features involved, as regards not only the formulation of the final design but the intermediate stages as well, as set out in Part IV, chapter 3 (Stages of the project). These are, in brief, the purposes of the present chapter.

The types of projects whose special features of formulation will be analysed here are correlative to Part IV, chapter 2 (Typology of projects). As pointed out in regard to other subjects on the index, the proposed coverage is provisional and is by no means intended to be exhaustive but simply to indicate the line of analysis to be followed. This warning is particularly significant in the case of the present chapter, since the subject is so vast that care must be exercised in two respects: first, to ensure that aspects that may be very important in the formulation of different types of projects are not ignored, and, secondly, to limit the presentation so as not to enter into a detailed examination of the fields which are supposed to be eventually covered by the specific handbooks and which would be outside the scope of this one.

It is hoped that the foregoing will give a reasonable idea of the framework, contents, and approach of this chapter, which will be set out as follows:

5.1 Characteristic features of the stage at which the basic idea is identified ("concept identification and exploratory design") in the different types of project

Each of the features discussed in this section will be analysed in terms of project relating to services (education, health, housing, etc.), infraestructure (transport, communications, energy)

/and research

and research (scientific, technological, etc.), with special emphasis on the characteristics peculiar to each type on the different approaches required for economic and for social development projects. This will be the form of analysis used throughout the chapter.

5.1.1 Possible sources of the idea

5.1.2 Individuals or agencies responsible for the idea

5.1.3 First steps on problem formulation

5.1.4 Factors involved in the decision to move on to the preliminary design.

5.2 The preliminary design phase

This section will focus on three points in particular: the agency or individual responsible for formulating the preliminary design; the definition of a feasible alternative, which may not necessarily be the best at this stage of the project; and the definition of the factors which in the different types of project may serve as the basis on which decisions can be taken regarding the continuation of studies.

In addition, the section will consider the extent to which the preliminary design phase is justified for every type of project. This is more than a mere academic exercise and it could become an important factor in determinig the economic justification of the studies.

5.2.1 Agents responsible for carrying out this phase for each type of project

5.2.2 Coverage an depth of the analysis at this phase

5.2.2.1 Selection of a feasible alternative

5.2.2.2 Information needed for decision-making

/5.2.3 Agent

5.2.3 Agent responsible for the decision to move on to the final design

5.2.4 Types of project for which this phase does not seem justified

5.3 The final design for different types of project

This section has been designed with due regard for the way in which the final design is formulated (Part IV, chapter 4) but with emphasis on the aspects that most differentiate each type of project. Without disregarding the warning made in the general comments to the effect that the analysis of this subject should certainly not be exhaustive, in this paper stress should be laid on certain points that should be given extensive consideration in the final form of this chapter.

A point that is important is the market concept which, if clarified at an early stage in projects relating to services and infraestructure, will obviate many problems and errors in the formulation of the project. Closely connected with this topic are the concepts of the product and the user. The usual economic terms are being kept for these three concepts, although it may become necessary in the final form of this chapter to use terms that are in common usage in other academic disciplines.

The concept of the alternative solution, which is to some extent the focal point of the mechanics of project formulation, will have to be reappraised in the light of experience in formulating projects for sectors other than industry. This should leave on to the steps that must be taken to establish the criteria for determining the choice of such alternative solution. It should be noted that the alternative solutions to be considered are similar in type to those discussed in Part IV, chapter 4 (Final Design). Such are some of the points that should be given close attention in this section.

/5.3.1 Scope

5.3.1 Scope and clarification of the concept of "market"

5.3.1.1 Existence of a market or forecast of future markets

5.3.1.2 The concept of "the product"

5.3.1.3 Factors influencing the market

5.3.1.4 Determination of future supply and demand

5.3.2 Analysis of alternative solutions for the project

5.3.2.1 Concept of the alternative solution for different types of project

5.3.2.2 Criteria for choice of alternative solutions

a) Emphasis on economic aspects

b) Emphasis on social aspects

5.3.2.3 Selection of alternative solutions

i) For the operation of the project

ii) For the project "market"

a) Scale

b) Location

iii) For the organization of the project

iv) For the financing of the project

5.3.3 Estimates of operating costs and income

5.3.3.1 Definition of the concept of costs

5.3.3.2 Definition of the concept of income

5.3.3.3 Analysis of the financing of costs

5.3.3.4 Annual cost and income budget

5.4 <u>The evaluation of different types of project</u>

About this topic it can be said, without any claim to originality, that it either warrants several heavy tomes or it should be summed up in a single page; there is no middle growth. And yet it is necessary to strike some compromise so as not to go beyond the scope of the present Handbook, or to limit its coverage too much. This difficult path will be drawn following the outline used in Part IV-4-6 (Evaluation of the project) with some variations, the

/most important

most important of which is the emphasis placed on the formulation of criteria for evaluation. The basic problem of evaluation, as a process subsequent to the preparation of the project,[1/] is to analyse how well the project meets certain single or multiple objectives. Hence, the evaluation will begin by classifying the objectives to be achieved by the project, then develop the most suitable criteria for determining the project's capacity to achieve them, go on to construct coeficients to reflect these criteria and, finally, to apply the coeficients to the project data. The results of this operation must then be compared with the criteria selected to ascertain how far the project meets the initial targets set. This section of the Handbook will deal with such process of evaluation, in the light of the special features of the different types of project.

1/ Throughout the index it was made clear, but it may not be out of place to reiterate it, that evaluation can be viewed as being parallel to and concurrent with the preparation of the project.

PART V

Auxiliary Data

Part V

GENERAL COMMENTS

This part will include supplementary reference material, tables, etc. which will enable the Handbook to be used as far as possible without recourse to other documentation. The reason for presenting this information here is to separate from the main chapters such material as is needed for its proper use but is not indispensable in order to understand it.

This separation will also facilitate the periodical updating of data which undergo changes over time, as in the case of economic statistics.

The material will be arranged, as far as possible, in the same order as the main chapters of the Handbook. The aim is to limit the supplementary material strictly to the content and approach of those chapters, and thus avoid the accumulation of highly specialized data, which, according to the formal conception of the Handbook, should be included in the supplementary specialized handbooks.

1. BASIC ECONOMIC CONCEPTS

1.1 Principal macro-economic characteristics by countries

This section will include data from all the Latin American countries and from selected industrialized countries for purposes of comparison.

It will put together macro-economic data requiring periodical updating, even though certain indicators, such as per capita consumption of specific goods and services, should be presented as supplement to the chapters dealing with market analysis.

By way of example, the following type of data would be included:

- Description of physical characteristics

  Population
  Area

- Description of economic characteristics

  Gross product
  Economic participation by major sectors
  Volume of imports and exports
  Percentage structure of the tax system
  Investment as a percentage of the product
  Changes in price indexes
  Changes in the exchange rate

- Some specific indicators for international comparisons such as:

  Per capita steel consumption
  Motor-vehicle inventory or number of vehicles per inhabitant
  Road network or number of kilometres of road per inhabitant
  Energy or power generation
  Paper consumption

/Description of

- Description of social characteristics

Length of schooling
Mortality rates
Income levels
Indicators of services per inhabitant (hospital beds, schools, drinking water, etc.)

2 BASIC FINANCIAL CONCEPTS

2.1 At the enterprise level

Standard forms for the preparation and presentation of balance sheets and financial statements

3. BASIC MATHEMATICAL CONCEPTS

3.1 General mathematics

Tables
Decimal and natural logarithms
Tables of derivatives
Tables of integrals

3.2 Financial mathematics

Compound interest
Annuities

3.3 Mathematical statistics

Tables of probability distribution
Binomial
Poisson
Normal
Ki-square
Student's t distribution
x
s

3.4 Statistical methods

Standard questionnaires for use in the different types of projects.
Statistical tables for sample design

4. MARKET RESEARCH

Standard forms for specification of different types of product

5. TECHNICAL SECTION

Abbreviations and symbols
Conversion tables and tables of weights and measures
Technical data on various materials
Profiles on the use of selected materials
Selected industrial profiles
Scales of production in selected processes

PART VI

Analytical indexes