METHODOLOGY FOR PROJECT PLANNING AND IMPLEMENTATION IN DEVELOPING COUNTRIES

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CHAPTER I

INTRODUCTION

Beginning with the industrial revolution in Great Britain, Western Europe, and North America a gap started to develop between the degree of economic and social development of the nations of these regions and the rest of the world, i.e., nations of Asia, Africa, and South America. This gap is most visible and pronounced in the economic sphere and has been subjected to intensive attention since the end of World War II. Different United Nations Agencies, governments in both the developed and the developing nations and many universities have done, and still are doing, extensive studies to find the causes of and remedies for this phenomenon which has divided the nations of our globe into two groups, namely the industrialized countries which are called developed and the non-industrialized ones which are called underdeveloped or developing. Some people prefer to use <u>industrialized</u> and <u>non-industrialized</u> to refer to the two groups. However, as the terms <u>developed</u> and <u>developing</u> are used both popularly and officially, they'll be used here, too.

The studies undertaken by the institutions mentioned above have resulted in a common understanding that underdevelopment can be overcome by systematic implementation of suitable projects. Such projects should, specifically, be formulated to eliminate the causes of underdevelopment. The causes of underdevelopment are diverse and exist in all aspects of life in the developing countries. But the degree of

development of these aspects varies from one developing country to another and within each country it varies regionally. This means that a single formula cannot be used either for all the developing nations or within a developing country. However, this does not mean that a common methodology cannot be used to formulate and implement different development strategies according to the particular needs of a country or a region. On the contrary such a methodology is advocated and it is believed that use of a common methodology enhances the chances of rapid development. But such a methodology should incorporate mechanisms that are capable of identifying these differences and prescribing remedies for them.

Suitable projects should cover areas such as industry, communications, transportation, education, health, housing, agriculture, recreation, arts, sports, and all other aspects of a developing culture. Of course such a program of action requires expert and consistent planning and careful implementation of the plans as a prime prerequisite to success. A system to plan and implement development projects should include means of identifying the areas requiring attention; that is, those areas in which the degree of development shows marked deficiencies compared to the developed nations. One of these areas is economic. But this is not the only dimension of development. As Robert S. McNamara contends [1, p. 4] "gross measures of economic strength and gross measures of economic growth - for example, levels of GNP or rates of change of GNP - as necessary as they are, cannot measure the soundness of the social structure of a nation." Some other measures such as illiteracy rate, life expectancy, infant mortality, unemployment rate, income distribution, quality of nutrition, etc., should be used to

assess the overall degree of development of a nation. Accordingly projects should be designed to alleviate deficiencies in these and other areas as dictated by the particular requirements of the people of a country or a region within the country. The emphasis on people is very important, because in many developing countries programs are initiated based on the interests of the rulers who are either ignorant of the needs of their nation or are so fond of building up prestige for themselves that many expend most of the resources of the nation on unworthy projects as far as the people are concerned.

Therefore any development program should be based on the needs of the people. And any system of project planning and implementation for the purpose of overcoming underdevelopment must be able to recognize these needs and initiate alternative courses of action to eliminate or reduce the needs and select the best possible course of action for implementation and to carry out the selected course of action. A system for planning and implementation of development projects has five di distinct phases:

1. Goal setting. To locate the problem areas and find out the deficiencies as related to the people of a country or a region. This should include the needs in their present context as well as assessing the future intensity of these needs and any other needs that may arise henceforth. Formulate development goals to overcome the deficiencies.
2. Project preparation. To formulate alternative courses of action (projects) to attain the development goals.
3. Project evaluation and selection. To evaluate the alternatives and select the best set of projects under the prevailing constraints.

4. Project implementation. To carry out the projects selected in phase three.

5. Effectiveness assessment. To measure the actual effects of the implemented course of action and to initiate corrective action as necessary.

1.1 Objectives and Scope

Extensive studies have been undertaken and a very useful body of knowledge has been generated. However, there are many areas that need exploration, elaboration, and extension. The purpose of this study is to undertake such a task. The studies done on the subject till now have mostly concentrated on the evaluation and selection phase. Relatively little attention has been paid to the other phases. Therefore the emphasis here would be on the other phases. However, the evaluation and selection are treated carefully and some new approaches to the problem of evaluation and selection are presented. In short, the objectives of this study are to set forth a framework for proper and satisfactory implementation of these phases and to provide analytical tools required to match the development objectives of a nation and the projects selected to achieve those objectives. Also, it is intended to set forth a proper method for implementation of such projects.

As mentioned earlier the objective of undertaking any development program is understood to be closing, or at least narrowing, the gap existing between different aspects of life in a developing nation and developed nations. Thus the logical starting point would be defining the present status or what gaps exist and then identifying the problem areas causing these gaps. Then suitable

projects should be initiated, evaluated, and implemented to reduce or eliminate these causes. Hence the method of attacking the problem here would be to present a framework that will provide guidelines for proper identification of the development needs of a nation and formulation and implementation of suitable projects that will result in elimination or reduction of the identified needs. Specifically, it is intended to cover the following areas:

1. To provide means for identification of the areas that need attention, i.e., to determine the objectives of the development programs based on the actual development needs of the people of a country or a region. Also, to forecast as to the intensity and nature of these needs and any others that may occur in the future.
2. To devise a system to set priorities for the recognized objectives.
3. To provide mechanisms required for preparation of a mix of projects suitable to cover the identified needs.
4. To introduce a methodology for the selection of the most satisfactory set of the projects for implementation under the prevailing constraints.
5. To provide the necessary tools and techniques required for proper implementation of the selected set of projects.
6. To provide measures for the assessment of the effectiveness of the course of action undertaken and to pinpoint the shortcomings in cases of ineffectiveness.

A management by objective approach is advocated so that every effort is directed to remedy causes of underdevelopment. The

interdependencies of different aspects of development as well as development programs are emphasized and a systems approach to the whole problem is recommended. Throughout the study an attempt will be made to use the most recent developments in the areas of corporate and strategic planning. Of course modifications, as required by the particular application, will be applied. For the implementation phase network methods and other tools of project management suitable for application in the developing countries will be proposed.

The work is organized such that those who are not interested in the details may only read the 2nd chapter that presents the overall system and major sub-systems and their components and relationships. The following chapters elaborate on the sub-systems and components of each sub-system. Chapter III will present a system for recognition of present needs and projection of future needs and translation of the needs into development objectives. In Chapter IV different methods of making these development objectives operational will be discussed and a framework for generation of alternative methods of attaining the objectives will be presented. Chapter V deals with the design of a system to set priorities, criteria, and methodology for evaluation and selection of the best set of projects. In Chapter VI the proper methods of implementing the projects will be presented and means of control and follow up will be discussed. Finally, in Chapter VII measures of assessing effectiveness will be presented.

CHAPTER II

A SYSTEM FOR PROJECT PLANNING AND IMPLEMENTATION

Both terms planning and system are subject to some degree of controversy. There exists a difference of opinion as to both their meanings and applications. Therefore it is appropriate to define the terms system and planning as they apply to this research.

2.1 System

A system in most general terms can be defined as "an organized, unitary whole composed of two or more interdependent parts, components, or subsystems and delineated by identifiable boundaries from its suprasystem" [2, p. 10]. Of course each subsystem may be considered as a system composed of subsystems of its own while being a subsystem of a larger system. Therefore there could exist a hierarchy of systems. As an example the human body is a system composed of many subsystems such as circulatory system, respiratory system, nervous system, etc., while itself is a component of many systems such as nature, nation, state, local PTA, etc. Figure 2.1 illustrates the idea of system subsystem and suprasystem.

As to the method of establishing the boundaries of a system two approaches are possible. Systems may be considered 'closed' or 'open' depending upon whether they interact across their boundaries with

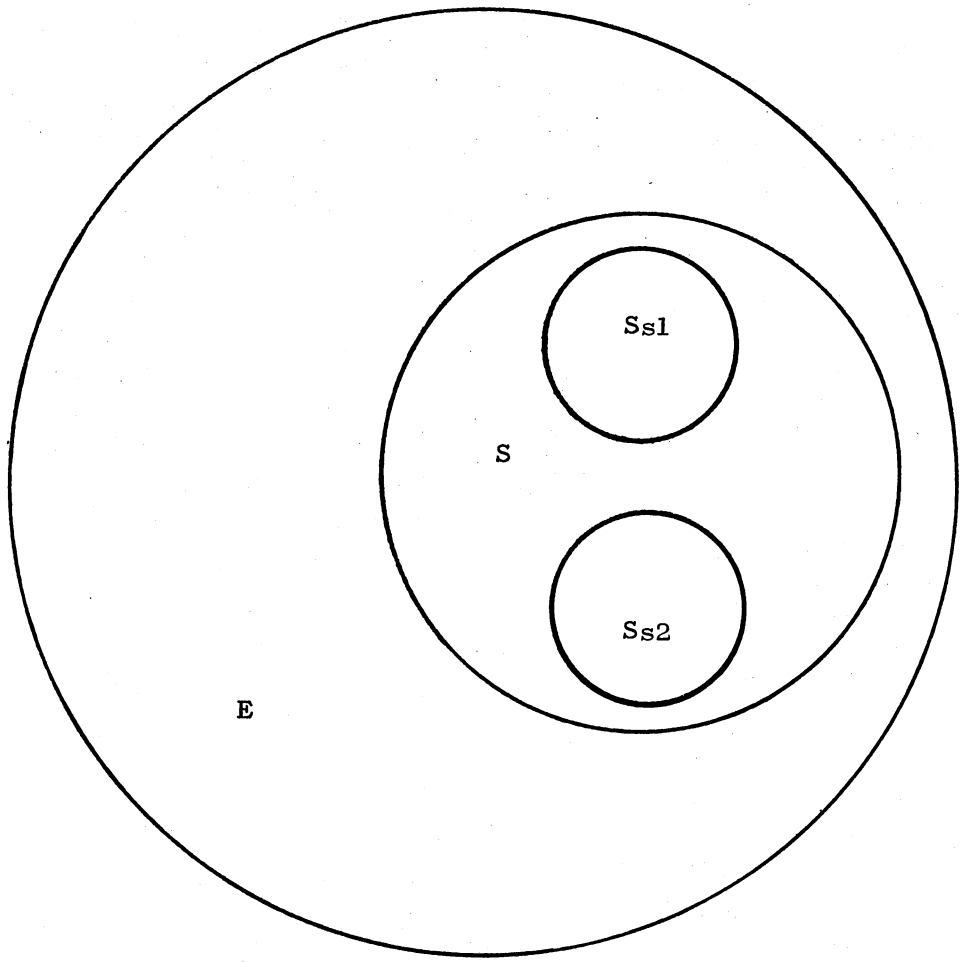


Figure 2.1. System, Subsystems, and Environment

their environmental system or not. If they do, they are called 'open systems' otherwise they are called 'closed systems'. A closed system with no interaction with its environment (the terms environment, environmental system, supersystem, and suprasystem will be used as synonyms) is impossible and so is an open system with no identifiable boundaries. Systems are partially closed or partially open depending on the extent of across the boundary interactions with their supersystem. However, the system which is the subject of this work, i.e., planning system is an open system. It is one of a class of systems called 'human social systems' which are all open systems [3, p. 10]. Therefore, in order to understand the environmental system in which a planning system operates we should have an understanding of the open system in general and those of human social systems in particular.

2.1.1 Features of Open Systems

The essential features of open systems are [3, p. 109; 2, p. 40]:

1. Open systems interact with their environment. The interactions are in the form of exchange of energy, material and information.
2. The entropy in open systems tends to increase.
3. Organization is another force characterizing the open systems which not only counterbalances the increase in entropy but also operates to achieve a higher level of organization and by import of energy and material from the environment may even produce a decrease in entropy of the system.
4. Open systems maintain a dynamic equilibrium; implying that the system continues to maintain its on-going rates of change.

5. Open systems are self regulatory and self adaptive.

6. Open systems are not deterministic. They have a property called equifinality; i.e., certain results may be achieved with different initial conditions, inputs and processes.

7. The open systems are non-causual; i.e., a direct cause and effect relationship does not exist between the initial conditions and the final states.

8. Open systems display major feed-back functions. Information about the output of the system is relayed back as an input to the system causing changes in the transformation process, if required. Feed-back may be positive or negative. Positive feed-back has 'amplification effects', while negative feed-back is used for control; i.e., to correct any deviations from a desired state.

9. There are hierarchial relationships between systems; i.e., a system is composed of subsystems as well as being a sub-system of another system.

10. All open systems can be represented by an input-transformation-output model.

Characteristics of Human Social Systems. Some characteristics of human social systems as set forth by Ozbekhan [3, p. 107] are:

1. Human social systems belong to the class of open systems.

2. The behavior of human social systems is purposive. Purposive behavior is an activity directed toward a goal or a set of goals.

3. Human social systems exhibit hierarchial relationships.

4. Human social systems tend to resist disturbances causing disequilibrium.
5. Human social systems possess identifiable and relatively narrow limits.
6. Human social systems tend to mechanize some processes; i.e., some activities within these systems tend to become routines or programs.
7. In human social systems energy is uniformly distributed; i.e., there is not much potential difference in the system to cause flow of energy from some high potential region to some other low potential region.
8. Human social systems are reproductive; i.e., they strive to survive.
9. Human social systems possess a property called 'functional unity'; the parts of the system work together with certain harmony without producing unresolvable conflict.

A knowledge of these features is helpful in analysis and design of a planning system. These features should be given careful consideration since the planning system has to survive in this environment.

2.2 Planning

Planning has been defined by several authors. The following are some of these definitions [4, p. 29]:

-- "Planning is a goal-directed decision making process."

-- "Planning is the formalization of factors involved in determining the goals and the establishment of decision processes to achieve these goals."

-- "Planning is making of models of causative anticipations."

-- "Planning is the systemic enrichment of the information base for decision making (pointing out consequences for the future of alternative courses of action taken in the present, and consequences for present action of alternative goals in the future)."

These definitions and others have one common implication -- planning is a purposeful activity. Planning is done to achieve something which is defined for the planner. Either he has defined this purpose or it has been defined for him. Since planning is an activity it has to operate on some object. In Ozhekhan's words "Planning is an activity which operates on something -- an object or entity that is distinct ... . Planning is done or applied to this entity for some specific purpose" [3, p. 52]. The on and the for are the factors that determine the dimensions of a specific planning system.

The objects that planning can operate on are as numerous as the objects that constitute the environment of the planning system. They range from very simple entities to highly complex systems such as the one which is the subject of this work, i.e., the environment of a developing nation. However, in any instance it is relatively easy to find out what is the object that planning is going to operate 'on'. But the 'for' becomes more difficult to identify as the changing relationships within the system on which planning is effected get more complicated.

2.2.1 Need for Planning

Planning is necessary "to effect pre-intended change in the object" [3, p. 54]. Therefore, planning can be considered as a vehicle of change in the system upon which planning is being effected. Johnson, et al. [5, p. 25], say

> ... under the system concept the planning process can be considered as the vehicle for accomplishment of system change. Without planning, the system could not adapt to different environmental forces. This distinguishes the social organizations from other open systems. In other types of open systems change occurs when environmental forces demand that a new equilibrium be established. In the organization these changes are dependent upon the rationality of the human decision process.

This idea that planning is a vehicle of change is, certainly, true in the case of planning and implementation of projects in developing countries for the purpose of social and economic development. What is necessary, in this instance, is to effect basic planned change in the social systems that have caused underdevelopment. In the process of this kind of planning, to effect intended change, the object, the purpose and the methods and actions to be undertaken should be identified and defined.

Recapturing what has been said about planning, one can state the following statements about planning [3, p. 54]:

-- "Planning is to act <u>on</u> some object."

-- "Planning is to act on some object <u>for</u> some purpose."

-- "Planning is to act <u>on</u> some object for the purpose of effecting change(s) in the object."

-- "Planning is the definition of the purpose of the change(s) one wishes to effect in the object."

-- "Planning is the design of the actions which will change the object in the manner that has been previously defined."

Now it would be desirable to establish a general characteristic of planning which will relatively stay unchanged for all planning purposes. That is to have a means that can be used to establish a tie between the 'on' and the 'for' of planning. Ozbekhan [3] contends that improvements leading to social progress establish such a characteristic. That

is planning activity is done on the system for the purpose of effecting change(s) in the system that will result in a more desirable state. Or planning is done to realize a more desirable, improved state in the system. One wants to change a system because he conceives that the future state of the system after the change will be more desirable and will constitute an improvement over the present state.

To determine what constitutes improvement is easy in the cases where only an individual is concerned. Any state more desirable to the individual than the present state is an improvement. But when improvement is considered from the point of view of a human social system many difficulties arise to define an improvement. If it was possible to extend the individual ideas of improvement so that one could claim that anything considered improvement by all or majority of individuals is an improvement, then the problem would have been solved. However, to do this would be very dangerous, because a consensus would be impossible in cases of large social systems such as nations. Without a consensus, even if the majority were right in their judgement (in many cases majorities and public opinions have shown not to be right) conflict would become inevitable. How to overcome this obstacle? Ozbekhan [3] proposes the idea of social progress. This means planning is done on the system for the purpose of effecting social progress. For the purpose of this work, social progress would be realization of a preconceived state of the system which is considered to be an improvement over present. It entails closing or narrowing the gap existing between social and economic aspects of life in developed and developing nations with minimum disturbance to the ecological and cultural systems of the developing nation undertaking to implement a development program. To

tackle this problem, two completely different approaches are possible. The first approach is to look for possible, feasible actions (projects) and plan them. Then try to predict the state which results after implementation of these actions and decide whether any improvement will result or not. The drawback of this approach is that one may fall into the trap of only exploring his immediate environment to find feasible actions and projects and lose sight of better possibilities. The second approach would be first to decide what is the desirable state or what constitutes an improvement. In other words first define what the future states of the system ought to be in order to be considered improvements. Then try to achieve those states as closely as possible by design of feasible actions (projects). It is planning in this latter sense that will be the object of this work. The desired states are defined goals and actions designed to attain these goals as closely as possible under the prevailing constraints.

2.3 Project Planning and Implementation

It was pointed out in the introduction and the previous sections that the purpose of undertaking development projects is to close or at least narrow the existing social and economic gaps between the developing countries and the developed nations. It is believed that the purpose of development programming should not be limited to this. It should attempt to do this job while avoiding the dysfunctional consequences which are being observed in the developed areas. This could only be done through systematic creation of the future by a proper planning system. Such a planning system should act <u>on</u> the environment of the developing nations <u>for</u> the purpose of changing that environment in such a

manner that not only the causes of underdevelopment are alleviated, but a future state which is considered desirable is attained as closely as possible. The planning system should generate the goals to be attained and the plans for their attainment. All this has to be carried out in the environment of the developing country. The system to accomplish this task should perform the following activities:

1. Survey the environment of the developing nation in order to find out the needs of the people. Find the causes of these needs. Augment the results with scientific forecasts to find out the extent and nature of these causes over the planning horizon. Then formulate development goals which will eliminate or reduce these causes, i.e., define a future state that is free of these causes as well as being desirable. This can be called the Goal Setting (GS) Phase.
2. To design actions (projects) that are deemed to attain the goals. This is the Project Preparation (PP) Phase.
3. Evaluate the prepared projects in terms of the prevailing constraints and select the best set to be implemented. This is the Project Evaluation and Selection (PE & S) Phase.
4. Implement the selected set, i.e., carryout the activities required to transform the project ideas into realities. This is the Project Implementation (PI) Phase.
5. Assess the effectiveness of the actions (implementation of projects) to attain the goals, and take corrective action (feed-back).

These five phases constitute the processing of the system. The inputs to the system are provided by the environment and the outputs

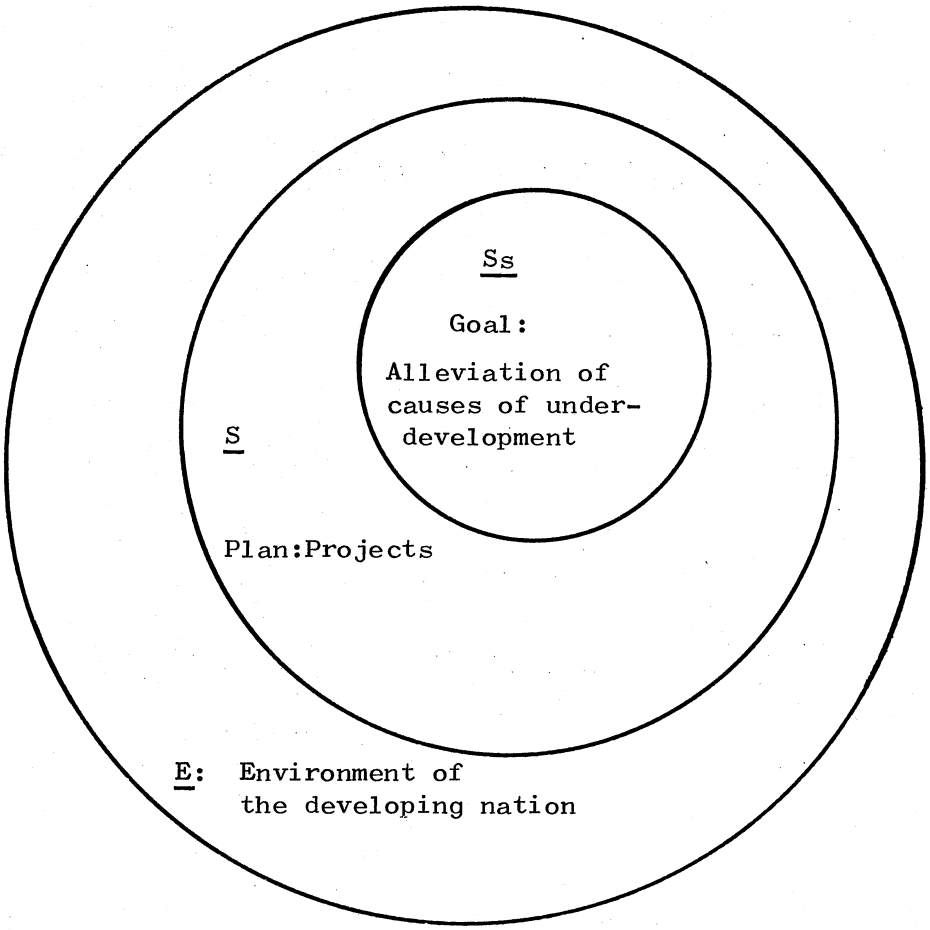


Figure 2.2. Goals, Plans, and Environment

received by it. The system is shown schematically in Figure 2.3. The thick arrows show input/output relations. The thin ones imply feedback. Of course there is some output from each phase to the environment. This is not shown. It is assumed that the system output is from the Project Implementation Phase only. As shown in the figure all the phases get their inputs from the environment through the value system and the output is also to this system. The value system includes all the institutions and factors within the developing country that determine the way of life of the nation. In other words values are factors that make the basis for distinction of acceptable and non-acceptable or good and bad, and therefore what is desirable. It is the value system which either provides or inhibits the inputs required to maintain any human social system within an environment. A system in order to survive should either adapt to the forces of the value system or attempt to change these forces so that it can secure the inputs required for its survival. A combination of adaptation and change, probably, is more appropriate.

In our case there is no doubt that the thrust of the system should be change. Otherwise the intended improvements will not take effect. Ozbekhan [3, p. 93] maintains that we can will the future "only if change is caused to occur in values rather than in the object's other attributes ... . Any change that is not a fundamental change in values merely extends the present rather than creating the future." Therefore, all attempts should be concentrated toward changing the value system, i.e., changing the institutions of the developing country.

To make any system operational requires various inputs to be processed by the system to generate the intended outputs. The

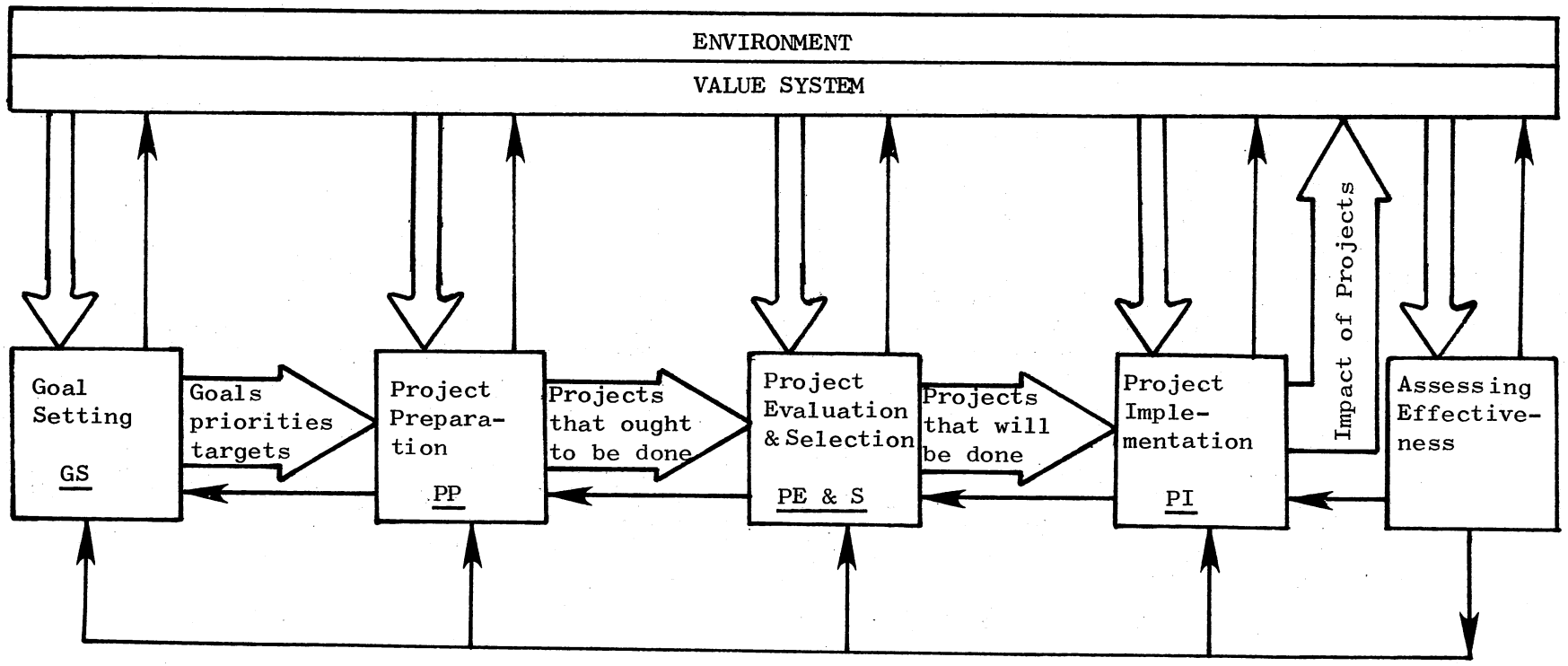


Figure 2.3. Project Planning and Implementation System

design of a proper organization for the realization of this system requires that these inputs, processes and outputs be specified in advance. The inputs, energy, material and information are processed by the technologies employed by the system and are transformed into the intended outputs plus some unintended outputs. The unintended outputs may be desirable or undesirable. However, good system design should attempt to minimize these unintended outputs while maximizing the intended outputs.

The material inputs are usually from the natural environment while energy could be from both human and natural varieties. Information is the knowledge possessed by people about the nature of the environment and how the environment can be acted upon to produce the intended outputs. In more concrete terms the inputs of a system are manpower, materials, equipment, and capital. The transformation processes of it, in our case, are the five phases and the intended output is development. Of course each phase of the system by itself constitutes a subsystem of the planning and implementation system. The inputs enter the system at all phases, but the main output substantiates after the implementation of the projects. The intended output (development) can only be measured by observation of improvements in the life of the nation. The effectiveness of the total system cannot be evaluated by measuring the performance at the subsystem level, even though the concrete outputs are measurable only at these levels. This is the reason for adding the fifth phase to the system, so that the overall system effectiveness is assessed as well as subsystems effectiveness and efficiency which should be evaluated at the subsystem level. When dealing with the total system it is effectiveness which should be the primary concern. Where

at the subsystem level both efficiency and effectiveness should be assessed in order to judge the subsystem performance.

At the subsystem level what is of primary importance is to carry out the tasks necessary to attain the goals of the subsystem. The outputs should be measured and compared to the inputs used to assess efficiency. At this level the inputs and outputs are well defined and easily measured. The concern is to measure the actual performance of the subsystem to assure efficient input/output relations. While at the system level the concern is to see how the efficiency of performance at subsystem level contributes to the attainment of the "willed future." Here we cannot measure the effectiveness with the comparison of inputs and outputs; for example, implementing n projects with an expenditure of x amount of each of the inputs does not tell us how effective we have been in improving the social and economic aspects of life in a nation. We have to use other criteria rather than comparing the inputs and the outputs. We have to measure the state of the nation and see how close this state is to what we wished it to be and whether the progress made is satisfactory or not. It is the effect of the projects implemented not their number that concerns us here. It is the actual improvement of the standard of living in the society not the increase in GNP that is relevant. It is the increase in number of people who can read and write not the number of schools built that should be observed. It is the increase in life expectancy, decrease in child mortality rate, and the quality of patient care and availability of the care to as many people as possible that are important not the number of hospitals built or number of doctors trained. And so on.

2.3.1 Some Organizational Considerations

Any model to be of any value should be properly implemented. To implement a model requires an appropriate organization or organizational subsystem. The organizational system has five subsystems [2, p. 14]: Goals and value subsystem, structural subsystem, psychological subsystem, technical subsystem, and managerial subsystem. Each and every one of these subsystems should be designed to fit the tasks to be undertaken. In our case the goal of the organization is to implement the system of Figure 2.3. The techniques and methods required for the technical system of the organization will be developed in the subsequent chapters. The psychological subsystem deals with the relationships of the people working in the organization both amongst themselves and with the organization. This subsystem should be dealt with case by case and is beyond the scope of this paper. However, it should be noted that the success of each organization depends on its people. Most careful consideration should be given to this subsystem. Because most of the problems facing an organization stem from the people. The other subsystems are also dependent on people; techniques and structures are created and implemented by people; goals are set by people, etc. The managerial subsystem is also dealt with in each instance. Its function, as defined by Barnard, is to maintain the organization, i.e., the managerial subsystem has the role of coordination of all other subsystems of the organization. The structural subsystem should, also, be dealt with in each case. However, there are some general notions about this subsystem that will be developed here.

The structural subsystem of the organization provides the work flow within the organization and its relations with the environment. To

design a structure for an organization, similar activities should be integrated and assigned to a department of the organization. In this case it seems that the activities can be assigned to three separate departments:

1. A department to carry out goal setting activities as well as assessing the effectiveness of the system. Phases 1 and 5.
2. A department to carry out the preparation, evaluation, and selection of the projects. Phases 2 and 3.
3. A department to implement the selected projects. Phase 4.

In most developing countries a national organization, usually called Central Planning Organization (CPO), exists to carry out the activities of development programming. Since the word central, usually, conveys the notion of centralization and a central authority to dictate policy, here the organization responsible for the activities of project planning and implementation will be called National Planning Organization (NPO). As shown in Figure 2.4, the NPO should consist of three major departments.

NPO		
Goals and Effectiveness (G & E)	Project Preparation, Evaluation, and Selection (PPE & S)	Project Implementation (PI)

Figure 2.4. NPO Departments

Of course, all the projects required to remedy underdevelopment are not national in scope. Some are local, the majority are regional and the rest national. Local projects are those projects that deal with the deficiencies which are specific to a municipality or localities such as villages, small towns, etc. Regional problems are those that are common to several localities forming a region or province within the nation. National problems are related to the whole country or to several regions, or are so large that the resources of any one province do not suffice to solve them. National problems may also include undertakings located in a province, or community, with outputs greater than that needed by the region and should be exported to other regions or abroad. National problems may also include undertakings that require inputs to be imported from other regions or abroad. A simple description of how the three levels should work together will be given below.

First, within each locality the development needs should be recognized. Then a decision as to their nature should be made in order to establish whether the needs are local, regional or national. If local, then a project (projects) should be prepared and implemented to overcome the needs. Otherwise the matter should be referred to the regional office. At the regional level, also, a decision should be made to see whether the problem is related to the region or it is national. If it is national then NPO should handle it. This procedure would be easy to do if the local authorities within a region were well aware of the needs within that region and other regions. But unfortunately this is not true most of the time.

To achieve such an awareness will require extraordinary amounts of communication between the local authorities which, if not impossible,

would be quite cumbersome. An alternative would be that all the needs to be relayed to the NPO through the regional office. At the NPO the needs received from all the regions will be augmented by the scientific judgement of the NPO experts and a decision as to their nature should be made. If the needs are found to be local or regional in nature they will be referred back to the respective regions and local offices, and proper action will be taken at these places. These ideas are depicted in Figure 2.5.

2.3.2 NPO Departments

The Goal and Effectiveness department should be set up to cover the whole nation. It has to have regional and local offices as well as a national office. Its regional offices should be located in a central location of a region. Where regions are formed by grouping local communities with similar development needs. These regions which may be called 'equal development regions' may or may not be identical to existing provinces of the country. The main consideration in forming these regions should be their state of social and economic development which should be as uniform as possible within each region. Besides these regional offices there should be local offices, preferably in each municipality or for several neighboring villages. These local offices collect information about the development needs of their local community and send the information together with suggested solutions to the regional office. At the regional office similar needs are integrated and supplemented and then relayed to the national office. At the national office the needs from all over the country are analyzed and sorted out. The sorting process should classify the

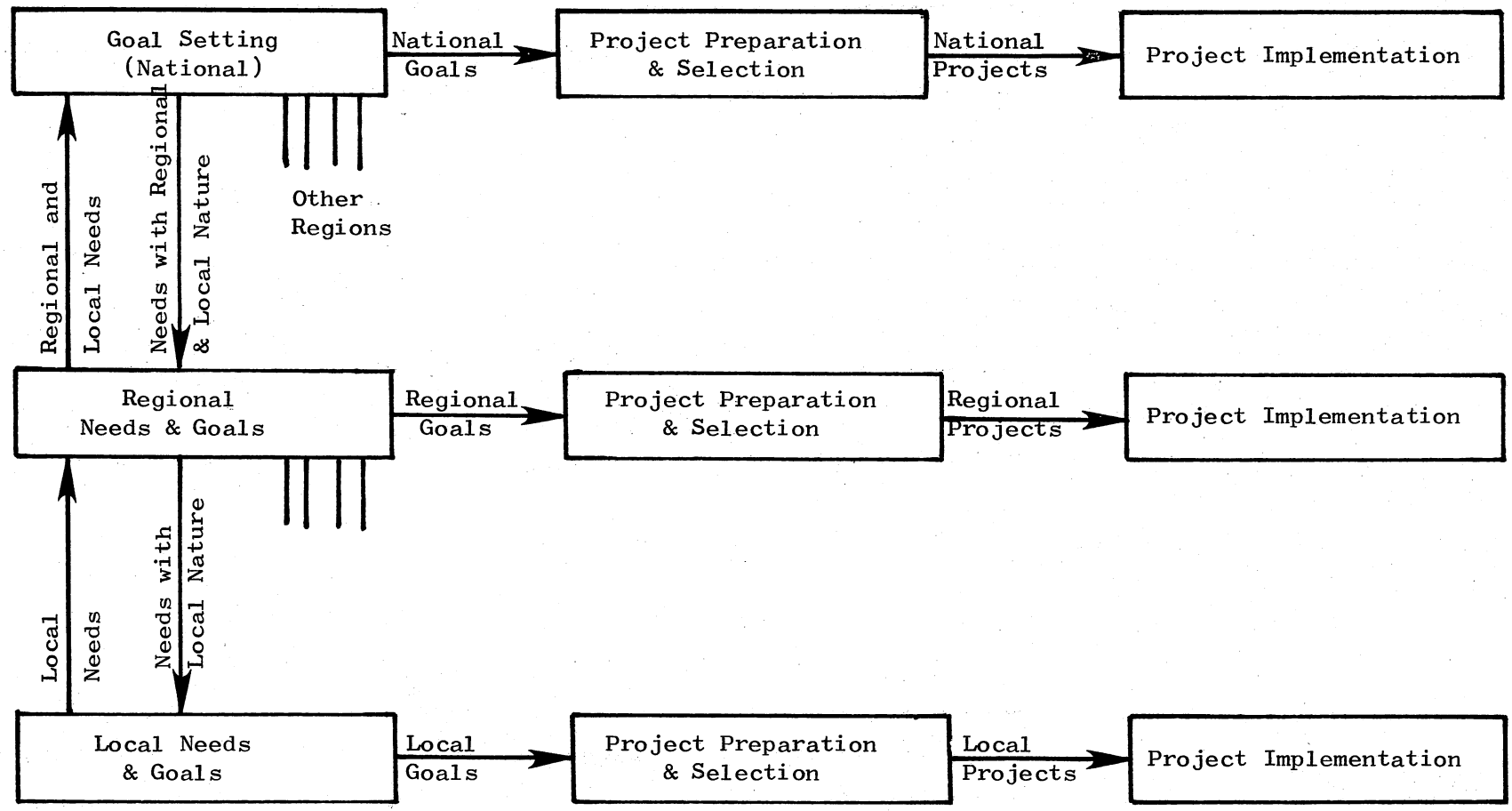


Figure 2.5. National, Regional, and Local Levels

needs into national, regional and local. It is the national category of needs that should be used by the goal setting function as the basis for setting national development goals which will be used for purposes of project preparation, evaluation, selection and implementation. The same procedures may be used at the regional and local levels, too. Therefore, the main concern here would be with the national level only. Figure 2.6 shows a diagram of the Goals and Effectiveness department.

Another function of G & E should be to compare actual accomplishments with intended goals and measure the degree of effectiveness of the programs implemented. If this is not satisfactory, the responsible parties should be informed so that they set out to find the causes of ineffectiveness and initiate action accordingly.

The preparation and selection department should set up at least three specialized groups:

-- A group who study the goals of development programming as set by the G & E and prepare alternative solutions. The suggested solutions given by the local and regional office should be considered at this stage. They should also do preliminary feasibility studies and prepare preliminary estimates for the alternatives they propose and finally come up with a set of alternative solutions to achieve the goals.

-- A second group evaluates the prepared projects in terms of the goals and selects a set of the projects that show more promise for implementation. The evaluation and selection should be done in terms of maximum goal achievement subject to all prevailing constraints -- capital, manpower, equipment, materials, etc.

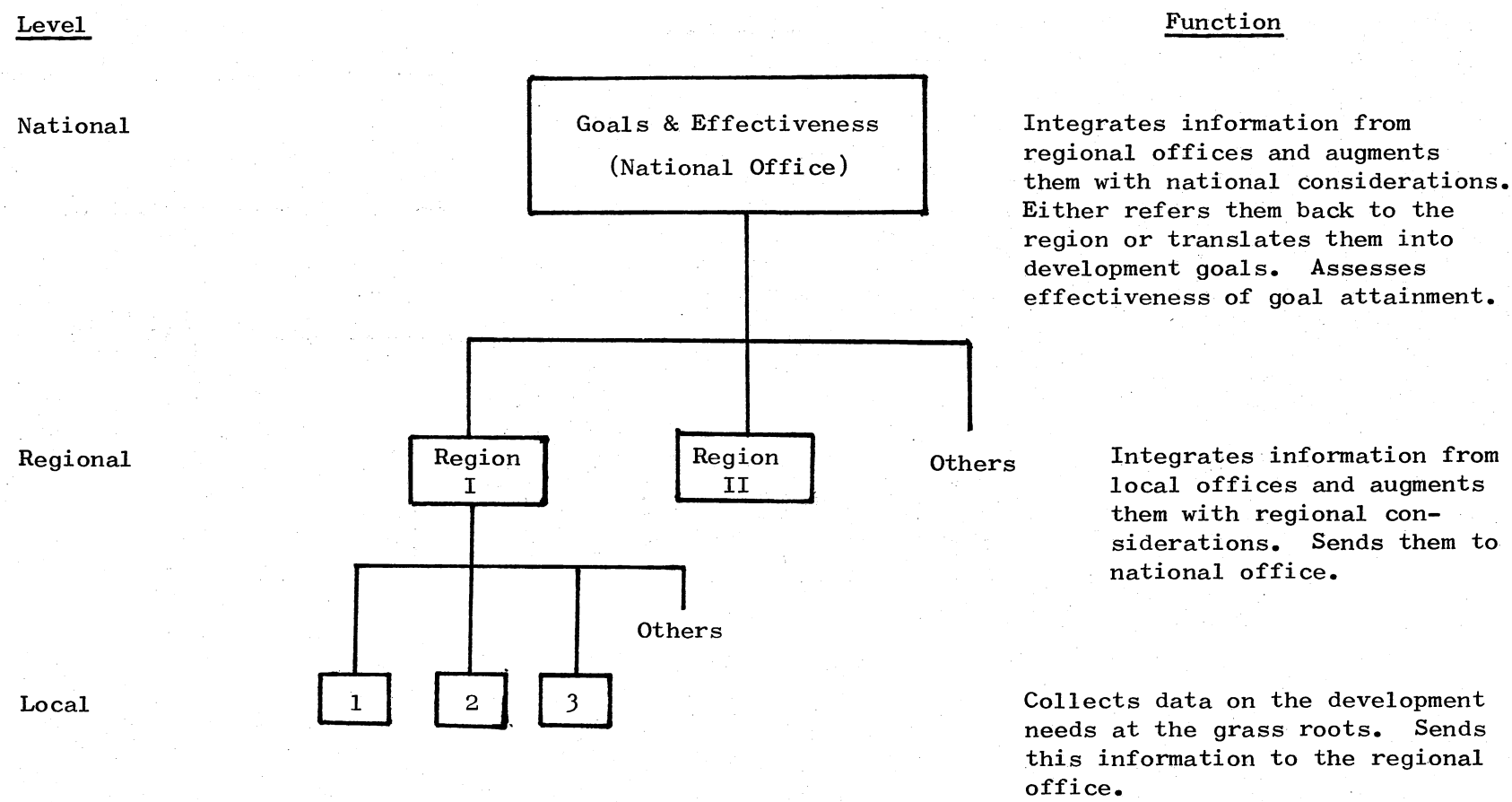


Figure 2.6. Goals and Effectiveness Department

-- The third function of PPE & S would be to plan the selected projects and prepare detailed resource requirements for each project and determine how the resources should be secured. Figure 2.7 shows this set up for PPE & S.

The third department of the NPO is the one that has the responsibility of implementing the selected projects. At the implementation phase we are dealing with actual realization of a specific project. The scope and the objectives are well defined. What has to be done is to organize the resources so that the final objectives of each project are achieved as efficiently as possible. A project manager should be assigned to each project when a project is selected for implementation. He then sets up a project group to help him to carry out the assigned project. Although the projects may be done by a contractor or contractors, not the NPO, the idea of a project manager who would have overall responsibility for the implementation of a project is crucial.

There are many ways that a project can be implemented under the responsibility of a project manager. It can be contracted out completely to a prime contractor who in turn may contract out parts of the project to different subcontractors. It may be contracted out directly to several subcontractors. It can be done by the implementation department of the NPO completely or partially where some parts are contracted out and others carried out by the NPO itself. Therefore, a project manager should be able to deal with a complex environment. He should use this environment to complete his project in a most efficient manner. This phase, project implementation, and the other phases of the system will be elaborated upon in the subsequent chapters.

PROJECT PREPARATION, EVALUATION AND SELECTION		
Project Preparation	Project Evaluation and Selection	Project Planning
Prepares alternatives for achieving the goals.	Evaluates and selects best alternatives that can be done under the prevailing constraints.	Plans the selected projects. Prepares detailed resource requirements. Determines how the resources are to be secured.

Figure 2.7. P P E & S

CHAPTER III

GOAL SETTING

One of the characteristics of human social systems mentioned in the previous chapter is that these systems are purposive, i.e, they are formed to accomplish some purpose(s). The main purpose of planning was stated to be acting on the environment to effect pre-intended changes in the environment. The changes are believed to create a state of the system that is considered to be more desirable than the present state. However, such a broad purpose is not significant operationally. One cannot start to plan action without further elaboration and formulation of operational goals; i.e., goals that can be used as basis of action.

In this chapter a framework for derivation of operational goals for the project planning and implementation will be presented. Also, methods of determining targets and priorities will be discussed.

3.1 Development Objectives

The earlier attempts at development planning were mainly concerned with economic aspects of development. Raising the GNP through industrialization was considered to be sufficient for overcoming underdevelopment. However, the failure of these early attempts promoted the idea that other objectives besides economic ones should be pursued, too. The most popular of these objectives are [6, 7]:

1. Raising the standard of living of the nation.

2. Increasing the national income.

3. Reducing unemployment.

4. To achieve self-reliance, i.e., to achieve and maintain a balance of payments.

5. Equitable income distribution.

6. Merit wants, i.e., social, cultural, recreational, etc.

Table 3.1 shows that these objectives are shared by the nations surveyed [7].

These objectives can be used as a starting point for the formulation of operational goals for the project preparation phase.

3.2 Goal Setting

Figure 2.3 shows the goal setting as the first phase of the project planning and implementation system. The inputs to this system are from the environment through the value system. It affects the environment through a feedback loop which consists of the ideas acquired by the people working in this phase and various interactions of this subsystem with the institutions forming the value system. It receives feedback from project preparation and effectiveness phases. The project preparation phase feedback is about the realistic nature of goals set by the goal setting phase. The feedback from the effectiveness phase is comprised of information about the actual changes effected in the environment by the whole system. The goal setting phase should analyze the inputs it receives from the environment and in the light of the feedback information from other phases convert them into goals, targets and priorities. In order to outline and see the nature of inputs to the subsystem a knowledge of the environment is essential.

TABLE 3.1

DEVELOPMENT OBJECTIVES

Country	Aims						Other
	To increase national income	To improve employment situation	To achieve and maintain balance of payments equilibrium	To achieve and maintain price stability	To obtain a more equal distribution of income between individuals	To obtain a balanced regional economic development	
Burma	x	x	x	x	x	x	To achieve an increased rate of growth of population.
Ceylon	x	x	x	x	x		To diversify the economy so as to make it less vulnerable to external changes.
Chile	x		x	x	x		
Czechoslovakia	x	x	x	x	x	x	Fundamental aim: To ensure material and cultural conditions for the development of the society and of every individual.
Ecuador	x	x	x	x	x	x	To improve education and achieve a system to technical education. To eliminate feudal relations that permit exploitation of working people.
France	x	x	x	x	x	x	To produce resources for aid to underdeveloped countries.
Greece	x	x		x	x	x	Progressive diminution of the dependence of the Greek economy on foreign economic aid.

TABLE 3.1 (Continued)

Country	Aims						Other
	To increase national income	To improve employment situation	To achieve and maintain balance of payments equilibrium	To achieve and maintain price stability	To obtain a more equal distribution of income between individuals	To obtain a balanced regional economic development	
Hungary	x	x	x	x	x	x	
Iran	x	x	x	x	x	x	
Japan	x	x	x	x	x	x	To achieve economic self-support.
Federation of Malaya	x	x	x		x	x	To widen variety of Malayan production.
Morocco	x	x				x	To establish economic independence of Morocco.
Netherlands	x	x	x	x	x	x	
Norway	x	x			x	x	Prevention of inflation: long-term external balance of the economy.
Poland	x	x	x	x		x	
Puerto Rico	x	x		x	x	x	
Turkey	x	x		x	x	x	
						x	
Yugoslavia	x	x	x	x	x	x	

Source: Tinbergen, Jan. Central Planning. New Haven, Conn.: Yale University Press, 1964, pp. 104-142.

3.2.1 The Environment

The environmental system of the project planning and implementation is very complex. At least it consists of five environmental subsystems [8, p. 8]:

-- economic environment

-- social environment

-- political environment

-- ecological environment

-- technical environment

Figure 3.1 shows these ideas schematically. The first four can be called the nontechnical environment to obtain a dichotomy of technical-nontechnical. The nontechnical environment is the main determinant of the goals, while the technical environment should provide the methods of attaining the goals. The technical environment is based upon the knowledge available in the form of science and engineering. The nontechnical environment determines what the goals should be and their priorities. The technical and nontechnical environments determine which of the goals are attainable and the extent of goal achievement. Of course the technical environment affects the goal setting; but the effect is through feedback.

The goal setting department of the NPO should survey and analyze the nontechnical environment of the developing country and define a desirable future state. Then formulate goals whose attainment will realize the desired state.

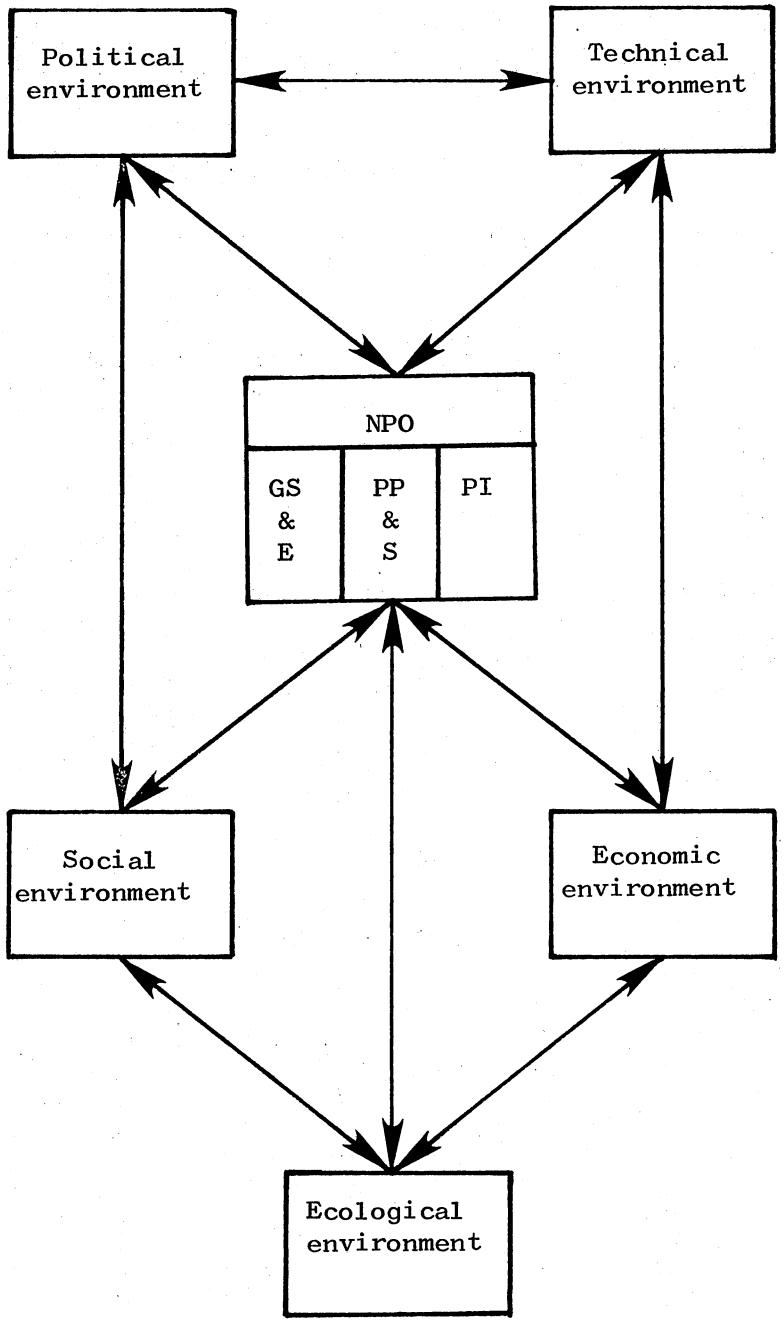


Figure 3.1. NPO Environment

Source: Bright, James R., and M. E. F. Schoeman (editors). A Guide to Practical Technological Forecasting. New Jersey: Prentice-Hall, 1973, p. 4.

3.2.2 State of the Nation

The state of any social system can be defined in terms of structure and performance [9, p. 35]. Both structure and performance must be specified. Structure includes the variables that make up a system. To define structure these variables should be identified and their desired levels specified. Realization of a desired structure requires action. So, to achieve a desired structure the performance required to achieve it should be specified too. This is what Gross [9] calls the duality principle. Both structure and performance are required. As Gross [9, p. 35] points out:

> What is more serious, national leaders often plan changes in structure without considering what kinds of performance are needed to bring about these changes or how such changes affect subsequent performance.

Without suitable performance a desired structure cannot be realized. Performance without a desired structure is purposeless and random; therefore not rational nor creative.

The mission of the goal setting organization is to determine the future structure of the developing country. To do this the variables making up the structure should be identified, their present levels measured. Then desired future levels determined based on the requirements set by the environment, i.e., the deficiencies in present state of the structure.

3.2.3 Structural Variables

The structural variables of a nation are numerous and diverse. Swayer [10, p. 145] listed 236 such variables. There are many more and the list cannot be exhausted.

> There are so many aspects of the structure of a national social system that no one need feel particularly unhappy if he cannot make a complete list of all of them. Indeed, a complete list would be impossible, since someone could always get new additions through subdivision or combination [9, p. 37].

Fortunately broad classifications are possible. Any list should meet two requirements according to Gross [9, p. 38]:

1. Providing a set of general categories in which all conceivable aspects can somehow or other be fitted, and

2. Providing a useful and reasonable ordering of the categories.

Swayer [10] contends that most of his 236 variables show high correlation with three general classifications that he calls dimensions. These are: size, wealth and politics. For the purposes of development planning (and planning in general) a complete listing is not necessary. The strategic factors; those factors that acting on them results in substantial improvements, should be identified and acted upon. Forrester says: "... great improvements can often be generated at small cost if the critical pressure points within the system can be identified" [4, p. 244].

It is the task of the goal setting organization to locate these strategic factors as related to the objectives of development. Raising the standard of living of the nation is usually at the top of any set of development objectives. Indeed, some works on the subject of development planning consider it the only objective. But there are serious implications to such an assumption. One such implication would be that all related variables can somehow be measured by some common unit. For example, one may try to assign a monetary value to each variable, in order to be able to form a single objective function with a single

attribute (monetary value) to be maximized. Aggregate consumption [6] is, also, proposed to be such a measure that incorporates all other development objectives. This might be true theoretically. Since other objectives are somehow meant to improve some aspects of life of the people. However, such an approach in practice leads to conversion of the inputs and outputs to monetary units. And sooner or later economic considerations become dominant, because they are easier to quantify in monetary terms. The result: a single objective of raising the GNP.

Therefore, the goal setting organization, in order not to fall into this trap, should list all the pertinent (strategic) variables related to the development objectives. Then determine the deficiencies and their causes. The goals of the planning system follow from the objective of eliminating these causes. This point, elimination of causes, is most important because it is possible to fall into the common pitfall of alleviating the symptoms and making the whole situation worse. In Forrester's words [4, p. 244]:

> From the viewpoint of system planning, a system study takes the emphasis off the correction of difficulties. Instead, it focuses attention on the causes of difficulty and their removal. Removing causes may take quite different actions from those aimed at alleviating symptoms. The cost of removing causes is often far less. The influence is much deeper. The improvements last longer. Good planning based on a deep insight into the behavior of complex systems will attempt to release the internal power, initiative, driving force, enthusiasm, and human potential of the people in the system. It will do this instead of heaping more work, more discipline, more repression, and more coordination on them in an effort to push back a social system that is still trying to go in the wrong direction.

3.2.4 Goals, Priorities and Targets

The goals, priorities and targets may be determined in two ways. First, the political system may impose them. This method, though

prevailing, is not consistent with the kind of planning pursued here. Second, the planning system itself establishes these goals, priorities and targets, of course, within the constraints imposed by the environment which the political system is just one part of. The most important element of a national environment is the people of the country. Other elements as listed and elaborated by Gross [9, p. 39] are: non-human resources, internal relations of the subsystems, external relations with the environment, values, and a central guidance system. The goals, priorities and targets should be defined in relation to all these elements. It should be noted that the relationships are usually more crucial than the elements themselves and strategic factors are usually found in the relationships. So it is these relationships that should be worked upon to produce desired changes. However, the goals, priorities and targets should be determined based upon the needs of the people. The goals should be defined and targeted so that the development needs are overcome.

The needs of the people can be only determined by the people. Therefore, the goal setting organization, in order to know what these needs are, should ask the people. Asking all the people is costly both in time and money. It is not necessary, either. Statistical techniques of survey sampling [14] can be used to do the job less costly and usually more accurately. The following procedures may be used to find the needs.

1. Divide the country into regions. The regions should be as homogeneous as possible with respect to different aspects of development. These regions may be called equal development regions. The divisions may or may not be the same as the

political provinces of the country.

2. Divide each region into several sampling units. These sampling units may be counties, cities, municipalities, or several villages.

3. Use techniques of survey sampling to obtain a suitable picture of the development needs of each region. Also collect information as to the extent and urgency of the needs. The urgency information would be used to determine priorities.

4. Analyze the survey results by suitable statistical methods. Augment them with other considerations.

5. Establish whether needs are local, regional or national.

6. Refer the local and regional needs to their respective places to be acted upon.

7. Act upon the national need at the NPO level.

This procedure establishes the national development needs that the NPO should take care of. The information about these needs should be used to establish primary goals, initial targets and priorities. When these targets are achieved the present needs will be eliminated. However, the needs of a nation will not remain the same over time. The developed nations will not stagnate either. Therefore, it is necessary to establish the extent and nature of the needs in the future. Some of the present needs may become irrelevant. Others may be intensified. More may be forthcoming. So these initial goals, targets and priorities should be modified by suitable forecasts.

3.3 Alternative Futures

Willing and creating a desirable future is the distinguishing characteristic of new planning. The procedure described above is intended to establish the basis on which such a future can be defined in terms of goals to be accomplished. The picture of a desired future may take different forms.

Gerardin [8, p. 276] distinguishes four different attitudes toward future. The first and the old one maintains that the future can be no different from the past. This is the attitude of the past, where the agricultural society did not have many choices except following the seasons. The second attitude, result of industrialization, is an opportunistic one [8, p. 277].

> The future no longer resembles the past, and more and more the dynamic change is the normal and not the static prennial ... carried off by the turbulent floods of life, man tries to avoid the dangers and to profit from the place in which he finds himself. He tries to organize his activities in order to extract the good (or more exactly not the bad) of the daily opportunities.

This has been, and still is, very common. The best result of such an opportunistic attitude would be local optimization at the expense of the total system, or the existence of continuous critical problems (CCP's) as Ozbekhan contends [1, p. 84]. The CCP's as listed by Ozbekhan are reproduced in Table 3.2.

The CCP's, with the probable exception of 11, 15, and 17, are the problems that the developing countries are confronting, too. Polution, spoilage of nature and discrimination against the aged, though yet not problems, are becoming more serious with progress in industrialization. Therefore, this list can be used in conjunction with goal setting and other operations of the NPO.

TABLE 3.2

CONTINUOUS CRITICAL PROBLEMS

1. Generalized Poverty within Affluence.
2. Discrimination vs. Minorities.
3. Obsolete Welfare Practices.
4. Insufficient Medical Care.
5. Hunger and Malnutrition.
6. Inadequate Education.
7. Inadequate Shelter.
8. Inadequate Transportation.
9. Urban and Suburban Sprawl.
10. Decay of Inner Cities (Slums).
11. Environmental Pollution.
12. Inadequate Crime Control.
13. Inadequate Law Enforcement.
14. Obsolete Correctional Practices.
15. Spoilage of Nature.
16. Inadequate Recreational Facilities.
17. Discrimination vs. the Aged.
18. Wastage of Natural Resources.
19. Uncontrolled Population Growth and Size.
20. Unbalanced Population Distribution.
21. Obsolete System of World Trade.
22. Underemployment.
23. Spreading Social Discontent.
24. Polarization of Military Power.
25. Inadequate Participation in Public Decisions.
26. Inadequate Understanding of CCP's.
27. Inadequate Conception of World Order.
28. Insufficient Authority of International Agencies.

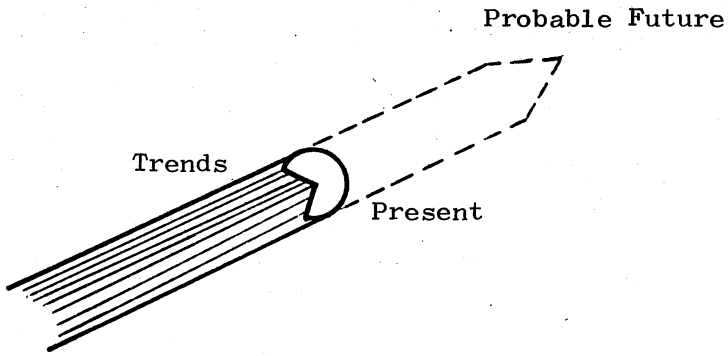
The above Continuous Critical Problems are not listed or grouped together in any particular order precisely because their very nature denies any logical ordering.

Source: Ozbekhan, Hasan. "Toward a General Theory of Planning." In E. Jantsch (ed.), Perspectives of Planning. Paris: Organization for Economic Cooperation and Development, 1969, p. 85.

The third attitude regarding the future is an adaptive one. "We try to optimize the today actions in order that their consequences are better adapted to the forseeable future" [8, p. 277]. Figure 3.2, due to Gerardin [8] depicts this adaptive philosophy. In this case the attempt is to forecast the future as an extrapolation of the past [8, p. 278].

> Adaptive attitude is better than opportunism, but adaptation is also outdated because it is based on illogism. What is a forecast? A forecast is an estimation of the probable state of something at a given future time under the hypothesis that everything will continue as in the past. But forecasts are made to act upon decisions. These decisions modify the environment, therefore the main hypothesis, according to which everything will continue as in the past, is no longer valid. Therefore, this is the illogism of adaptive attitude.

The adaptive attitude is useful so far as the effects of decisions made are negligible. This is probably true for short and medium range planning and in stable environments. But development planning is more concerned with fundamental changes in the environment. Thus, at least, at the goal setting stage an adaptive attitude would be harmful. The attitude most suitable for this purpose is a creative attitude. In this case the value of a forecast is measured by the degree it influences present action rather than the accuracy of the predicted future. "There are no future facts such as 'past' and 'present' facts but only a set of potentialities which outline a set of possible futures (futuribles, to use the word coined by Bertrand de Jouvenel)" [8, p. 279]. This is what Ozbekhan calls creative planning. Any system has several possible alternative futures (A, B, C, etc.) as shown in Figure 3.3 which should replace Figure 3.2 if this attitude should prevail. One of these possible futures is the probable future that results from trend extrapolation.



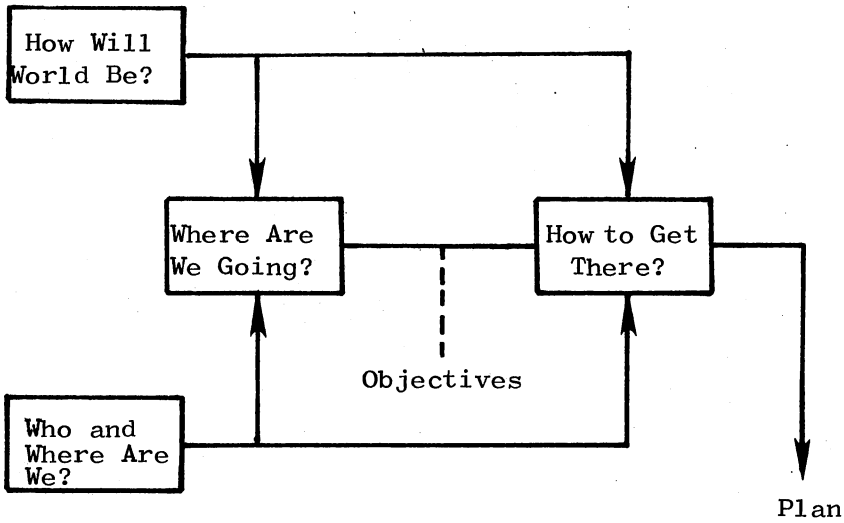
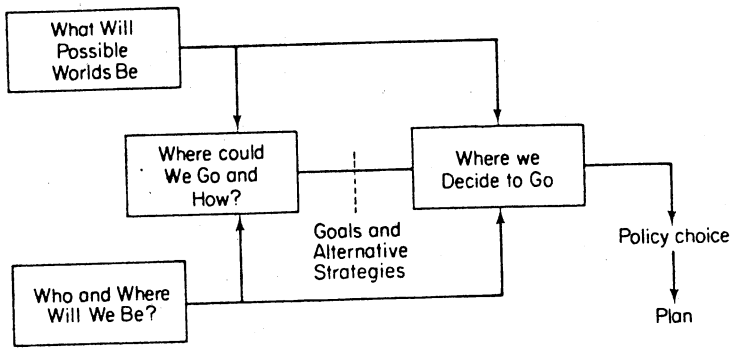


Figure 3.2. Adaptive View

Source: Bright, James R., and M. E. F. Schoeman (editors). A Guide to Practical Technological Forecasting. New Jersey: Prentice-Hall, 1973, p. 277.



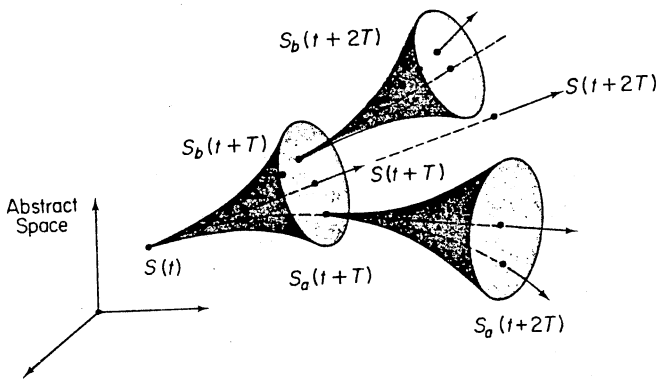


Figure 3.3. Alternative Futures--
Creative View

Source: Bright, James R., and M. E. F. Schoeman (editors). A Guide to Practical Technological Forecasting. New Jersey: Prentice-Hall, 1973, p. 280.

There are several methods that can be used to implement this creative attitude. Among these are scenario writing, morphological analysis, Delphi, etc. For details of these and other methods reference should be made to [4, 8, 11, 12].

3.4 Summary

The goal setting department should be responsible for the formulation of development goals, targets and priorities. This process starts with the identification of development needs and ends by generation of a set of goals, priorities and targets that when accomplished will realize a desirable future free of the causes of underdevelopment. Figure 3.4 depicts the procedure schematically.

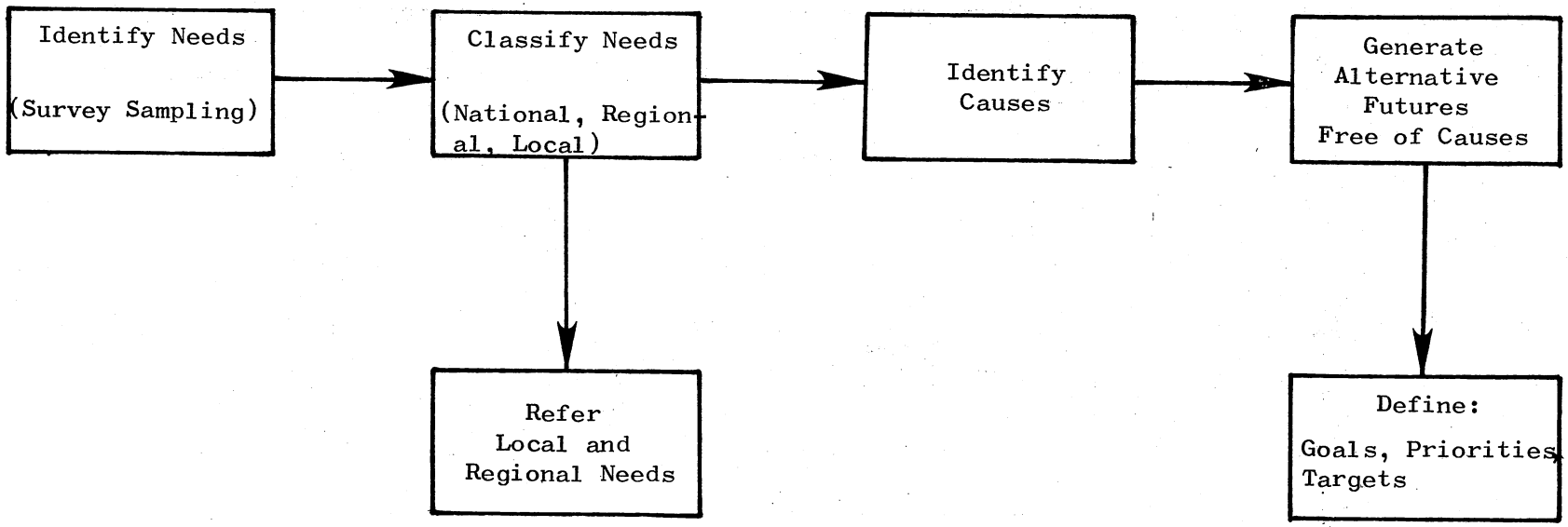


Figure 3.4. Goal Setting Phase

CHAPTER IV

PROJECT PREPARATION

Goal setting process should lead to the definition of a desired structure for the future. The project preparation phase should establish what kind of performance is required to realize the desired future structure. It should define the necessary actions as well as the resources, human and nonhuman, that should be expended in the process of development planning.

A goal or several goals may be achieved by one project. On the other hand it is possible to realize a project by alternative modes of action. In project preparation phase these alternatives should be explored and the best possible courses of action to achieve the goals determined. At this stage only technological feasibility in present or in the desired future should determine the boundary of possible courses of action. That is action which can be realized by either presently available technologies or potential future technological developments. In the next phase, project selection, resource (financial, manpower, etc.) constraints should be applied to assure maximum possible goal achievement with the available resources.

The project preparation phase has four stages:

1. Definition of the objectives and scope of the project.
2. Formulation of alternative courses of action for the achievement of the objectives.

3. Preliminary screening of the alternatives in terms of contribution to objective, cost and degree of feasibility.
4. Analysis of the remaining alternatives and preparation of information required for the selection phase.

This four-stage procedure is depicted in Figure 4.1. The diagram shows that a problem exists when the present levels are lower than the goal levels. The difference between the two constitutes the problem. Therefore there are two factors involved in definition of the objectives of a project. These factors are the present level of variables involved, and the desired future levels. In order to solve the problem (to achieve the goals) the causes of the difficulties should be found and eliminated. There are alternative solutions to each problem. The alternatives should be evaluated and screened in terms of contribution to development objectives of the country, cost and feasibility.

4.1 Project Objectives

The objectives of development planning as established in the previous chapter are so broad and many that no single project can deal with all of them. Many projects are required to achieve them. Each project should be formulated to contribute to one functional area such as transportation, education, etc. Of course contribution to other areas may happen as side effects of a project. However, each project should be prepared in relation to one functional area. Contributions to other objectives, if they occur, should be welcome; but not determine the course of the project.

The first step in definition of the objectives of a project is to determine to what functional goal it should contribute. Then the

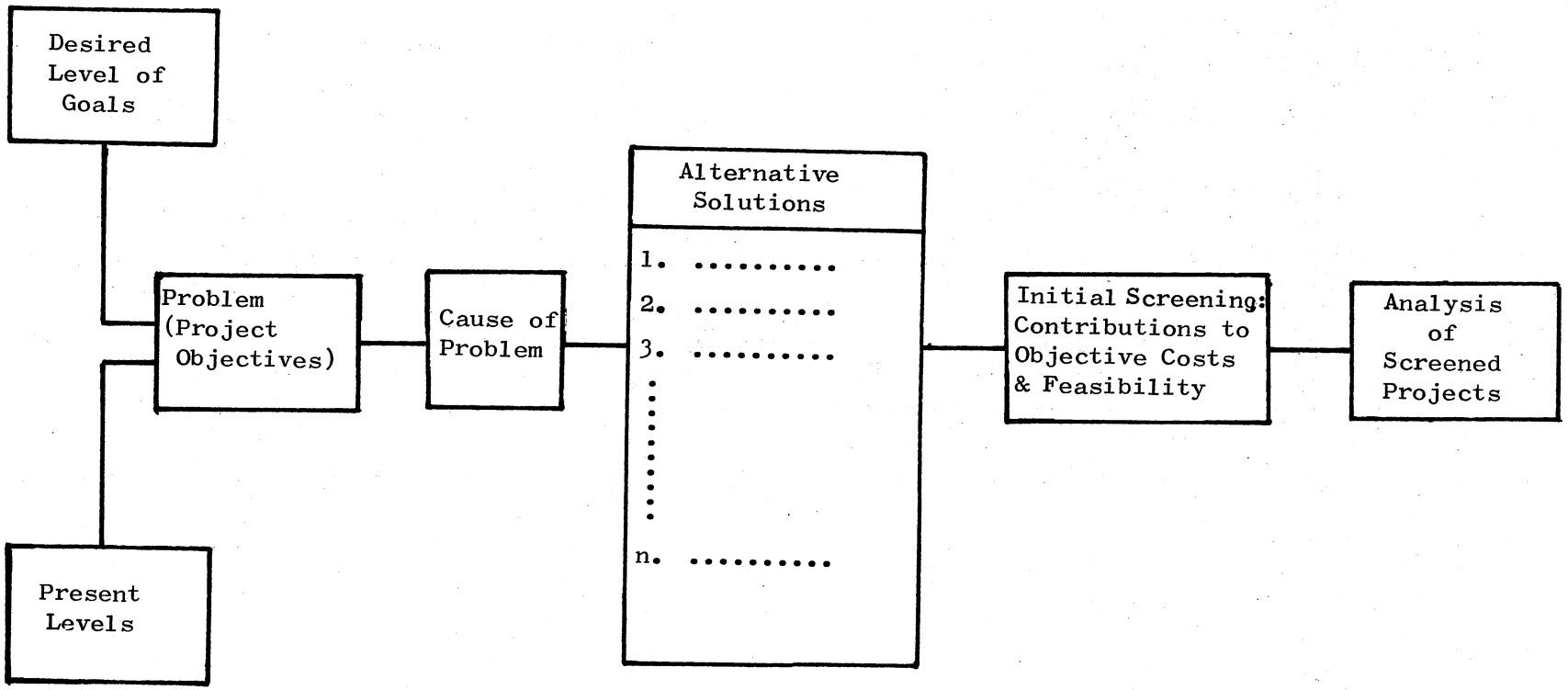


Figure 4.1. Stages of Project Formulation

specific contributions to be expected should be specified. For example the functional areas to be considered may be transportation, housing, health, education, food production, etc. Transportation may be further subdivided to urban transportation, cross country transportation, etc. It should be noted that classifications such as air, sea, and land or truck and train are not warranted here. These should be considered when alternative methods are being formulated. These latter classifications are alternative methods of doing the transportation function. They are not ends but means to other ends.

This process of defining the objectives first and then proceeding to formulate projects is of utmost importance. The traditional approach of looking for possible project and then finding out how the project may contribute to the objectives is not the proper approach. It corresponds to the opportunistic attitude discussed in the previous chapter. This opportunistic approach usually looks for easy solutions found in the immediate environment. It is essential that the starting point of project preparation be a statement of the objectives of the project in functional terms. Otherwise the intermediate means (products) may become ends in themselves. In such a case success is doubtful. As more than two decades of experience in development planning has not resulted in narrowing the development gap, the United Nations statistics covering 1960-1972 period are most discouraging. They indicate that the gap is becoming even larger in a majority of the developing countries [20, 21].

As an example this is a statement of objectives and justification for undertaking a project as given in a UNIDO recent publication [15, p. 11]:

> The government of a certain country is considering the idea that it should in the future mass produce small electric motors. To prepare for the timely mobilization and organization of the country's resources, it is necessary to consider all relevant political, environmental, economic and technical factors. An electric motor manufacturing facility known as the Motoric Manufacturing Company already exists.

The first sentence states the objective of the project to be prepared. However, this is not the proper method of stating the objective. Why should the small electric motors be produced? In the next section of the same publication this question is answered in this manner:

> The higher authorities in the government who have developed the idea that an electric motor factory should be built confirm the initial need for the project, analyze this need and state the requirements of the project.

The need for doing a project should be established by the planning system. The government constitutes a very important part of the planning environment. But the task of the government is not to dictate project ideas. The government should exercise its role by deciding on the amount of capital to be invested for the purposes of development planning. It should also exercise oversight necessary to make the planning system carry out its duties effectively. As a powerful element of the planning environment, the government influences the goal setting to a great extent. But it should not interfere with technical matters such as dictating project ideas. The government actions are mostly determined by the political environment. While project preparation is predominantly technical, the political consideration have their place in goal setting and project selection.

In the case of the electric motors the function or need for the service that electric motors are supposed to render should be stated as

the objective of a project. The mass production of electric motors might be one alternative of providing the function or service.

Therefore, the objectives of a project should be stated in terms of expected contribution to one functional area. Any product (electric motors, cars, milk, wheat, telephones, etc.) is sought for its utility to satisfy some human needs. These products are means. They should not become ends in themselves. Raising the GNP is not an end. It is a means to raise the standard of living of the nation.

At the project preparation phase the goals established by the goal setting phase should be analyzed in light of the functional approach. Then projects formulated to produce products or services that are means of satisfying some needs of the people. In this manner mere feasibilities and easy found opportunities will not dictate what should be done, and opportunistic surveillance would be applied where it belongs; in search for alternatives.

In a country which is a major oil producer and exporter it is hardly possible to imagine another oil related industry will be of much help, when the country is importing billions of dollars worth of products and services. If there are any priorities they should be to substitute the huge imports where the competition can be easily thrown out of the market by suitable actions such as tariffs, quotas, etc. If the functional approach based on the needs of the country had been used the valuable resources expended would have been used in more useful endeavors.

Therefore it is the task of the project preparation phase to translate functional goals into specific objectives for different projects, then find what products or services will contribute to the

goals and formulate alternative methods of securing those products or services.

4.2 Alternatives

Any goal or sets of goals stated as the objectives of a project can be attained in a variety of ways. This is the place where all possible opportunities which may lead to the achievement of the stated objectives should be sought. At this stage exploratory forecasting and opportunistic surveillance should be used efficiently. At the goal setting phase normative thinking prevailed, i.e., the objective was to find out what ought to be done. The needs in their present and future context formed the basis of action. At the alternative generation stage exploratory forecasting and opportunities should lead the way.

The objective of this stage is to explore the opportunities, present and future, that will help to attain the normative forecasts as closely as possible. All possible answers should be considered. Both present and future technologies should be explored for possible solutions.

A systematic procedure is required for proper accomplishment of such a job. Such a procedure will consists of these steps:

1. Gathering all the relevant facts about the objectives of the project.
2. Deciding whether the objectives of the project can be achieved by provision of some products or services or both.
3. Searching for suitable technologies.
4. Formulating alternative plans.

5. Classifying the inputs and outputs of each alternative.

6. Establishing relevance of outputs to some goal area.

4.2.1 Gathering the Facts

There are many ways of obtaining the data that make up the facts and the data that indicate the facts are true. Some of these are:

1. Some facts can be obtained from the personal knowledge of the individuals who are looking for alternative solutions. In this case one lists the facts as he knows them. This is a good starting point.

2. Other facts can be found from other sources. In the majority of cases the needed data has been collected by some agencies. Among such sources are:

   -- Various United Nations' statistical books and other publications. For examples see [20, 21, 22, 23].

   -- The reports of the Central Bank of the Country.

   -- The reports of the World Bank and other international organizations.

   -- Any other sources that may be at the disposal of the project formulators.

3. Another method of gathering data is to ask from the people who are knowledgeable about the subject under study. This could be done in a variety of ways:

   -- Face to face interviews.

   -- Telephone interviews.

   -- Mail questionnaires.

For details of these methods see [16, 17, 18].

In whatever manner the facts are obtained, they will not be any good unless proper inferences are drawn from them. To infer properly, the facts should be classified into major categories. This makes analysis easier. After categorizing their relevance to the objectives of the project should be established. In this process utmost effort should be spent to quantify the information. Wherever quantification is not possible the information should be used qualitatively. Statistical analysis should be applied as much as possible in analysis of and inference from data. Statistical techniques should be also used in data collection.

A most important consideration here is gathering the relevant facts only. An abundance of data, particularly when irrelevant, is harmful. It makes analysis difficult and correct inferences become hardly possible. Statistical techniques should be used to determine the amount of data necessary for proper inference and to establish correlations.

4.2.2 Nature of Objectives

The objective of any project is to provide means for provision of either some products or services or both. Projects in health, education, communications, etc., are aimed at providing services. Although some products and buildings are required to provide the medium for the services sought. Therefore at first any project objective can be classified as to whether it should provide a product or a service. Then it should be decided whether the product or service will be used by the general public or by some other organization as its input to produce other goods or services. For example, steel manufactured by a

steel mill is not usually used by the public. It is used to make equipment or building or appliances to be used by the public. Another useful classification is to decide whether the product or service is being used presently or it is intended to add to the present consumption. If it is being used presently, it should be established whether it is produced locally or it is being imported or it is intended for export totally or partially. This kind of classification is helpful for evaluation purposes, avoiding duplicating and decision on technology.

4.2.3 Searching for Technology

"Technology is the instrument which enabled man to depart from purely biological evolution and to enter a psycho-social phase of evolution which he shares with no other creature of nature" [19, p. 27]. Technology, as defined by Ayres [12, p. 46], "... is the systematic application of organized knowledge to practical activities, especially productive ones."

In planning terminology, technology is a means for realization of planned change. Technology is used to engineer the environment in order to produce the intended changes. In this respect engineering can be applied on four elements of the environment: nature, society, man, and technology itself. So the intended changes can be accomplished through four kinds of engineering, i.e., Nature Engineering, Social Engineering, Human Engineering, and Technology Engineering [19, p. 27]. Figure 4.2 shows how these forms of engineering are related through technology engineering. That is, technology provides the interface of all and is the means used by all.

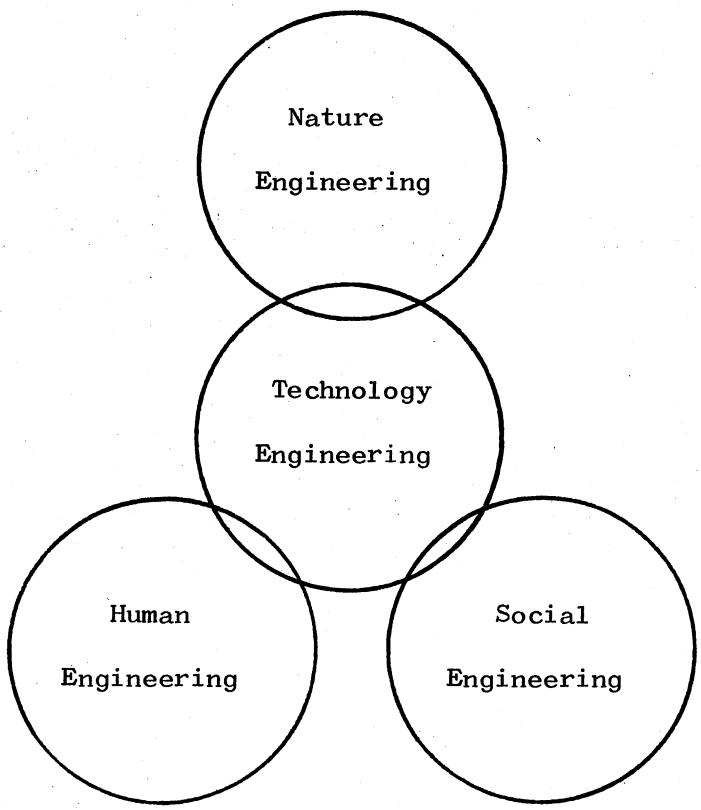


Figure 4.2. The Interaction of Different Forms of Engineering

Source: Jantsch, E. Technological Planning and Social Futures. New York: John Wiley and Sons, 1972, p. 28.

It is usual that the four forms of engineering be applied autonomously and develop independent of each other. This endangers stability [19, p. 28] and causes the problems which Ozbekhan calls continuous critical problems (see Table 3.). In order to avoid such complications the systems approach should be used. This means that the four forms should be considered simultaneously and their development should be consistent. Jantsch [29] calls this Echological Engineering. Others prefer calling it Systems Engineering.

The distinguishing characteristic of the autonomous development of each form of engineering is independent growth of technology engineering and its dominant role. On the other hand, systems engineering will set to bring about a balanced growth in all aspects. This implies that in selection of technology, prompt and sufficient attention must be paid to the effects of technology on all subsystems and the changes to be designed where they produce maximum intended change and minimum unintended side effects.

In the present case, search of technology for development projects, these considerations should be given utmost attention in order to avoid the dysfunctional consequences of development. When the present developed countries were developing systems engineering concepts were not developed yet. Therefore one cannot blame them for not using them. But in the case of developing countries which are planning development now, such mistakes cannot be overlooked. The knowledge is there, it must be used.

At any given point in time two types of technologies should be considered: those available commercially and those that are being developed or may be developed in future. Information about present

technologies can be found from patents, libraries, corporations, technical journals, etc. Information about future technologies can be obtained through search and technological forecasting. For techniques of such forecasting see [8, 11, 12, 19]. A summary of applicable methods are given in Tables 4.1 and 4.2. Table 4.1 lists the applicable techniques for different problems. Table 4.2 displays some actual utilization of the techniques by government and industry in the United States.

4.2.4 Alternative Projects

When specifying a project the following should be defined:

1. Project Outputs
2. Project Inputs
3. Process (Technology)

1. Project Outputs. The project outputs should be listed in terms of contribution to objectives. The unintended results should be listed, too. These may be desirable or undesirable such as pollution, noise, etc. In the project evaluation phase some projects may be discarded if their undesirable outputs exceed a specified level. Another specification of output may be in terms of whether the product or service is being used at present or not. If yes, is it produced locally or is it imported? Or is it intended for export in which case the markets and their characteristics should be mentioned as well. Figure 4.3 provides a tabular form for output classification.

2. Project Inputs. All the required inputs, human and non-human, should be identified, quantified and tabulated as in Figure 4.4.

TABLE 4.1

QUESTIONS AND APPLICABLE TECHNIQUES

Question	Applicable Technique	State of the Art
1. Scientific breakthroughs.	?	
2. Technological breakthroughs.	Trend (envelope curve) extrapolation?	Uncertain
	Morphological research.	Useful, partly proved.
	Relevance tree.	Feasible.
3. Areas of fundamental research and exploratory development to be favoured.	Trend (envelope curve) evaluation.	Proven, but limited.
	Contextual mapping.	Feasible.
	Morphological research.	Very useful, partly proved.
	Economic analysis.	
	Horizontal decision matrix.	
	Vettical decision matrix.	Useful within limits.
	Simple operations research.	
	Simple decision theory.	
	Relevance tree.	Very useful, proved.
	Normative operational models.	Uncertain.
	Systems analysis.	Potentially very useful, proved.
4. Nature of technological innovation.	Brainstorming.	Doubtful.
	"Delphi" technique.	Useful within limits.
	Morphological research.	Very useful, proved.
5. Technological performance (technical parameters, functional capability, etc.).	Trend extrapolation (analytical).	Unsatisfactory.
	Trend extrapolation (phenomenological).	Useful, proved.
	Contextual mapping.	Feasible.
	Morphological research.	Useful in combination with trend extrapolation, etc.
	Systems analysis.	Feasible?
6. Development time.	"Delphi" technique.	Tested, some doubts.
	Trend extrapolation (analytical).	Unsatisfactory.
	Trend extrapolation (phenomenological).	Useful, proved.
	Learning curves.	Tested, needs much further evidence.
	Network techniques.	Feasible.

TABLE 4.1 (Continued)

Question	Applicable Technique	State of the Art
7. Development costs.	Learning curves.	Unproved.
	Network techniques.	Feasible?
8. Return on investment.	Economic analysis.	Very useful, especially discounted cash flow.
9. Production costs.	Learning curves.	Tested, needs much further evidence.
10. Maintenance costs.	?	
11. Horizontal impact (especially market impact).	Economic analysis.	Useful in combination with other techniques.
	Operational models (gaming).	Promising, unproved.
	Operational models (rigid models).	Useful, proved for established business areas, unproved for general technological acceptance.
	Systems analysis.	Useful, proved.
12. Vertical impact.	Scenario-writing.	Promising, being tested.
	Iteration through synopsis.	Useful, partly tested.
	Historical analogy.	Uncertain, partly tested.
	Operational models (gaming).	Very promising, being tested.
	Operational models (rigid models).	Promising, unproved.
	Systems analysis.	Useful, proved.
13. Lower level goals (tasks, missions, etc.)	Brainstorming.	Doubtful.
	"Delphi" technique.	Useful within limits.
	Scenario-writing.	Feasible.
	Horizontal decision matrix.	Useful, partly proved.
	Vertical decision matrix.	Useful, being tested.
	Rel vance tree.	Very useful, proved.
	Systems analysis.	Potentially very useful, partly proved.

TABLE 4.1 (Continued)

Question	Applicable Technique	State of the Art
14. High level goals (national, social, etc.)	Brainstorming.	Very doubtful.
	"Delphi" technique.	Very promising, partly tested.
	Utopia, science fiction.	Potentially partly useful, unproved.
	Scenario-writing.	Useful, proved.
	Operational models (gaming).	Potentially useful.
	Operational models (rigid models).	Potentially useful in auxiliary function.

Source: Jantsch, Erick. Technological Forecasting in Perspective. Paris: OECD, 1967, pp. 125-126.

TABLE 4.2

UTILIZATION OF TECHNIQUES

Type of Technique	Utilization
A. Technological Development Environments	
Brainstorming.....	More or less out of date in the U.S., still found useful in a few European companies and in NATO in a version which includes systematic preparation.
"Delphi" technique.....	Tests planned by TRW Systems (U.S.).
Trend extrapolation on phenomenological basis.....	Extensive use, including refined S-curve and envelope curve extrapolation, in military environments in both the U.S. and Europe, in industry mainly in the U.S., most systematic use is for the preparation of input information to PATTERN scheme (Honeywell), necessitating hundreds and thousands of individual evaluations.
Contextual mapping.....	Limited application in a few places, growing importance.
Morphological research.....	According to its author, 30 industrial applications already, the most thorough application being to jet propulsion systems at Aerojet; also applied to basic astronomy.
Scenario-writing.....	Applications only where higher-level goals are to be explored, for example at Honeywell for the preparation of their PATTERN scheme, and at the big oil companies, in Europe as well as in the U.S.
Iteration through synopsis...	Systematic application by Unilever (Brech) in the United Kingdom. Less systematic applications apparently numerous, including the big oil companies in Europe.

TABLE 4.2 (Continued)

Type of Technique	Utilization
Economic analysis.....	Practically all companies with large research and development programes. Discounted cash flow methods are used by approximately 20 to 25 per cent of the companies visited and are generally applied to well-defined projects in the advanced development stage. The Swedish Wallenberg group (ASEA, Ericsson, etc.) applies it rigorously for project selection. Ranking procedures based on refinements of DCF are used in several places, for example SCAIR in GEC (United Kingdom).
Exploratory operational models--gaming.....	Possibly occasional application of business games; under consideration by Canadian Paper and Pulp Research Institute, growing general interest.
Exploratory operational models--rigid computer models.....	Integrated business models are also used for forecasting (Xerox Corp., U.S.) but are very rare; ad-hoc models are used occasionally; applications in the military technological area (?).
Horizontal decision matrices.	Wide use, especially research/resources matrices; some rigorous application for decision-making (Boeing).
Vertical decision matrices...	Some applications, especially of the research development programe type; ambitious three-dimensional matrix to link space developments to social end-uses applied by North American Aviation.
Simple decision techniques based on an operations research approach.....	In spite of the interest of professional operations research people, only few applications so far; generally combined with economic analysis (maximization of total expected net value); possibly a "growth field."

TABLE 4.2 (Continued)

Type of Technique	Utilization
Simple decision techniques based on a decision theory approach.....	Numerous applications of check lists with and without rating, but apparently decreasing in number, some numerical formulae in military environments for ranking (France) or partial problems (US Navy), few in industry.
Integrated multi-level relevance tree schemes.....	Six known applications of PATTERN (Honeywell, military/space and medical, NASA, US Air Force); at least three applications of other techniques (including NASA); under development at the Battelle Memorial Institute; under consideration by US Navy; arousing great interest--enthusiasm as well as scepticism--and the wish to design similar techniques in a simpler way so as to reduce the substantial effort involving setting them up; operations of a "pioneering" character possibly giving rise to applications in wider technological and governmental decision-making areas.
Network techniques.....	Application, for example, by General Electric Atomic Power Dept., under consideration at the Battelle Memorial Institute.
Normative operational models --rigid computer models....	A few applications for new consumer products (BBDO's "Demon" and the 3M Company's "New Products" models in the US); a model in preparation for use by the US Air Force; the Battelle Memorial Institute is considering applications.
Systems analysis.....	Pioneered and applied to tasks involving technological forecasting by the RAND Corp., System Development Corp., and General Electric's TEMPO; also in industrial environments such as General Electric Atomic Power Dept. or North

TABLE 4.2 (Continued)

Type of Technique	Utilization
	American Aviation; can probably be applied usefully only where sophisticated management environments exist.
B. The Aggregated Level	
"Delphi" technique.....	Application to population forecast tested (doubtful).
Exploratory aggregated level techniques.....	Applications of statistical models (Battelle Memorial Institute, CECA) input/output analysis (Quantum Science Corporation, RAND/US Air Force, attempted for US economy by Harvard Economic Project), chains of industries (France's BIPE), horizontal diffusion models on empirical basis; forecasts of energy consumption, number of telephone subscribers and telephone traffic are beginning to incorporate technological change in the models used.
Horizontal decision matrices.	French national research/research matrix, in experimental stage.
Vertical decision matrices...	French national research/industry matrix, being tested.
C. Environments of "Social Technology"	
"Delphi" technique.....	First tests have been made (RAND Corporation), others in progress (US Air Force), great interest aroused.
Contextual mapping.....	Being considered for application.
Morphological research.....	According to its author, applications are being considered for city planning and education.

TABLE 4.2 (Continued)

Type of Technique	Utilization
Scenario-writing.....	Pioneered by the RAND Corporation, System Development Corporation, and Particularly the Hudson Institute (Kahn, Brennan); applied to the "Year 2000 Program" of the American Academy of Arts and Sciences and other broad programs with a socio-economico-political context.
Historical analogy.....	Systematic testing by the American Academy of Arts and Sciences ("The Railroad and the Space Program"); large scale use doubtful.
Exploratory operational models--gaming.....	Considered as an important rool by all leaders in "social technology," but apparently not yet applied to problems involving technological forecasting.
Exploratory operational models--rigid computer models.....	Proposed by Abt Associated to OECD, considered important by leaders in the field, but apparently not yet applied.
Normative operational models--gaming.....	Gordon and Helmer's "Game of the Future," being tested in 1966.
Systems analysis.....	Applications by the RAND Corp. (cities and vehicles of the future, etc.), System Development Corp. (education, etc.), General Electric's TEMPO (cities of the future).
Feedback models.....	Development phase, pioneered by System Development Corporation (US).

Source: Jantsch, Erick. Technological Forecasting in Perspective. Paris: OECD, 1967, pp. 128-130.

PROJECT: (Project Name and Alternative Number)

Output Description	OUTPUT CLASSIFICATION							
	Desirable	Undesirable	Present Consumption		Addition to Present Consumption	To Be Imported	To Be Exported	Others
			Local Production	Imports				
Output 1								
Output 2								
.								
.								
.								
.								
.								
.								
.								
.								
.								
.								
Output n								

Figure 4.3. Output Specification

PROJECT: (Project Name and Alternative Number)

Input Description	INPUTS				
	Human			Non-Human	
	Unskilled (Source)	Skilled		Available (Source, Price)	Import (Source, Price)
		Available (Source)	To Be Trained (How)		
Input 1					
Input 2					
Input 3					
.					
.					
.					
.					
.					
.					
.					
.					
.					
Input n					

Figure 4.4. Input Specification

It should be established if the inputs are available or not? If not, how would they be secured? All sources, local and import, prices, foreign exchange requirements, etc., should be identified and recorded. This will help to focus attention where deficiencies exist. For example, when the number of skilled persons and their type of skills are determined, then you will try to find out whether they can be hired or should be trained. Then at the completion of the project you have all the required inputs and do not run into trouble. It should be remembered that the underutilization of human resources is the most important strategic factor of under-development and its cause is inadequate education and training.

3. Process. A suitable technology should be found and specified for each input-output combination. Maybe there exists several technologies for the same input-output combination. In this case the input-output combination and each technology should be listed as separate options of same alternative. The inputs requirements are mainly determined by the technology.

The technologies requiring inputs available in the country should be given preference to those which their inputs should be imported. However, this should not be the prime consideration. The choice of technology should be based on the overall efficiency, i.e., cost effectiveness coupled with maximum goal achievement and minimal harmful side effects. The skill requirements are, also, a major

consideration. As a rule, all other things equal, the technology with lower skill requirements should be preferred.

4.3 Preliminary Evaluation

Any evaluation should be with respect to some criteria. The criteria to be used here are contribution to development objectives, cost, and feasibility, i.e., will it really work at a reasonable cost with reasonable contributions to development objectives? The matrix in Figure 4.5 may be used to facilitate this process. The headings in this figure are tentative. Others may be used as required by particular applications. After all the formulated alternatives of a project are listed those that are obviously inferior should be eliminated. Inferiority can be established on several bases:

1. A cost effectiveness measure may be used to eliminate those alternatives that do not meet the measure.
2. A harmful side effect measure may be used to eliminate some alternatives, too.
3. Those alternatives that all their contributions are lower and their cost and harmful side effects are higher than some other alternatives should be eliminated.
4. Other considerations that may be applicable for the particular project on hand.

The remaining alternatives should be subjected to further analysis. In the selection phase these different alternatives of same project should be treated as mutually exclusive cases, i.e., one and only one of them may be selected.

PROJECT: (Project Name)

Alternatives	Contribution to Objectives								Cost		Feasi-bility	Location
	Food	Housing	Health	Educa-tion	Trans-porta-tion	GNP	Exports		Foreign Ex-change	Local Cur-rency		
1												
2												
3												
.												
.												
.												
.												
.												
.												
.												
.												
.												
.												
n												

Figure 4.5. Listing Project Alternatives

4.4 Further Analysis

After the alternatives were screened and the weak ones eliminated, the remaining should be subjected to more vigorous analysis. Estimates of cost and contributions should be reviewed and further refined. Among the estimates that should be prepared for the selection phase are:

1. Contributions to development objectives.
2. Total cost.
3. Foreign exchange requirements.
4. Personnel requirements when operational.
5. A breakdown of personnel requirements according to skill and education.
6. How the required personnel should be secured.
7. Other benefits than contribution to objectives.
8. Dysfunctional consequences by type and level.

Input-output analysis, cost-effectiveness studies, economic analysis, cost-benefit analysis simulation, and gaming are some of the techniques that can be used at this stage. More alternatives may be eliminated as a result of this more detailed analysis.

When the project preparation phase is completed, different alternatives for each and every one of the development goals should be on hand. Alternatives for each project should be succinctly defined. Required estimates for each alternative should be tabulated as in Figure 4.5, so that the next phase, project selection, could be done easily and fruitfully.

It should be remembered that the selection phase will be successful if and only if the prepared projects in this phase are relevant and

efficient. If you select the best set of some fair or poor projects, you will end up with a fair or poor set. You will have a best set when the selection is from a larger choice of good projects. Good projects can be formulated if a systematic approach starting with clear and relevant objectives is used. At all stages maximum contribution to objectives, efficiency (minimum use of scarce resources) and minimum harmful side effects should be the leading principles of project formulation. This could be achieved with systems engineering or as Jantsch calls it, ecological engineering.

CHAPTER V

EVALUATION AND SELECTION

The purpose of project evaluation and selection is to assure effective and efficient use of available resources. A project is effective if the intended objectives are achieved to a satisfactory degree. A project is efficient when the desirable outputs of the project are obtained with minimal undesirable side effects and reasonable expenditure of scarce resources. The evaluation process should determine the soundness of each alternative in relation to some predetermined criteria. The selection process should result in selection of a set of projects which will attain the goal targets as closely as possible under resource and other prevailing constraints.

Therefore we are confronted with a two stage process:

1. Individual alternatives are evaluated to establish that they satisfy some minimum standards of effectiveness and efficiency.
2. At any particular time the resources available are short of meeting all the requirements. Therefore a set of projects should be selected for implementation from the alternatives that have passed the test of stage 1. The two stages will be dealt with in detail in the following sections of this chapter.

5.1 Evaluation of Alternatives

The basic criterion used by the private enterprise to evaluate alternatives is commercial profitability which is measured by determination of return on investment. This could be done by calculation of the internal rate of return (IRR) of the cash flow resulting from the project or computing the present value of the cash flow at a predetermined minimum attractive rate of return (MARR).

The first step in such a procedure is to find the cash flow due to the project in each year of its life. Determination of such a cash flow requires a knowledge about both receipts and disbursements due to the project. In private enterprise definition and determination of these flows is supposed to be easy, because up to now only tangible economic benefits and losses determined the bases of the required measurements and computations. The other effects being either totally neglected or considered as intangibles at the time of decision. But these intangibles in the greatest majority of cases do not have any substantial influence on investment decisions. All this was from the simplistic assumption of 'economic man' which postulates that human beings undertake different ventures in order to make economic gains. This postulate forms the basis of commercial profitability which is to maximize profit or wealth. However, this notion of man has been and is being strongly challenged by organization, system, and human behavior theories. It can be claimed that this notion of man has no place in contemporary scientific thinking. Man is a multi-purpose, versatile being. His behavior is based on social, psychological as well as economical forces.

Even if such a simplistic assumption about nature of man could be accepted, it would not be appropriate to extend it to national levels. But such an extension in the name of national economic profitability is quite common. Although its proponents introduce some new concepts into it (which are mainly in how to measure and price inputs and outputs), in the final analysis it boils down to the same kind of analysis and perhaps same conclusions as well.

Although the above line of reasoning implies that this method should be discarded, in reality it is a good starting point. If the proposed measurements and conversions could be done it would be a good measure too. The measurement and pricing problems associated with them have been dealt with in detail elsewhere [6]. Therefore we will start with a brief description of national economic profitability and then proceed to other methods rather than dealing with measurement and price problems.

5.1.1 National Economic Profitability

Two approaches are possible:

1. Measuring all inputs and outputs and pricing them so that a common monetary medium could be used for calculations and maximize monetary gains so obtained.
2. Use one of the objectives as the unit of account and convert all other benefits and costs to it and price this unit of account and maximize the benefits so calculated.

Direct Pricing. If the alternative produces K_1 outputs each in amount of X_{rt} in year t and the price of each is P_{rt} in the same year then the cash inflow in year t $(CIF)_t$ is

$$(CIF)_t = \sum_{r=1}^{K_1} P_{rt} X_{rt} \tag{5-1}$$

Similarly if there are K_2 outputs, each in amount and price X_{jt} and P_{jt} in year t, then cash outflow $(COF)_t$ is

$$(COF)_t = \sum_{j=1}^{K_1} P_{jt} X_{jt} \tag{5-2}$$

The net cash flow, $(NCF)_t$ is

$$(NCF)_t = \sum_{r=1}^{K_1} P_{rt} X_{rt} = \sum_{j=1}^{K_2} P_{jt} X_{jt} \tag{5-3}$$

Considering that inflows and outflows differ in sign only we can write

$$(NCF)_t = \sum_{j=1}^{K} P_{jt} X_{jt} \tag{5-4}$$

where $K = K_1 + K_2$ and inputs are negative in sign, outputs positive.

If the project life is n years then the cash flow of each year should be converted to an equivalent amount based on intertemporal preferences. This requires a discount rate or calculation of a rate of return.

If a discount rate i, such as MARR, is given then the net present value of the cash flow at i, NPV(i) can be found from (5-5).

$$NPV(i) = \sum_{t=0}^{n} \frac{(NCF)_t}{(1+i_t)^t} \tag{5-5}$$

The rate of return, i*, can be found by equating the present value equal to zero, i.e.,

$$NPV(i^*) = \sum_{t=0}^{n} \frac{(NCF)_t}{(1+i^*)^t} = 0 \qquad (5\text{-}6)$$

In case of present value, if

$$NPV(i) > 0$$

the alternative is acceptable. If

$$NP(i) < 0$$

the alternative is not acceptable. In case of rate of return, if

$$i^* > MARR$$

the alternative is acceptable. If

$$i^* < MARR$$

the alternative is not acceptable.

When NPV(i) = 0, or i* = MARR the alternative is marginal and the decision could go either way based on other considerations.

<u>Conversion to A Unit of Account</u>. This approach requires the selection of one of the objectives as unit of account and converting others to it by applying suitable weights. If the net contribution of the project to this unit of account is B and its net contributions to other objectives are B_1, B_2, ..., B_n and each unit of B_i is equivalent to w_i units of B then in year t,

$$B_t = \sum_{i=1}^{n} w_{it} B_{it} \qquad (5\text{-}7)$$

If P_t is the price of B_t, then

$$(NCF)_t = P_t B_t \tag{5-8}$$

and

$$NPV(i) = \sum_{t=0}^{n} \frac{P_t B_t}{(1+i_t)^t} \tag{5-9}$$

This approach makes the pricing problem easier. But the difficulty is shifted to the determination of w_i's. A method which partially avoids this problem is to assume that the outputs of a project are needed and must be produced. Therefore the best way to produce them should be employed. In this case the evaluation of the project is done in relation to costs only. The attempt is to produce the outputs at minimum possible cost. This method seems to be more appropriate for evaluation of development projects. The whole business of development programming is undertaken to alleviate the development needs of the nation. Thus assuming that the outputs are required is not far from reality.

5.1.2 Minimum Revenue Requirements

There are two assumptions related to this method:

1. The output of the project is needed by the public, i.e., it should be produced.
2. The outputs cannot be sold at market prices. The prices are regulated and only moderate profits are permitted.

Having these in mind the project evaluation should compute the minimum revenue that will meet all the cost incurred due to the project. In other words, what is the total cost of producing and supplying the

outputs to the public. The lower this cost the better the alternative. This method is used by regulated public service companies in the United States.

Calculation Procedure. The following are the general elements that constitute the cost of a project [25]:

1. Capital recovery (book depreciation), D_b.
2. Interest paid on loan portion of investment, I_d.
3. Return on equity portion of investment, I_e.
4. Taxes, t.
5. Costs, C.

   Including:

   -- Operating and Maintenance costs, C_{OM}

   -- Renewal and Replacement costs, C_R

   -- Insurance costs, C_I

   -- Other expenses due to project, C_O

In any year, x, the minimum revenue, R_x, required to offset all these, the sum of all, is:

$$R_x = D_{bx} + I_{dx} + I_{ex} + t_x + C_x \qquad (5\text{-}10)$$

The minimum revenue requirement calculated in this manner for each year allows one to see both the short term and long term effects on an alternative.

Except for the taxes other calculations involved are rather easy. Tax considerations, depending on the tax structure of the country, make the calculations quite involved. After presentation of a general procedure these points will be cleared by an example showing two procedures:

1. No taxes at all.

2. Taxes include income tax, investment tax credit, and property taxes.

Another complicating factor is the depreciation models used for book and tax purposes. If these two are different, i.e., accelerated depreciation for tax purposes, then the method of treating the differed taxes should be specified in advance. One other point in relation to taxes is that whether investment tax credit should be treated.

The following are the steps required to calculate annual minimum revenue requirement:

Step 1. Determine:

1. The initial installed cost of the project, P.

2. The average life of the project, n.

3. The salvage value of the project, S.

Step 2. Determine the capitalized interest rate, K.

$$K = \frac{\text{(allowable interest rate)(construction period in month)}}{(2)(12)}$$

Step 3. Find the capitalized initial installed cost of the project, I.

$$I = P + KP$$

$$I = P(1 + K) \qquad (5\text{-}11)$$

NOTE. This is required to take into account the interest on the initial investment, P, during the construction period.

Step 4. Generate depreciation schedules for book and tax depreciation purposes.

Step 5. Compute the differed taxes, d_t, for each year, x.

$$d_{tx} = T_x(D_{tx} - D_{Sx}) \qquad (5\text{-}12)$$

where

D_{tx} = Depreciation for tax purposes in year x.

D_{Sx} = Straight line depreciation for tax purposes in year x.

T_x = Income tax rate in year x.

This is done to spread the tax advantages of accelerated depreciation over the life of the project.

Step 6. Calculate the investment tax credit, I_{tc}. If investment tax credit is i_{tc}, then:

$$I_{tc} = i_{tc}P \tag{5-13}$$

Step 7. Compute property taxes, t_p, and

$$t_p = \text{(property tax rate)(initial cost)}$$

$$t_p = T_p I \tag{5-14}$$

NOTE: The property taxes occur each year starting year 2 or after the project is completed.

Step 8. Estimate costs for each year.

Step 9. Calculate the investment chargeable to the project in year x.

$$CI_x = CI_{x-1} - D_{bx} - I_{tc} - dt_x + A_t - KP \tag{5-15}$$

where

$$A_t = \frac{I_{tc}}{n} \tag{5-16}$$

is the amortized amount of investment tax credit per year. This is required where it is desired to spread the tax credit over the entire life of the project rather than when it occurs, i.e., after completion of the project.

$$CI_o = \text{initial capitalized cost}$$

$$CI_o = I = P(1 + K)$$

Step 10. Calculate debt interest, I_d.

$$I_{dx} = c(CI_{x-1})\ id \tag{5-17}$$

where

id = debt rate of interest

c = debt ratio

Step 11. Calculate return on equity, I_e.

$$I_{ex} = (1 - c)(CI_{x-1})ie \tag{5-18}$$

where ie = required return on equity.

Step 12. Calculate after tax taxable income, G_x.

$$G_x = I_{ex} + D_{bx} + dtx + I_{tc_x} - A_{tx} - D_{tx} - KP_x \tag{5-19}$$

Step 13. Find the income tax in year x.

$$t_x = G_x \left(\frac{T}{1-T}\right) - \frac{I_{tcx}}{1 - T} \tag{5-20}$$

Step 14. Find R_x.

$$R_x = D_{bx} + I_{dx} + I_{ex} + (dtx + I_{tcx} - A_{tx} + tp + tx) + C \tag{5-21}$$

The elements within the parentheses are due to tax effects.

Step 15. Calculate PV_x, the present value of R_x.

$$PV_x = \frac{R_x}{(1 + i)^x} \tag{5-22}$$

where i is the average cost of capital.

$$i = c(id) + (1 - c)ie \tag{5-23}$$

or in terms of interest factors

$$PV_x = R_x \, (^{P/F}\ i;x) \tag{5-24}$$

Step 16. Calculate equivalent revenue requirements until year K.

$$E_K = \left(\sum_{x=1}^{K} PV_x \right) (^{A/P}\ i;K) \tag{5-25}$$

If $K = n$, E_n is the annual equivalent revenue requirement over the life of the project.

EXAMPLE. A power distribution system is to be provided for distribution of electrical power to a rural area in a developing nation. The data for one alternative of doing the job are:

First cost	$5,000,000
Average life of project	28 years
Salvage value	10% of first cost
Debt ratio	40%
Debt interest rate	9%
Required return on equity	14%
Book depreciation model	Straight line
Tax depreciation model	Sum of year digits
Income tax rate	30%
Investment tax credit	10%
Property taxes	.1%

It is required to find the minimum revenue requirement (or total cost) of this project under the following conditions:

(a) no tax considerations,
(b) full tax considerations.

(a) No Taxes.

Step 1.

$$P = \$5,000,000$$

$$n = 28$$

$$S = .1(5,000,000) = \$500,000$$

Step 2. Assuming an allowable interest rate of 8% and a construction period of 6 months

$$K = \frac{8 \times 6}{24} = 2\%$$

Step 3.

$$I = 5,000,000\ (1 + .02) = 5,100,000$$

Step 4.

$$D_b = \frac{5,100,000 - .1(5,100,000)}{28} = 163,928 \text{ per year}$$

Steps 5, 6, and 7 not applicable.

Step 8. Costs:

-- Operation and maintenance costs can be estimated as a percentage of the first cost. For example assuming 3% of initial cost

$$C_{OM} = .03(5,100,000) = 153,000 \text{ per year}$$

It is also possible to assume that these costs increase over the years. For this example they are assumed constant. This assumption is reasonable since we include renewal and replacement costs separately.

-- Renewal and replacement costs are most difficult to estimate. They account for difference in lives of various components. One method of estimating these costs is from expression (5-26).

$$C_r = (BVI_o - \text{salvage}) \times A \times B \qquad (5\text{-}26)$$

where,

A = annuity depreciation with dispersion.
B = annuity depreciation without dispersion.

$$B = \frac{i}{(1 + i)^n - 1} = (^{A/F}\ i,n) \qquad (5\text{-}27)$$

and i is the weighted average of debt and equity rates. In our case

$$i = .4(9\%) + (1 - .6)(14\%) = 12\%$$

$$B = (^{A/F}\ 12\ 30) = .00524$$

Calculation of A is more involved. It requires a knowledge of the estimated life of various components. The following expression can be used to calculate A.

$$A = \frac{1}{\sum_{i=1}^{m} M_j\ (^{P/F}\ i,j)} - i \qquad (5\text{-}28)$$

where,

M_j = proportion (percentage) of mean survivors at the end of year j.

m = year when mean survivors is less than a percentage, e.g., 1%.

The values of M_j's can be found from survivors curves. These curves give the percentage of mean survivors as a function of life. Figure 5.1 shows an example of such curves. For this example the value of A is found to be

$$A = .0106$$

Sample calculations for finding this value are shown in Table 5.1. So

$$C_r = (5,100,000 - 51,000)(.0106 - .00524) = 24,600 \text{ per year}$$

-- Insurance costs can be estimated as a percentage of first cost, e.g., 1%.

$$CI = .001(5,100,000) = 5,100 \text{ per year}$$

-- Other costs depend on the particular situation. They are assumed to be zero here.

Therefore the total annual cost

$$C = 153,000 + 24,600 + 5,100 = \$182,700$$

Step 9.

$$CI_0 = 5,100,000$$

$$CI_1 = 5,100,000 - 163,928 = 4,936,071$$

$$CI_2 = 4,936,071 - 163,928 = 4,772,143$$

And so on as tabulated in Table 5.2.

Step 10.

$$I_{d1} = (.4)(5,100,000)(.09) = 183,600$$

$$I_{d2} = (.4)(4,936,072)(.09) = 177,698$$

Step 11.

$$I_{e1} = (1 - .4)(5,100,000)(.14) = 428,400$$

$$I_{e2} = (1 - .4)(4,936,071)(.14) = 414,630$$

Step 12. Not applicable.

Step 13. Not applicable.

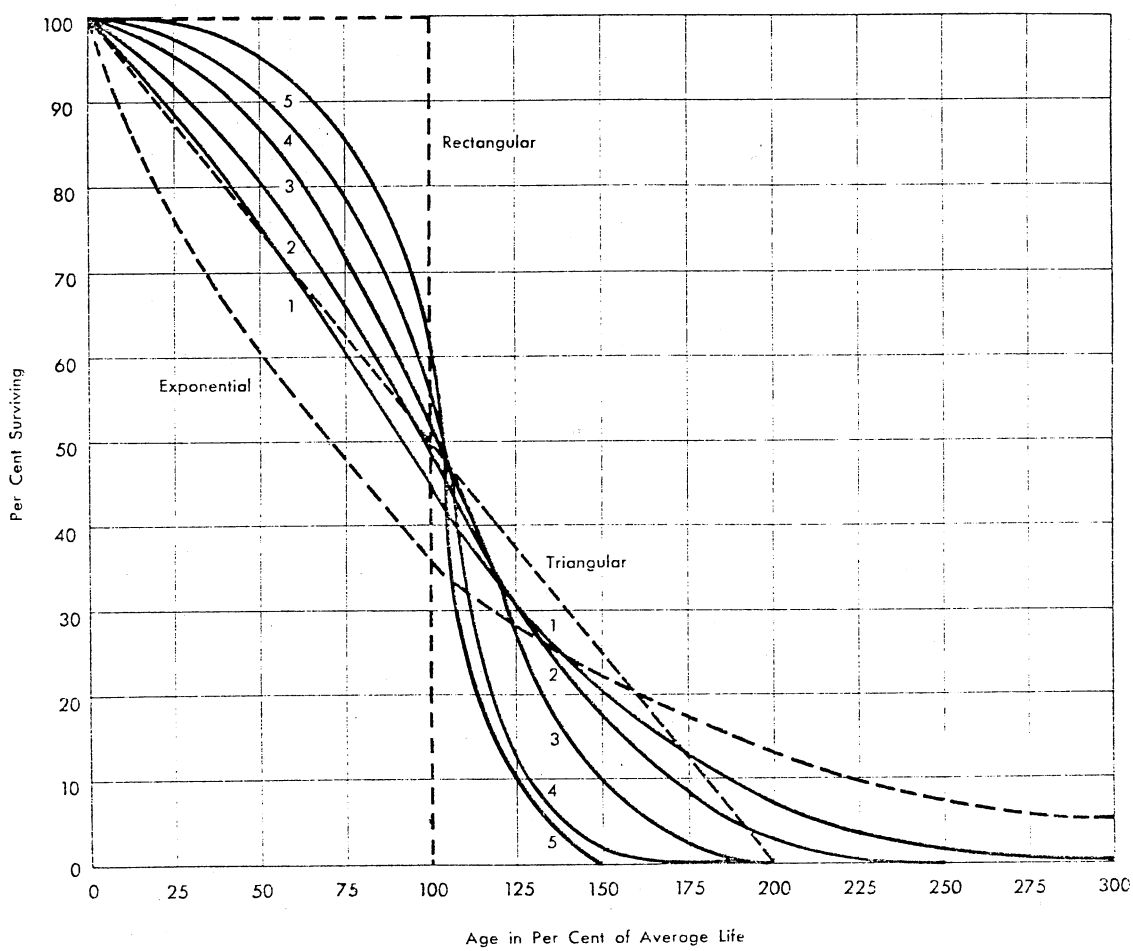


Figure 5.1. Typical Survivor Curves

Source: American Telephone and Telegraph Company Engineering Department. Notes for Engineering Economics Courses. New York: American Telephone and Telegraph Company, 1962, p. 124.

TABLE 5.1

CALCULATION OF A

End of Year	Percent of Average Life	Percent of Remaining Survivors*	P/F12,j**	Present Values of Remaining Survivors
1	3.57	99.792	.8929	.8910
2	7.14	99.552	.7972	.7936
3	10.71	99.274	.7118	.7066
4	14.28	98.953	.6355	.6288
5	17.85	98.584	.5674	.5594
6	21.42	98.160	.5066	.4973
7	24.99	97.745	.4524	.4422
8	28.56	97.117	.4039	.3923
9	32.13	96.669	.3606	.3489
10	35.70	95.761	.3220	.3084
11	39.27	94.943	.2857	.2713
12	42.84	94.018	.2567	.2413
13	46.41	92.974	.2292	.2131
14	49.98	91.797	.2046	.1878
15	53.55	90.490	.1827	.1653
16	57.12	89.025	.1631	.1452
17	60.69	87.393	.1457	.1273
18	64.26	85.581	.1300	.1126
19	67.83	83.574	.1161	.0970
20	71.40	81.353	.1037	.0844
21	74.97	78.888	.0926	.0731
22	78.54	76.215	.0827	.0630
23	82.11	73.266	.0738	.0541
24	85.68	70.042	.0659	.0462
25	89.25	66.542	.0588	.0391
26	92.82	62.762	.0525	.0330
27	96.39	58.716	.0469	.0275
28	100.00	51.448	.0419	.0216
29	103.53	49.946	.0374	.0187
30	107.10	45.320	.0334	.0151
31	110.67	40.624	.0298	.0121
32	114.24	35.943	.0266	.0096
33	117.81	31.365	.0238	.0075
34	121.38	26.981	.0212	.0057
35	124.95	22.864	.0189	.0043
36	128.52	19.085	.0173	.0033
37	132.09	15.675	.0157	.0025
38	135.66	12.667	.0141	.0018
39	139.23	10.053	.0125	.0013
40	142.80	7.823	.0108	.0008

TABLE 5.1 (Continued)

End of Year	Percent of Average Life	Percent of Remaining Survivors*	P/F12,j**	Present Values of Remaining Survivors
41	146.37	6.446	.0099	.0006
42	149.94	4.423	.0090	.0004
43	153.51	3.195	.0081	.0003
44	157.08	2.235	.0072	.0002
45	160.65	1.511	.0061	.0001
46	164.22	.976	.0056	.0001
47	167.79	.592	.0051	.0000
48	171.36	.321	.0046	.0000
49	174.93	.143	.0041	.0000
50	178.50	.045	.0035	.0000
51	182.07	.006	.0030	.0000

$$A = \frac{1}{7.6558} - .12 = .1306 - .12 = .0106^{***}$$

*Uses linear interpolation.

**Uses linear interpolation after i=35.

***7.6558 is the sum of the values in the last column.

TABLE 5.2

REVENUE REQUIREMENTS WITH NO TAX CONSIDERATION

Year	Chargeable investment CI_{x-1}	Debt interest Id_x	Return on equity Ie_x	Minimum revenue R_x	Present value of R_x PV_x	Annual equivalent E
1	2	3	4	5	6	7
1	5100000	183600	428400	958628	855918	958628
2	4936071	177698	414630	938957	748530	949349
3	4772142	171797	400860	919285	654329	940440
4	4608214	165895	387090	899614	571721	931898
5	4444285	159994	373320	879942	499303	923719
6	4280357	154092	359550	860271	435840	915901
7	4116428	148191	345780	840600	380244	908437
8	3952500	142290	332010	820928	331559	901322
9	3788571	136388	318240	801257	288041	894550
10	3624642	130487	304470	781535	251649	888113
11	3460714	124585	200700	761914	219032	882003
12	3296785	118684	276930	742242	190515	876212
13	3132857	112782	263160	722571	165594	870730
14	2968928	106881	249390	702900	143827	865549
15	2805000	100980	235620	683228	124823	860658
16	2641071	95078	221850	663557	108240	856048
17	2477142	89177	208080	643885	93778	851708
18	2313214	83275	194310	624214	81172	847627
19	2149285	77374	180540	604542	70191	843796
20	1985357	71472	166770	584871	60631	840202
21	1821428	65571	153000	565200	52314	836836
22	1657500	59670	139230	545528	45083	833687
23	1493571	53768	125460	525857	38801	830744
24	1329642	47867	111690	506185	33348	827997
25	1165714	41965	97920	486514	28618	825436
26	1001785	36064	84150	466842	24518	823051
27	837857	30162	70380	447171	20969	820831
28	673928	24261	56610	427500	17899	818769

Step 14.

$$R1 = 163{,}928 + 183{,}600 + 428{,}400 + 182{,}700 = 958{,}628$$

$$R2 = 163{,}928 + 177{,}698 + 414{,}630 + 182{,}700 = 928{,}957$$

Step 15.

$$PV_1 = 958{,}628 \overset{P/F\ 12\ 1}{(\ .8929\ )} = 855{,}918$$

$$PV_2 = 938{,}957\ (.7972) = 748{,}530$$

Step 16.

$$E_1 = 855{,}918 \overset{A/P\ 12,1}{(\ 1.12\ )} = 958{,}628$$

$$E_2 = (855{,}918 + 748{,}530)\overset{A/P\ 12,2}{(\ .5917\ )} = 949{,}349$$

The results of these calculations are tabulated in Table 5.2. The last E figure, i.e., E_{28} is the annual equivalent revenue requirements of the project. The sum of all PV_i's gives the present worth of all revenue requirements. Either of these two can be used for comparison purposes.

(b) With Taxes.

Steps 1, 2, and 3 same as before.

Step 4.

Three depreciation schedules are required:

1. Straight line depreciation schedule for book purposes D_b. This is the same as before. First cost includes capitalized interest.
2. Straight line depreciation schedule for tax purposes. The initial cost for this schedule must not include capitalized interest.
3. Sum of years digits (or any other) depreciation schedule for tax purposes. Initial cost does not include capitalized interest.

1. D_b as before.

2. $$D_S = \frac{5{,}000{,}000 - .1(500{,}000)}{28} = 160{,}714 \text{ per year}$$

$$D_{tx} = (P - S)\ \frac{2(n - x + 1)}{n(n + 1)} \qquad (5\text{-}29)$$

$$D_{t1} = (5{,}000{,}000 - 500{,}000)\ \frac{2(28)}{28 \times 29} = 310{,}344$$

$$D_{t2} = (4{,}500{,}000)\ \frac{2(27)}{28 \times 29} = 299{,}261$$

and so on.

Step 5.

$$dt_1 \doteq (310,344 - 160,714)(.30) \doteq 44,889$$
$$dt_2 = (299,261 - 160,714)(.30) \doteq 41,564$$

Step 6.

$$I_{ct_1} \doteq .1(5,000,000) = 500,000$$

Step 7.

$$tp = .001(5,100,000) = 5,100$$

Step 8. Same as before.

$$C = 182,700$$

Step 9.

$$CI_0 = 5,100,000$$
$$CI_1 = 5,100,000 - 163,928 - 500,000 - 44,889 + \frac{500,000}{28} = 4,409,039$$
$$CI_2 = 4,409,039 - 163,928 - 41,564 + 1,790 = 4,221,403$$

Step 10.

$$I_{d1} \doteq .4(5,100,000)(.09) = 183,600$$
$$I_{d2} = .4(4,409,039)(.09) \doteq 158,725$$

Step 11.

$$I_{e1} = (1 - .4)(5,100,000)(.14) \doteq 428,400$$
$$I_{e2} = (1 - .4)(4,409,039)(.14) = 370,359$$

Step 12.

$$G_1 \doteq 428,400 + 163,928 + 44,889 + 500,000 - 1,790 - 310,344 - 100,000 \doteq 709,015$$
$$G_2 = 370,359 + 163,900 + 41,564 - 1,790 - 298,900 \doteq 258,733$$

Step 13.

$$t_1 = 709,015\left(\frac{.3}{1 - .3}\right) - \frac{500,000}{1 - .3} = -410,421$$

$$t_2 = 258,733(.428) = 110,885$$

Step 14.

$$R_1 = 163{,}928 + 183{,}600 + 428{,}400 + (44{,}889 + 500{,}000 - 1{,}790 - 410{,}421) + 182{,}700 = 1{,}075{,}238$$

$$R_2 = 163{,}928 + 158{,}725 + 370{,}359 + (41{,}564 - 1{,}790 + 5{,}100 + 110{,}885) + 182{,}700 = 1{,}015{,}406$$

Step 15.

$$PV_1 = 1{,}075{,}238(.8929) = 960{,}034$$

$$PV_2 = 1{,}015{,}406 = 809{,}475$$

Step 16.

$$E_1 = 960{,}034 \left(\overset{A/P\ 12,1}{1.2} \right) = 1{,}075{,}238$$

$$E_2 = (960{,}034 + 809{,}475)\left(\overset{A/P\ 12,2}{.5917} \right) = 1{,}047{,}015$$

The results for this case are tabulated in Table 5.3. The procedure for years not calculated here are identical.

Another point to be noted is that under different tax system and different accounting procedure the method should be modified to become compatible with the relevant tax and accounting practices. For example, capitalized interest, differed taxes, and investment tax credit may be treated differently, i.e., they may not be spread over the life of the project as we did here. They may be accounted for as they occur. In such a case:

$$G_x = I_e + D_b - D_t \tag{5-30}$$

and

$$T_x = I_e + D_b + I_d' + t + c \tag{5-31}$$

where I_d' includes the capitalized interest as well as normal debt interest. No capitalized cost is needed, i.e.,

$$BVI_0 = P$$

TABLE 5.3

REVENUE REQUIREMENTS WITH FULL TAX CONSIDERATIONS

Year	Tax depreciation (S-Y-D) Dt_x	Deffered taxes dt_x	Chargeable investment CI_{x-1}	Debt interest Id_x	Return on equity Ie_x	After tax taxable income G_x	Tax t_x	Minimum revenue R_x	Present value of R_x PV_x	Annual equivalent E_x
1	2	3	4	5	6	7	8	9	10	11
1	310344	44889	5100000	183600	428400	709015	-410421	1075238	960034	1075238
2	299261	41564	4409039	158725	370359	258733	110885	1015406	809475	1047015
3	288177	38238	4221403	151970	354597	250730	107456	986134	701911	1028973
4	277093	34913	4037093	145335	339115	243007	104146	957382	608433	1013994
5	266009	31588	3856108	138819	323913	235562	100955	929148	527223	1000638
6	254926	28263	3678448	132424	308989	228398	97885	901433	456694	988414
7	243842	24938	3504113	125148	294345	221513	94934	874237	395460	977097
8	232758	21613	3333103	119991	279980	214906	92102	847560	342315	966565
9	221674	18288	3165418	113955	265895	208579	89391	821401	296235	955741
10	210591	14963	3001059	108038	252088	202532	86799	795761	256213	947567
11	199507	11637	2840024	102240	238562	196764	84327	770639	221540	939001
12	188423	8312	2682315	96563	225314	191275	81975	746037	191480	931005
13	177339	4987	2527931	91005	212246	186065	79742	721953	165453	923547
14	166256	1662	2376871	85567	199657	181135	77629	698387	142904	916596
15	155172	-1662	2229137	80248	187247	176484	75636	675341	123382	910124
16	144088	-4987	2084729	75050	175117	172112	73762	652813	106488	904106
17	133004	-8312	1943645	69971	163266	168019	72008	630804	91873	898515
18	121921	-11637	1805886	65011	151694	164206	70374	609314	79234	893328
19	110837	-14963	1671453	60172	140402	160573	68859	588342	68310	888520
20	99753	-18288	1540344	55452	129388	157418	67465	567889	58871	884070
21	88669	-21613	1412561	50852	118655	154443	66190	547955	50718	879956
22	77586	-24938	1288103	46371	108200	151747	65034	528540	43679	876157
23	66502	-28263	1166970	42010	98025	149330	63998	509643	37605	872653
24	55418	-31588	1049162	37769	88129	147193	63083	491265	32365	869425
25	44334	-34913	934679	33648	78513	145335	62286	473405	27847	866455
26	33251	-38238	823522	29646	69175	143757	61610	456055	23952	863725
27	22167	-41564	715689	25764	60117	142457	61053	439243	20597	861219
28	11083	-44889	611182	22002	51339	141437	60616	422940	17708	858921

The most important advantage of this method is that it does not require comparison of outputs. That is, it is not necessary to compare or put monetary value on outputs. This is a great advantage. How could one put monetary value on a health project or on the services of a highway patrol? These are the kind of measurements and comparisons involved. Such comparisons, if not theoretically impossible, are practically impossible. The procedure outlined here avoids these difficulties, but gives a measure of cost of those outputs. It provides the possibility of detecting the alternative that can provide the required output at a reasonable cost.

5.2 Comparison of Alternatives

The methods discussed in the previous section, national economic profitability and minimum revenue requirements, are suitable for a single alternative. That is, you can assess the acceptability of the single alternative in relation to some minimum requirements. But the more usual case is when it is desired to compare alternatives. This requires to generate minimum revenue requirements (from now on our discussion will center around this method) for each alternative, as in Tables 5.2 or 5.3. Then the alternatives can be compared based on their revenue requirements. The lower the revenue requirements, the better the alternative. But such comparisons are based on the implicit assumption that all the alternatives provide equal service and other effects. Then the annual equivalent revenue requirements over the entire life of the project is a good measure of its long term effects. The short term effects are reflected in the annual revenue requirements. In making such comparisons due consideration should be given to the life

of the alternatives. Otherwise the comparisons made are not equitable. One method of providing equitable comparisons is to use a study period. A study period is the length of time over which the alternatives are compared. Then the alternatives have to be compared based upon what happens in this period in each case. Therefore the problem is to find out what is the correct length of time to be used as a study period. The answer to this question depends upon the length that the product or services provided by the alternative are required, rather than the actual life of the project. Two cases are possible:

1. The products and services are needed indefinitely.
2. They are required for a finite period.

In the indefinite case where the services or products are required for a long enough period such that present value of the consequences of the alternatives after that period are negligible, the least common denominator of expected lives of the alternatives should be used as the study period. For example, if the life of alternative A is 15 years and that of alternative B is 20 years, then the study period should be selected as 60 years. Then the annual equivalent cost or benefits of the alternatives or their present worth over 60 years could be used for purposes of comparison. Such comparisons are based on the two assumptions:

1. The services or products of the alternatives are required for at least 60 years, and
2. What happens in the first life cycle of the alternatives will repeat in the subsequent life cycles.

The latter assumption is adequate only and only when there is no reliable information beyond the life of the alternatives. Otherwise

whatever happens after the first life of the alternatives should form the basis of the calculations and comparisons.

In the finite life case the study period must be the length of time that the products and services are required. For example, if it is believed that the services of alternatives A and B are required for 12 years only, then the study period must be selected to be 12 years. This may require an adjustment in the salvage values which must be done if so. Everything that happens after this period must be forgotten.

Detailed treatments of this subject (study period) are found in the standard literature of engineering economic analysis [24, 36, 39]. Therefore, we will not deal with it any more. Just a final word of caution: only those alternatives that are on equivalent basis on all other consideration can be compared by either profitability or minimum revenue requirements.

5.3 Selection

If there were no constraints project choice would have been very simple. Just pick up the best alternative for each project. This could be done by selecting the alternative with minimum revenue requirements. Or the one with highest profitability as the case may warrant. Unfortunately such a situation does not exist anywhere on earth. There are many constraints; budget, manpower, equipment, etc. These constraints limit the capacity of project implementation. We should select a set of projects that can be implemented under the constraints imposed on us.

In the evaluation stage we should make sure that all alternatives meet some minimum performance requirements. In the selection stage we

should select from these a set of alternatives that is within the constraints and accomplishes our goals as closely as possible. This selection can be carried out by mathematical programming or simulation. Only mathematical programming will be considered here. Specifically linear programming and linear goal programming will be considered.

5.3.1 Linear Programming

In this method the goals should be expressed as constraints. Assuming that meeting the goal targets while minimizing revenue requirements is the goal of project selection, the problem can be stated mathematically as

$$\text{Minimize:} \quad \sum E_j X_j \tag{5-32}$$

Subject to:

1. Goal constraints,
2. Resource constraints,
3. Technological and other constraints, and
4. All $X_j = 0, 1$;

where $X_j = 1$ if alternative j is to be selected and $X_j = 0$ otherwise.

E_j = the annual equivalent revenue requirements of alternative j over the study period.

The present value of annual revenue requirements of alternative j over the study period, PV_j, could also be used to form the objective of the linear programming problem. Solution of the above zero-one problem could be obtained from readily available linear programming algorithms.

Although the formulation and solution of the project selection problem can be easy in this manner, there are serious drawbacks which justify search for other methods:

(a) No priority could be assigned to goals.

(b) There may not be a feasible solution which satisfies both goal and other constraints. In such a case sensitivity analysis becomes extremely difficult.

These disadvantages more than offset the ease of formulation and solution.

5.3.2 Goal Programming

The constraints of a linear programming are fixed. They cannot be altered during the solution procedure. If such changes are feasible they have to be done as postoptimal analysis. In real world problems such fixed situations are rare. That is, you may be able to add to a resource or reduce a goal target to obtain a compromised solution. This compromized solution might not be optimal. However, this does not pose a serious threat. As McMillan [26, p. 587] says: "We really suboptimize when we employ optimizing algorithms. The problem for which we find an optimal solution is always extracted from a larger problem with respect to which our solution may indeed be suboptimal."

Even this kind of suboptimization is only possible with a commensurable objective function. In cases where multiple conflicting objectives exist formulation of such an objective function is in practice impossible. Therefore, we should be looking for a solution method that will select a solution which can handle multiple objectives in their units of measurement.

Goal programming is a mathematical programming technique that can handle this situation. The constraints of the goal programming problem are expressed as loose expressions that may be altered in search for a solution. The objective function of goal programming problem is to minimize the sum of the deviations from the goal values according to pre-assigned priorities. The priorities need not be cardinal priorities. An ordinal expression of priorities is sufficient. An example will help to demonstrate the concepts.

Example. It is required to produce two kinds of products, consumption goods and producers goods [27]. Five hundred units of the former and 900 units of the latter are needed. Two inputs, A and B, are required. Input A is required for both outputs. B is required for producer goods only. The availability of A and B is 800 and 600 units, respectively. Every unit of input produces one unit of output. What are the proper input amounts, X_1, X_2, and X_3, that should be used? Each unit of inputs A or B can be procured at unit monetary price. The following goals are supposed to be achieved as closely as possible:

1. To produce at least 500 units of consumption goods.
2. To produce exactly 900 units of producer goods.
3. Use at least 800 units of A and 600 units of B. (This may be required to boost the local businesses that produce these.)
4. The maximum budget for procurement of inputs should not exceed 1200 monetary units.
5. Minimize input requirements.

Input Requirements.

$$X_1 + X_2 + d_1^- - d_1^+ = 800$$
$$X_3 + d_2^- - d_2^+ = 600$$

where

X_1 = the amount of input A used to produce consumption goods.

X_2 = amount of input A used to produce producer goods.

X_3 = amount of input B used for producer goods.

d_i^- = amount of underachievement of goal i.

d_i^+ = amount of overachievement of goal i.

Output Requirements.

$$X_1 + d_3^- - d_3^+ = 500$$
$$X_1 + X_2 + d_4^- - d_4^+ = 900$$

Budget.

$$X_1 + X_2 + X_3 + d_5^- - d_5^+ = 1200$$

Objective Function.

First priority: Minimize d_3^-

Second priority: Minimize $(d_4^- + d_4^+)$

Third priority: Minimize $(d_1^- + d_2^-)$

Fourth priority: Minimize d_5^+

Fifth priority: Minimize $d_1^+ + d_2^+$

The complete problem can be stated as:

$$\text{Minimize: } P_1 d_3^- + P_2 (d_4^- + d_4^+) + P_3(d_1^- + d_2^-) + P_4 d_5^+ + P_5 (d_1^+ + d_2^+)$$

Subject to:

$$
\begin{array}{lllllllllll}
X_1 + X_2 & & + d_1^- & & & & - d_1^+ & & & & = 800 \\
 & X_3 & & + d_2^- & & & & - d_2^+ & & & = 600 \\
X_1 & & & & + d_3^- & & & & - d_3^+ & & = 500 \\
 & X_2 + X_3 & & & & + d_4^- & & & & - d_4^+ & = 900 \\
X_1 + X_2 + X_3 & & & & & & + d_5^- & & & & - d_5^+ = 1200 \\
\text{All } X_i\text{'s and } d_i\text{'s} & & & & & & & & & & \geq 0
\end{array}
$$

It should be noted that when underachievement is undesirable (greater than constraints) the negative devistions, d_i^-'s, should be minimized. When overachievement is undesirable (less than constraints) the positive deviations, d_i^+'s, should be minimized. In case of equality constraints both deviations ($d_i^- + d_i^+$) should be minimized.

This problem could also be presented in vector-matrix notation:

$$
(P_1, P_2, P_3, P_4, P_5) \begin{vmatrix} d_3^- \\ d_4^- + d_4^+ \\ d_1^- + d_2^- \\ d_5^+ \\ d_1^+ + d_2^+ \end{vmatrix}
$$

$$
\text{S.T.} \begin{vmatrix} 1 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 1 \\ 1 & 1 & 1 \end{vmatrix}
\begin{vmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{vmatrix}
\begin{vmatrix} -1 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & -1 \end{vmatrix}
\begin{vmatrix} X_1 \\ X_2 \\ X_3 \\ d_1^- \\ d_2^- \\ d_3^- \\ d_4^- \\ d_5^- \\ d_1^+ \\ d_2^+ \\ d_3^+ \\ d_4^+ \\ d_5^+ \end{vmatrix}
= \begin{vmatrix} 800 \\ 600 \\ 500 \\ 500 \\ 900 \end{vmatrix} \quad (5\text{-}33)
$$

$$
\underbrace{\qquad\qquad}_{B} \quad \underbrace{\qquad\qquad}_{I} \quad \underbrace{\qquad\qquad}_{-I}
$$

All X_i's and d_i's ≥ 0.

In general the goal programming problem can be stated as

$$\begin{aligned} &\text{Minimize:} \quad Pd \\ &\text{S.T.:} \quad AX + I_d^- - I_d^+ = b \\ &\qquad\quad X,\ d^-,\ d^+ \geq 0 \end{aligned} \tag{5-34}$$

where

P = row vector of priorities.

d = column vector of deviations corresponding to priorities.

A = matrix of coefficients of decision variables.

I = identify matrix of size equal to the number of constraints.

X = column vector of decision variables.

d^- = column vector of negative deviations.

d^+ = column vector of positive deviations.

b = column vector of target values of constraints.

If

$$B = \left| A \mid I \mid -I \right|$$

$$Y = \left| \begin{array}{c} X \\ \hline d^- \\ \hline d^+ \end{array} \right| \tag{5-35}$$

Then the goal programming model becomes:

$$\begin{aligned} &\text{Minimize:} \quad Pd \\ &\text{S.T.:} \quad BY = b \\ &\qquad\quad Y \geq 0 \end{aligned} \tag{5-36}$$

5-36 is the most general form of the goal programming problem.

Goal Programming Model of Project Selection.

Let $\bar{X}$ = column vector of decision variables. Each element of $\bar{X}$, X_j, correspond to an alternative. If the alternative is selected $X_j = 1$, otherwise $X_j = 0$.

G = p x n matrix. Each element g_{ij} of G corresponds to the contribution of alternative j to goal i.

b' = column vector of goal targets. Each element b_i'' of b' corresponds to the desired (target) value of goal i.

C = q x n matrix of constraint coefficients.

b'' = column vector of size q. Elements of b'' are the right hand side values of constraints.

Using this notation the project selection problem could be stated as:

Minimize: Pd

$$GX + I_{d_G^-} - I_{d_G^+} = b' \qquad (5\text{-}37)$$

$$CX + I_{d_c} - I_{d_c} = b''$$

$$\text{All } X_j = 0, 1$$

$$d\text{'s} \geq 0$$

or

Minimize: Pd

$$\text{S.T.:} \left| \begin{matrix} G \\ C \end{matrix} \middle| \; I \; \middle| \; -I \right| \; X \left| \begin{matrix} X \\ \hline d^- \\ \hline d^+ \end{matrix} \right| = b \qquad (5\text{-}38)$$

$$\text{All } X_j = 0,1 \qquad d^-, d^+ \geq 0$$

where

$$d^- = \left| \begin{matrix} d_G^- \\ \hline d_c^- \end{matrix} \right| , \quad d^+ = \left| \begin{matrix} d_G^+ \\ \hline d_c^+ \end{matrix} \right| , \quad b = \left| \begin{matrix} b' \\ \hline b'' \end{matrix} \right|$$

I = identity matrix of size m, and

m = P + q.

<u>Example</u>. There are four projects A, B, C, and D. There are two alternatives of A, three of B, and one of C and D. Contribution to goals, goal targets, resource requirements, and availabilities are summarized in Table 5.4. In addition, it is known that project C is contingent upon alternative two of project B. The priorities are:

1. Meet the budget constraint exactly.
2. Meet goals 1 and 2.
3. Meet goal 3.
4. Not to exceed material availability.
5. Use the available manpower exactly.

$$\bar{X} = \begin{vmatrix} X_1 \\ X_2 \\ \vdots \\ X_7 \end{vmatrix}, \quad b' = \begin{vmatrix} 1500 \\ 40 \\ 100 \end{vmatrix}, \quad b'' = \begin{vmatrix} 300 \\ 30 \\ 80 \\ 1 \\ 1 \\ 0 \end{vmatrix}$$

$$G = \begin{vmatrix} 500 & 200 & 650 & 1000 & 250 & 100 & 300 \\ 10 & 20 & 10 & 0 & 15 & 20 & 10 \\ 50 & 100 & 50 & 10 & 20 & 20 & 20 \end{vmatrix}$$

$$C = \begin{vmatrix} 100 & 90 & 150 & 180 & 80 & 70 & 100 \\ 10 & 7 & 8 & 12 & 8 & 6 & 8 \\ 25 & 30 & -5 & 25 & 20 & 15 & 18 \\ 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 1 & 0 \end{vmatrix}$$

TABLE 5.4

DATA FOR EXAMPLE PROBLEM

	Project	A		B			C	D	Right* Hand Side
	Alternative	1	2	1	2	3	1	1	
Contribution to goals	Goal 1	500	200	650	1000	250	100	300	1500
	Goal 2	10	20	10	0	15	20	10	10
	Goal 3	50	100	50	10	20	20	20	100
Constraints	Budget	100	90	150	180	80	70	100	300
	Manpower	10	7	8	12	8	6	8	30
	Material	25	30	-5	25	20	15	18	80

*Goal targets/resource or other constraints availability.

The last three constraints are required to express mutually exclusive alternatives and contingent constraints. Since these constraints must be satisfied for any solution to be feasible, top priority should be given to minimizing the positive deviations of these constraints. Indeed if there are any other constraints that must be satisfied in one direction, i.e., no movement of the constraint is feasible, they should be treated in the same manner. Therefore the objective function for this problem becomes:

$$\text{Minimize: } P_1 (d_7^- + d_7^+ + d_8^- + d_8^+ + d_9^+) + P_2(d_4^- + d_4^+) + P_3(d_1^- + d_2^-) + P_4 d_3^- + P_5 d_5^+ + P_6(d_6^- + d_6^+) \qquad (5\text{-}39)$$

S.T.:

Goals

$$500 X_1 + 200 X_2 + 650 X_3 + 1000 X_4 + 250 X_5 + 100 X_6 + 300 X_7 + d_1^- - d_1^+ = 1500$$

$$10 X_1 + 20 X_2 + 10 X_3 + 15 X_5 + 20 X_6 + 10 X_7 + d_2^- - d_2^+ = 40$$

$$50 X_1 + 100 X_2 + 50 X_3 + 10 X_4 + 20 X_5 + 20 X_6 + 20 X_7 + d_3^- - d_3^+ = 100$$

$$100 X_1 + 90 X_2 + 150 X_3 + 180 X_4 + 80 X_5 + 70 X_6 + 100 X_7 + d_4^- - d_4^+ = 300$$

Resource Constr.

$$10 X_1 + 7 X_2 + 8 X_3 + 12 X_4 + 8 X_5 + 6 X_6 + 8 X_7 + d_5^- - d_5^+ = 30$$

$$25 X_1 + 30 X_2 - 5 X_3 + 25 X_4 + 20 X_5 + 15 X_6 + 18 X_7 + d_6^- - d_6^+ = 80$$

Mutually exclusive

$$X_1 + X_2 + d_7^- - d_7^+ = 1$$

$$X_3 + X_4 + X_5 + d_8^- - d_8^+ = 1$$

Contingent

$$-X_3 + X_6 + d_9^- - d_9^+ = 0$$

All $X = 0$ or 1, All $d^-, d^+ \geq 0$

The solution procedure for this problem is given in Appendix A.

5.4 Choice of Method

In the previous pages of this chapter two methods were discussed for evaluation of individual projects, i.e., national economic profitability and minimum revenue requirements based upon a specified return on capital. Also two methods were presented for selecting a set of projects which is feasible in regard to the constraints and satisfies minimum goal requirements. Which should be used in actual situations?

Those projects that their inputs and outputs are easily measured in economic terms and have been intended to increase the national income should meet minimum profitability. Therefore national economic profitability should be applied in their evaluation. However, most of the projects undertaken for development purposes do not render themselves to such measurements. The intended results cannot be solely attributed to an increase in national income. Such projects should be evaluated based on their cost, i.e., minimum revenue requirements. Of course at every instance one should be careful when he is judging projects on their costs. The criterion of rejection should be the existance of possibility of lower cost projects. The mere magnitude of costs should not be the reason for rejection. In fact, in cases where overall inferiority of an alternative is not obvious the alternative should be retained for the selection stage where selection or rejection is possible in relation to other alternatives and overall situation.

For selection purposes the goal programming algorithm is recommended. Because it renders itself to incorporation of priorities and

finds a compromised solution in case that goals and constraints are incompatible. It, also, has many possibilities for sensitivity and post-optimal analysis.

CHAPTER VI

IMPLEMENTATION

Implementation could proceed in different manners. Some projects may be contracted out completely, others may be done partly by the NPO Implementation Department and partly contracted out. Some projects may be undertaken by the private sector, while the majority would be implemented by the government through the National Planning Organization.

Whichever the case, a suitable project management organization equipped with proven methods and techniques should be established to carry out each project. In this chapter a general methodology for project implementation will be presented.

6.1 Project Management

Project management is the system of planning, coordinating, and controlling of all the activities that have to be carried out to realize the objectives of a project within specified time and cost targets. The essentials of project management are [14]:

- -- Clear defined final objectives.
- -- Organization of tasks, manpower, finances, and other resources toward the final objectives.
- -- Total technical, financial, and schedule responsibility vested in project leadership.
- -- Constant consideration and thinking in terms of efficient accomplishment of final objectives.

The preceding phases of the system of project planning and implementation should have established clear defined objectives for each

project. This phase, project implementation, should set out to establish a suitable project management organization to carry out each project. The proven and well developed principles of project management should lead the way in this endeavor.

The most distinguishing characteristics of new project management are:

-- Total responsibility for project implementation delegated to a project management organization under the leadership of a project manager.

-- Extensive use of network optimization techniques for planning, scheduling and control of project implementation.

Therefore, in order to implement a project efficiently, immediately after selection each project should be assigned to a project manager. The project manager, then, should seek to set up a suitable organization for implementation of the project. The organization should be so designed that it could strongly deal with the project environment as well as being capable of using network and other project management techniques effectively. The project management environment in the developing countries is very complex. Figure 6.1 illustrates a typical project management environment in the developing countries. Besides the elements shown in the figure, special attention should be paid to securing or training the necessary personnel required for the operations phase of the project. Unlike in the developed nation, a pool of skilled personnel to be drawn from does not exist in the developing countries. Thus considerations in this respect should receive prime attention.

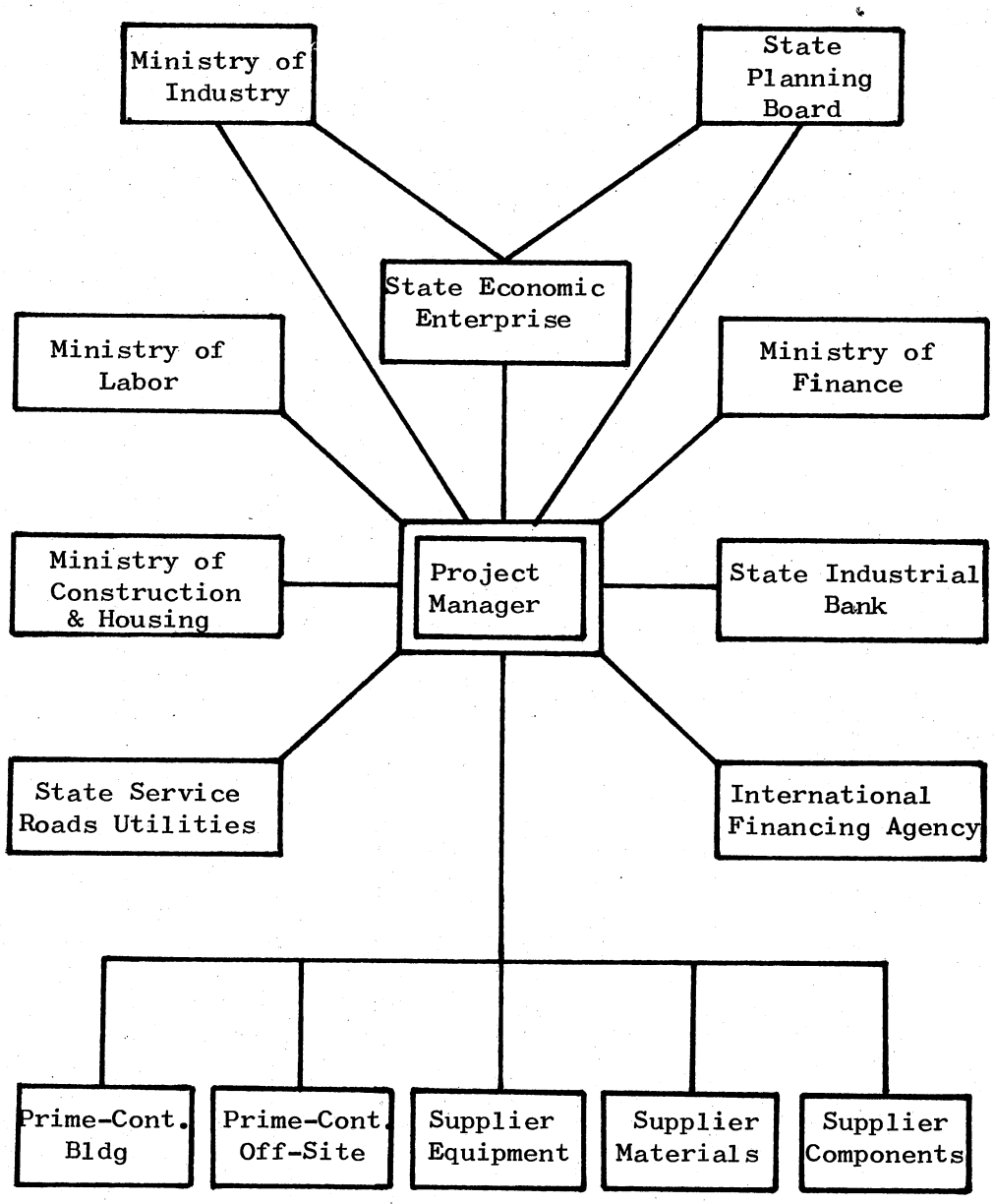


Figure 6.1. Project Management Environment

Source: Eldin, H. K., and M. H. A. Hamdy. "Project Management and Implementation in Developing Countries." Fifth International Seminar Symposium, Project Management Institute, Toronto, Canada (Oct., 1973), p. 383.

All network and other project management techniques are applicable in developing countries. The NPO as one of its primary responsibilities should secure the required specialists either through hiring or training. Since these techniques are well developed and presented in the project management literature [28, 29, 31, 32], they will not be discussed here. Instead, the emphasis would be on organization and information system consideration and mentioning the applicable techniques wherever warranted.

6.2 Project Management Information System

A project management information system (PMIS), like any other information system, should be designed to provide the information required for proper functioning of the project management system, i.e., efficient execution of project implementation. It should provide the communication channels required for easy interaction of all parties involved, so that the main functions of project management, planning, coordinating, and controlling the project work, to be performed smoothly and effectively. The scope, time, and cost of the project are items of prime importance.

Any PMIS should be designed with the capability of gathering and processing the data necessary for provision of the information required to accomplish the scope of the project within specified time and cost limits. Two types of organization are proposed for this purpose [30, p. 257]:

-- Total computer control (centralization)
-- Total decentralization.

6.2.1 Total Computer Control

Under this scheme all groups involved come under a team of specialists who report directly to the project manager. The team uses network and other project management techniques, such as resource leveling, time-cost trade-offs, etc., together with an electronic computer to schedule, monitor, and control time and other aspects of the project. Some disadvantages of this method are [30, p. 258]:

1. Cost. The cost of such a system may run quite high and could become prohibitive, except for very large projects. These costs should be carefully examined and compared to the advantages before any commitment.
2. Universality. Not all contractors, consultants, etc., are equipped with or believe in network techniques and use of a computer. This may constitute a serious difficulty in the developing countries. However, most of the development projects are considerably large. So that use of network techniques and a computer will be quite beneficial in both implementation of projects and educating the project planning and implementation personnel which in itself helps the development objectives.
3. Complexity. Network techniques are sophisticated and generate a large amount of data which need interpretation. Updating is a problem, too.

However, it should be noted that none of these disadvantages are serious enough to rule out this method. On the contrary, establishment of a good computer system within the NPO is a primary requirement.

6.2.2 Total Decentralization

Under this system each manager on a team is given full responsibility in his area. There are a number of sub-projects (usually in functional terms such as electrical, civil, etc.) that can be controlled by network techniques. But there is not a single organization responsible for the whole project. Control is applied by higher levels of

management through functional departments. Each team manager is responsible to his functional boss.

Some shortcomings of this method are [30, p. 258]:

1. Decentralization may lead to loss of control. This could happen due to lack of a central authority (project manager) and a common data base which makes systematic analysis and synthesis very difficult, if not impossible.
2. It does not provide means to integrate time, cost, and other performance requirements.
3. Some team managers may create their own organizations within the organization. This results in duplication, overlapping, thus, an expensive and inefficient system.

6.2.3 Project Control Office

However, when a centralized system is not possible, then creation of a project control office (PCO) which shall play the counterpart of production control in manufacturing is a possibility. The PCO will perform its duties as follows [30, p. 260]:

-- Acting in a staff capacity, responsible to the project manager: it gathers scheduling and other information and provides same to the relevant team managers.
-- Analyzes the information and recommends time-cost trade-offs to team managers and to the project manager on exception bases.
-- Provides expertise on network and other project management tools and techniques to team managers.

The PCO should have access to a good computer system and exploit it to the fullest possible extent. Figure 6.2 depicts the PCO concepts. Heavy lines show line responsibility, dashed lines staff responsibility.

6.2.4 Special Considerations for Developing Countries

The project management environment in the developing countries requires special attention. Some of the more important of such considerations are:

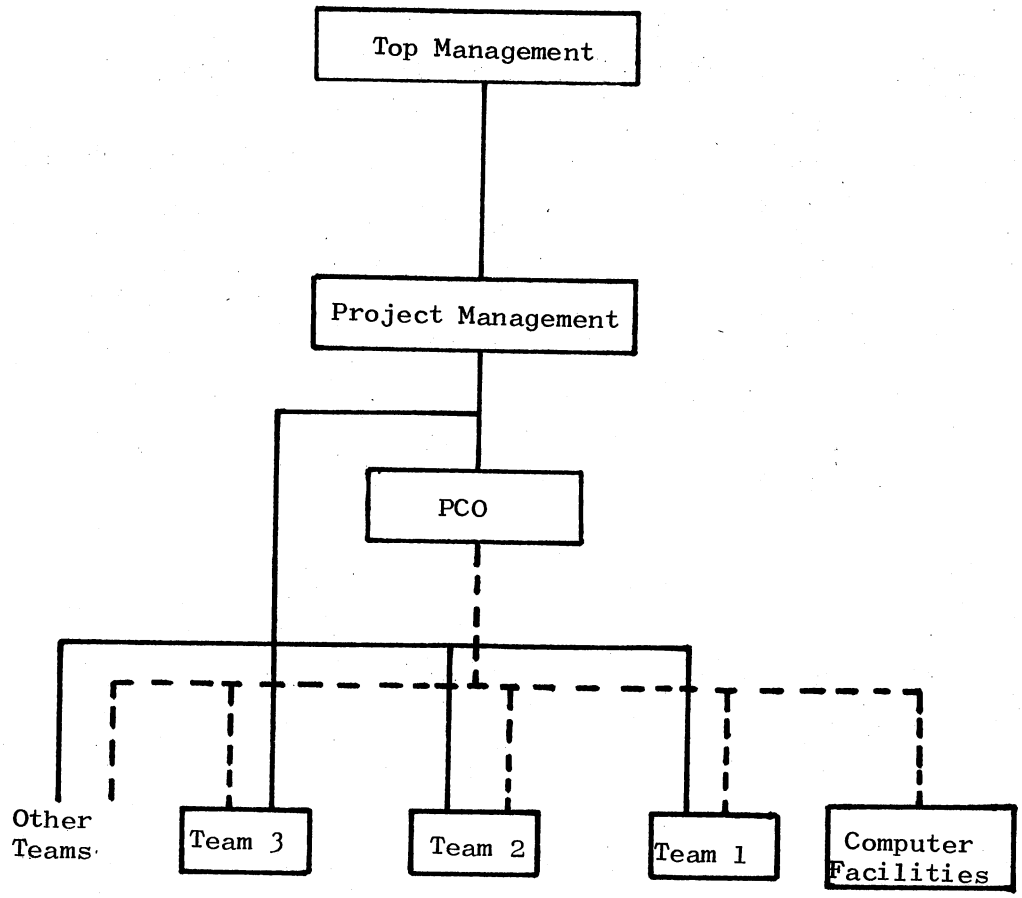


Figure 6.2. PCO in Project Management System

1. Most of the projects of considerable size are either undertaken by government directly or are government sponsored and have to be approved by some government agency. In any case the government agencies concerned form a very important part of the environment.
2. Most of the resources needed to implement and later to operate a project--skilled manpower, adequate technology, plant, and equipment, etc.--are usually in short supply.
3. The domestic contractors are usually inexperienced and incompetent due to lack of equipment, supplies, and adequate knowledge.
4. The foreign contractors take advantage of the shortcomings in developing countries and do poor jobs. For example, they use low quality materials or discontinued items which cause numerous problems in commissioning debugging and operation phases. One of such difficulties being unavailability or high prices for spares necessary for maintenance purposes.

Any project management system in order to survive in this environment should be so designed and equipped that it can reasonably address these problems and solve them. It seems that the PCO concepts can be utilized in this situation. A team should be assigned to take care of each of these problems as well as any other that may arise in a particular situation. This team should specifically be responsible to secure the necessary skilled personnel through either hiring or training. This should include the people required for both implementation and operations of the project. The preparation of a competent team for the operation phase is very important. Many projects done in

the developing countries fail due to lack of considerations such as the ones cited here. The diagram in Figure 6.3 shows how to incorporate these ideas into the project management system.

6.2.5 PMIS Functions

The essential functions of the information system are [31, p. 9]:

1. To develop plans, schedules, and standards required for proper execution of the project.
2. To provide the required information to all contributors (teams) as to their responsibilities and time when they should take action and what kind of action.
3. To gather data from field and generate information as to the progress of different activities and inform the responsible parties accordingly.
4. To verify, analyze and summarize this information and translate them into suitable mediums of communication such as lists, graphs, tables, and other forms of display that make interpretation and synthesis easy.
5. To revise or redevelop plans, schedules, and other project information and convey this information to all those concerned.
6. To simulate alternative decisions in order to find out what are the effects of the decision on project course and recommend suitable decisions.

These functions can be performed by the PCO methodology without considerable friction between the involved parties. Special considerations should be given to the design of an information system that can perform these complex and demanding functions. Individuals with knowledge of information and organization theory and practice should be sought to undertake the design and implementation of such a system. These individuals should make provisions for establishment of suitable policies, procedures, and facilities, such as a computer, required to do these functions. Flexibility should be given prime consideration.

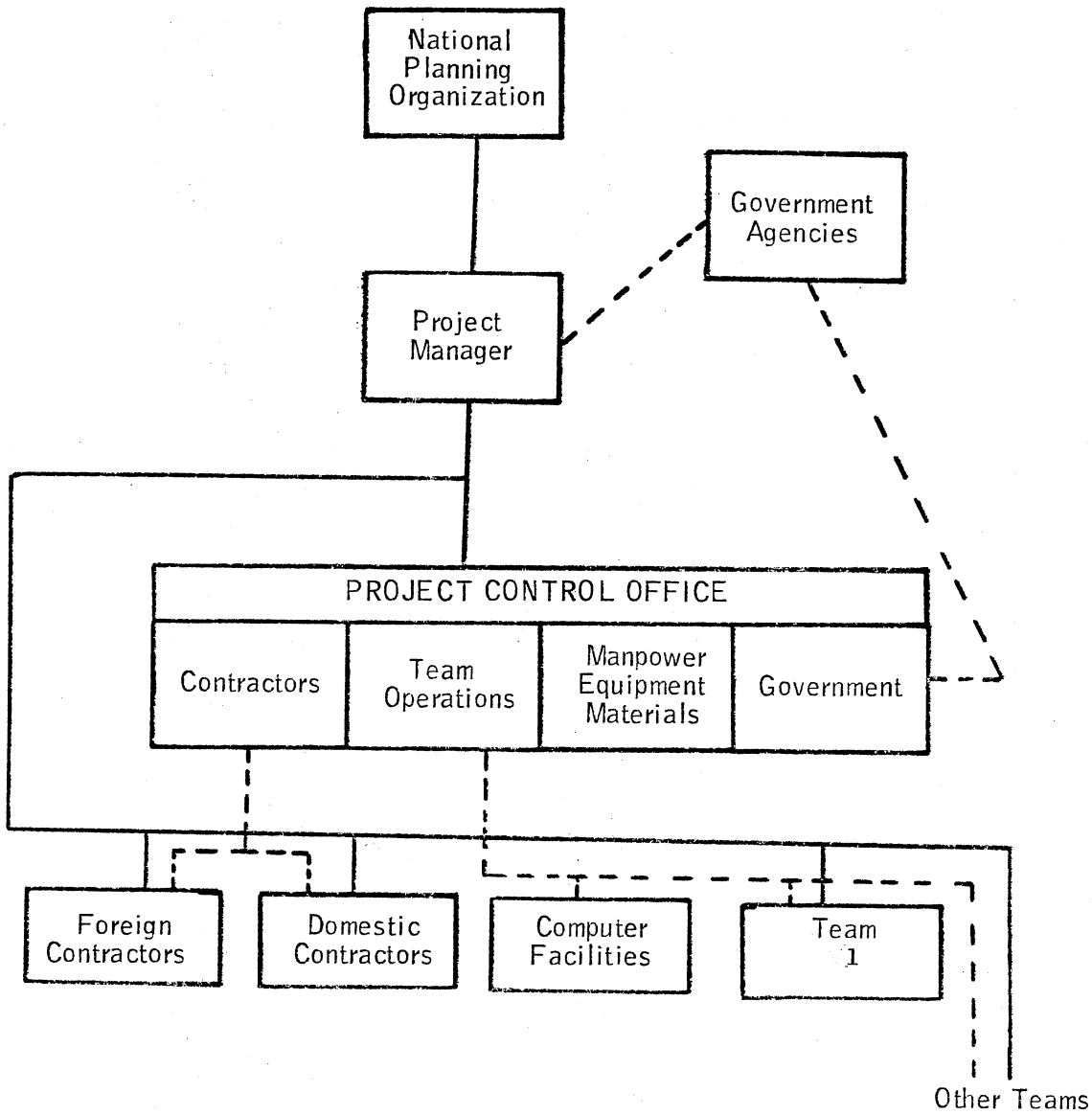


Figure 6.3. A Project Management System for Developing Countries

6.2.6 Information Requirements

The following categories of information are required for proper implementation of projects [31, p. 18]:

1. Financial information:
   a. Financial plan
   b. Financial progress reporting and document control
2. Definition of project structure and scope:
   a. Project structure and scope
   b. Responsibilities and organization of work
3. Project action plan and control:
   a. Master plan and schedule
   b. Task statements and action plans for them
   c. Task schedules
   d. Progress reports
4. Resource and budgets:
   a. Manpower, material, equipment, etc., cost estimates
   b. Manpower, material, equipment, etc., budgets
5. Contracting, work authorization and resource control:
   a. Work packages, work orders, contracts
   b. Expenditure records
   c. Information for control of work and fund flows
6. Output:
   a. Descriptions, drawings, standards, and specifications
   b. Output control information. (This category of information is required for changes in output specification, kinds, amounts, etc.)
7. Environmental information, etc.

6.3 Project Planning Elements

To implement a project adequately the following items, called project planning elements or objectives, should be done [29, 30]:

1. Work definition. To specify what has to be done. It should lead to a detailed breakdown of the work to be performed for accomplishment of project objectives.
2. Organization definition. Who should do the work?
3. Cost estimation. How much will the work cost?
4. Scheduling. When should the work be done?
5. Monitor and Control. Does the actual performance equal that planned. If not, what kind of action is required?
6. Report. Accumulate and summarize the information required for management reports. The reports should form bases of action by management.

6.3.1 Work Breakdown Structure

The key to the success of the whole project management system lies in proper identification, definition, and breakdown of the work requirements of a project. A work breakdown structure (WBS) should be prepared for this purpose. The work breakdown structure starts with the general objectives of the project and systematically prepares a hierarchy of WBS; so that at the end of the process manageable units of work are defined. When all these work units (activities) are done the project is completed.

The WBS should fulfill the following requirements [30, p. 262]:

1. It should define the work to be done in operational units and establish the relationship of each work package to the end objectives of the project.
2. It should establish the framework for progressively summarizing costs for reporting to higher management levels.
3. It should develop work units that can be used as activities on nework for purposes of planning, scheduling and progress reporting.
4. It should provide a work classification and coding system that can be used for integration of time, cost and other performance variables.

The work breakdown structure can be developed in a logical manner in five levels [29, 30]. The concept of levels is quite common in production too. For example, Figure 6.4 shows how (a) an assembly is made in five levels; (b) an automobile is manufactured in five levels, too. A project can also be broken down to its elements in the same manner. The basic principle is to start with the highest level and progressively divide the whole project into smaller and smaller elements, so that the fifth level defines manageable work units. Figure 6.5 shows the five levels of WBS for a missile weapon system.

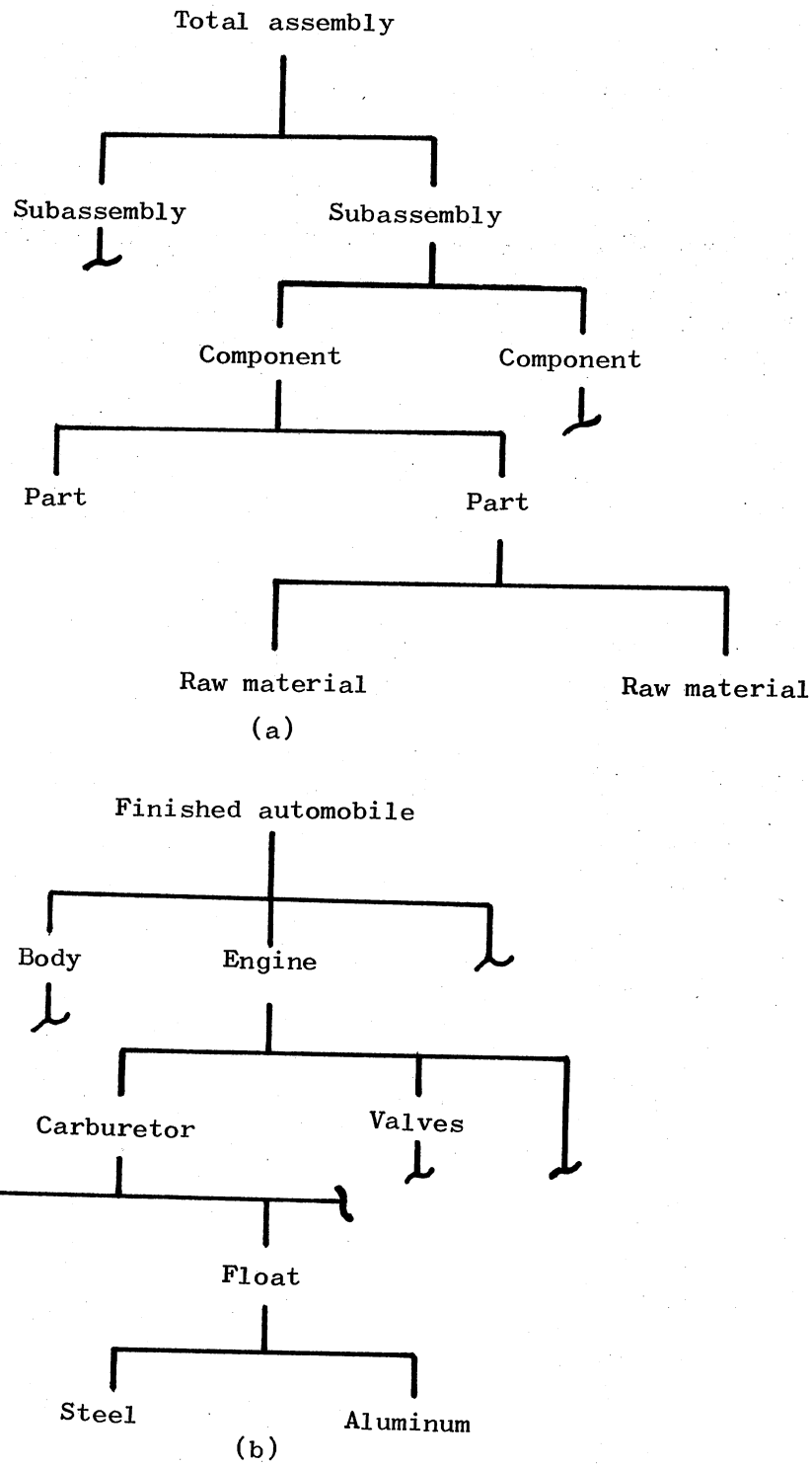


Figure 6.4. Illustration of WBS Levels

Source: Archibald, R. D., and R. L. Villoria. Network-Based Management Systems (PERT/CPM). New York, London: John Wiley and Sons, Inc., 1967, p. 30.

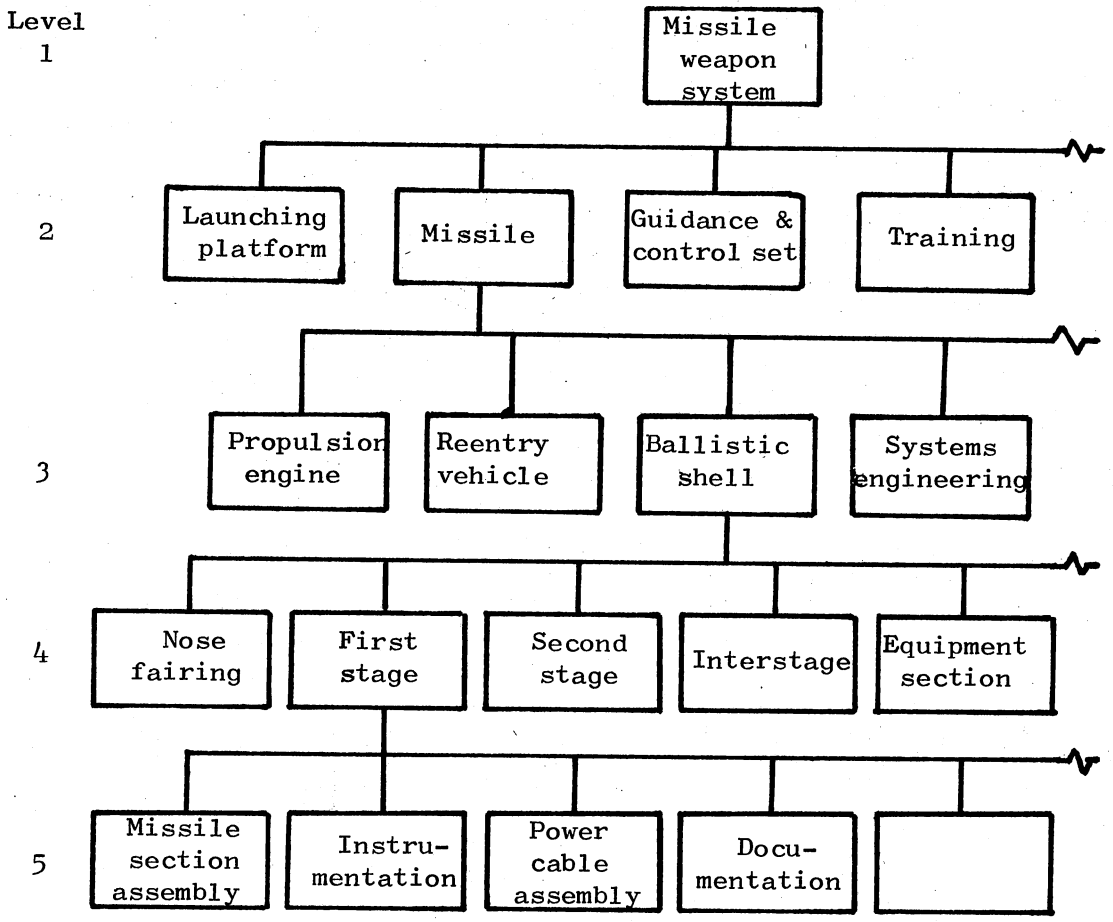


Figure 6.5. WBS Levels for a Missile Weapon System

Source: Archibald, R. D., and R. L. Villoria. Network-Based Management Systems (PERT/CPM). New York, London: John Wiley and Sons, Inc., 1967, p. 31.

In general the WBS for any project could be developed as follows:

Level 1. The project. Completion day requirements, statement of objectives, etc., are some of the matters to be considered at this level.

Level 2. Major projects. Any project is composed of several subprojects. For example a school project consists of:

-- Construction of building.

-- Securing teaching and staff personnel.

-- Provision of equipment and facilities for labs, classrooms, etc.

-- Others.

Level 3. Functional (technical) areas, e.g., architectural, civil, electrical, etc.

Level 4. Major tasks, e.g., lighting, wiring, etc., within the electrical function of a building.

Level 5. Work units (activities). Every major task is composed of elementary work units that should be identified and listed. A very important consideration at this level is the degree of detail, i.e., how far one should go in definition of these work units. Among the factors to be considered here are economy and accuracy of presentation on networks. For further details on this subject see [29, p. 53]. Figure 6.6 illustrates these levels.

The WBS, in addition to subdividing the whole project into work units, should, also, determine the phases that the actual work will go through. In general there are eight such phases [30, p. 264]:

1. Concept planning. Provides preliminary outline plans.

2. Design criteria, which provides a reference point for all design work.

3. Preliminary design; which should provide the interface between different areas.

4. Contract documents. This phase is necessary for those parts of project that are contracted out before final design. Or parts of the final design work that are contracted. If only after the final design the works are contracted, then this phase should be done after phase 5.

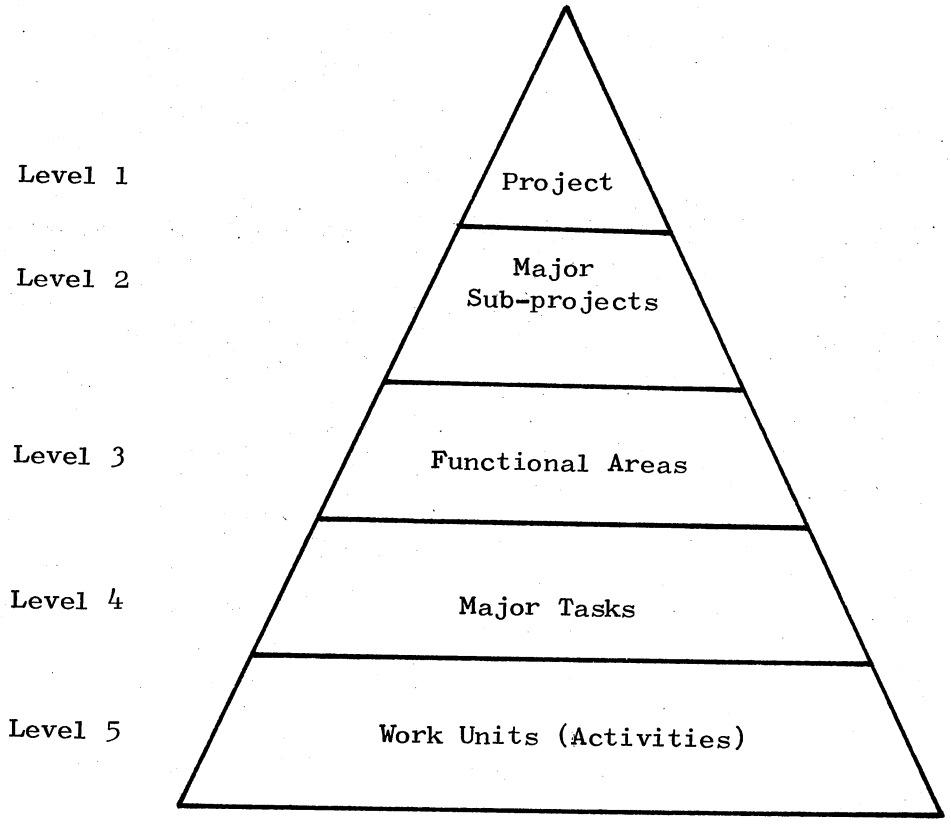


Figure 6.6. Hierarchy of WBS

5. Final design and drawings. This may be done by consultants, contractors, or the project implementation department itself. (An important consideration for developing countries during thisphase is determination of personnel requirements and provision of a plan to secure them.)

6. Procurement of materials and supplies. This phase could start immediately after phase 3. In developing countries it is very important that to order the required materials and supplies as soon as possible. Because it takes a long time until the orders are done. This is true about both local and imported items. In case of imported items it usually takes between 6-30 months depending on the individual items. The local items may take less time, but there is a lot of uncertainty on whether the order will be delivered or not.

7. Construction. Either by contracts or the implementation department or any other arrangements.

8. Commissioning, debugging, and transfer to operating personnel.

In order to do a successful job all these phases should be carried out with utmost care. However, it should be noted that the most critical of these phases are 1, 5, 6, and 7. These phases will usually account for more than 80% of the project budget [30, p. 264]. Two of the most important considerations in relation to developing countries, personnel and material, should be carried out in phases 5 and 6.

6.3.2 Organization Definition

Another major function of the project management system is to assign the jobs to different internal groups or external groups such as consultants and contractors. In particular it is important to make a decision on the parts that should be contracted. This should be done as early as possible in order [30, p. 266]:

1. To provide required input for proper establishment of PCO teams.

2. To provide necessary input for establishing financial and accounting charts and thus to know cash and other requirements in advance.

3. To provide milestones for completion of work by different contractors.

4. To check the validity of previously prepared schedules.

5. To provide means of classifying the work according to the responsible firm or group, hence basis for a coding system for such a classification.

6. To have means of cross-referencing the budget from elements to work packages.

7. To have the necessary information for staffing of contract administration teams in PCO, also, other teams that should deal with internal groups.

In general, all groups shown in Figure 6.1 are involved in project work. Of course, in specific situations the project organization will differ according to the requirements of that situation. A coding system should be developed to refer to groups and tasks assigned to them. This is required for computer processing and ease of reference. For example, the following coding system may be used for the project environment shown in Figure 6.1.

Project Management Teams	100/00
State Planning Board	150/00
Ministry of Industry	200/00
Ministry of Finance	250/00
State Economic Enterprise	300/00
Ministry of Labour	350/00
State Industrial Bank	400/00
Ministry of Construction & Housing	450/00
International Financing Agency	500/00
State Service Roads & Utilities	550/00
Contractors	600/00
Suppliers	650/00

and so on for any other groups involved. The digits after the slash will be used for reference to groups with the main organization referred to by the first three digits. Of course, any other coding system suitable for a specific situation may be used.

6.3.3 Cost Estimation

The costs of a project can be classified into direct and indirect. The direct costs include labor and material costs and contract costs in case of jobs contracted. The indirect costs include supervision and other overheads as well as any penalty (bonus) paid for completing the job after (before) a desired date. Indirect costs should, also, include interest on investment, if this interest has not been capitalized (see Section 5.1.2).

The costs should also be coded. An example of a cost coding system is given in Figure 6.7.

Cost estimating prior to implementation of any activity is highly conceptual. Many time-cost combinations are possible. Further, there is some degree of uncertainty associated with every estimate. All attempts should be made to make the estimates as realistic as possible. As the job progresses the previous estimates should be reviewed and revised if applicable. For details of estimating procedures and treatment of estimates see [28, 29, 33-38].

6.3.4 Scheduling

The discussion so far should provide the following materials required for scheduling.

-- A breakdown of project work into activities (work units).

-- A coding system for purposes of computerizing, accounting, etc.

-- Cost estimates of elemental work units.

-- A suitable organization to carry out the work.

-- Assignment of elemental work units to different parts of the organization.

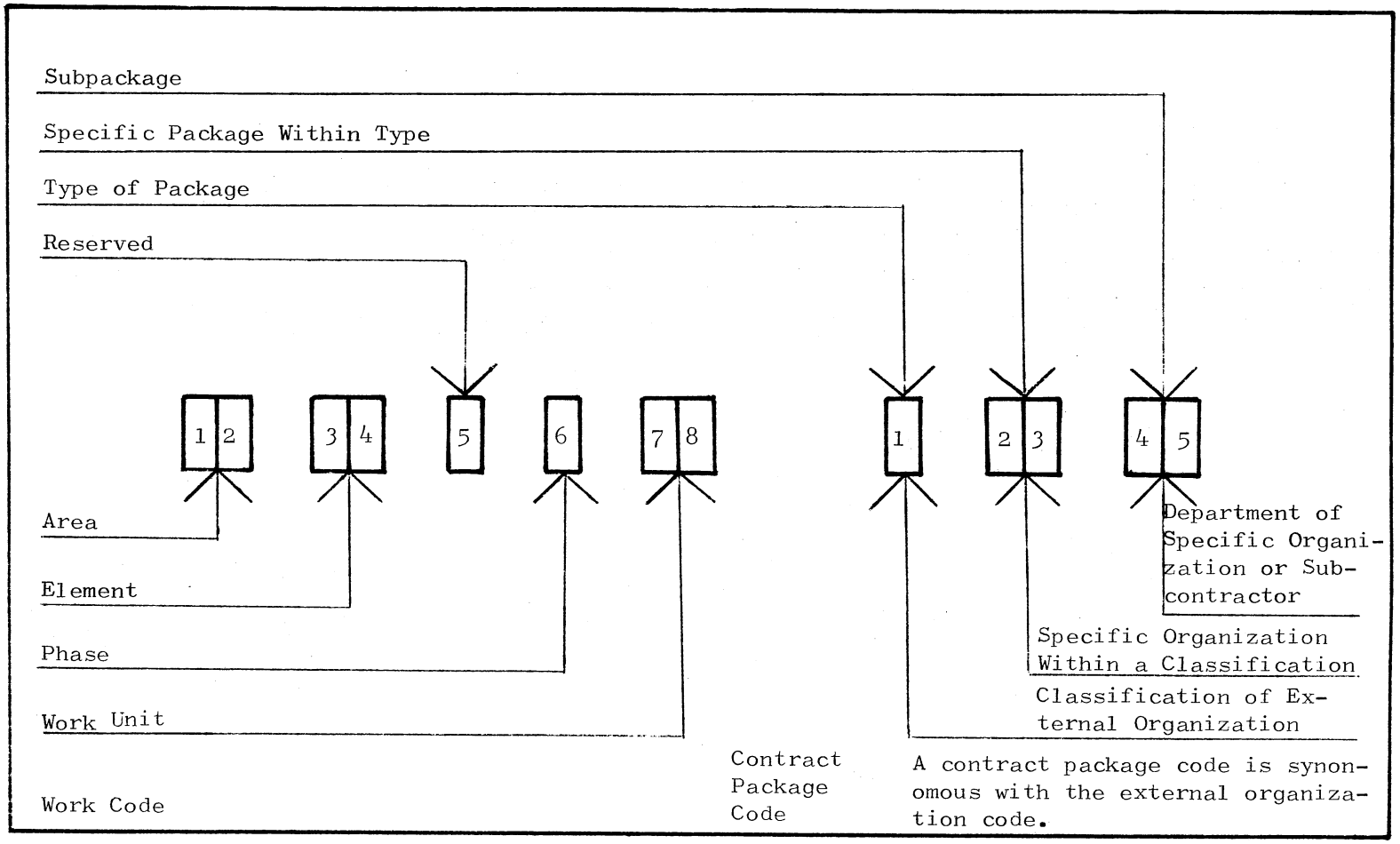


Figure 6.7. Coding System

Source: Suhanic, George. "Methodology and Organization for a Project Management Information System." Fifth International Seminar Symposium, Project Management Institute, Toronto, Canada (Oct., 1973), p. 268.

In order to accomplish the project objectives effectively this information should be integrated into schedules for actual implementation of the work. Network techniques such as CPM, PERT, precedence diagramming, and other project management techniques, such as resource allocation and leveling procedures should be fully utilized for this purpose. For details of these techniques and others see [28, 29].

A most important consideration here is the level of detail. In case of large projects a single network for everybody's use is not feasible. It is required to prepare the networks with different levels of detail. A useful method is preparing a hierarchy of plans corresponding to the levels of WBS. Each higher level uses a network based on next lower level. In this manner at the lowest level networks are prepared for major tasks assigned to each group. A master plan of all the project work is prepared by the PCO team responsible for scheduling. This master plan integrates all the sub-nets prepared by the task groups and provides the means of integrating all the project work by the PCO. The members of this team collect all the required information and do the needed calculations to generate and update the master plan; and convey the information to relevant teams and to the project manager on exception basis.

6.3.5 Monitor and Control

There are two main items to be monitored--cost and time. To monitor time it is important that both critical and noncritical activities be observed. Any noncritical activity may become critical if not attended properly. While about 10% of the activities may be critical, others are noncritical. Therefore, while the critical

activities are monitored closely, the rest should be monitored, too, so that they do not become critical due to lack of attention.

One method of establishing satisfactory progress is to review the tasks in form of audits [39, p. 317]. This could be performed against two standards: cost and time. For example, it is possible to check the percentage of scheduled budget or time used against the percentage of work completed.

Schedule analysis, milestone status charts, schedule trend charts, and different management reports may be used to effect control. Details of these techniques can be found in [30, 31]. Exception reporting is a powerful tool that warrants special mention. Exception reports may be issued at predetermined intervals or when major inconsistency occurs between planned schedules and actual achievement.

6.4 Resource Allocation

The resource allocation problem can be broadly classified into:

1. Unlimited resource leveling.
2. Limited resource allocation.

6.4.1 Unlimited Resource Leveling

If sufficient quantities of the needed resources were available, then the problem would be to complete the project by a specific date with minimum resource cost. Costs of hiring and firing personnel and acquiring other resources are appreciable and sometimes retiring of neither personnel nor equipment is possible during the whole project life. Therefore, cost minimization can be achieved through leveling resource requirements

over the project life as much as possible. Burgess and Wiest leveling procedures [29, pp. 163-171] are amongst the methods available for this purpose.

6.4.2 Limited Resource Allocation

It is more usual that some resources such as skilled personnel and equipment, etc., to be available only in limited amounts. In this case the problem is to use these limited resources and try to complete the project as early as possible. This problem is more usual and complicated when several projects draw upon some common resources such as construction equipment, professionals, etc. Moder and Phillips [29] present two procedures for this purpose. For details of these methods see [29, pp. 158-162 and 172-176].

A simple manual procedure which is suitable for few projects (10-15) that depend on some common resources will be briefly described below.

6.4.3 Multi-Project Resource Allocation

If there are n projects that use m limited resources, and each project can be assigned a priority, then the following procedure can be used to allocate the resources:

1. Schedule the top priority job first.
2. Then schedule the lower priority jobs as resources become available.

The priorities could be based on completion date requirements or any other considerations that may prevail.

This procedure can be easily implemented by use of commercially available load charts which are modifications of the basic Gantt chart. Figures 6.8 and 6.9 show two projects scheduled separately without consideration of resource constraints. The vertical lines present precedence relationships. Solid horizontal lines show the activity durations. Dashed lines imply float (slack). Data for these examples are given in Tables 6.1 and 6.2.

Figure 6.10 shows a schedule for both examples. It is assumed that all the resources are required for the entire duration of each activity. Therefore, no two activities requiring the same resource can be scheduled simultaneously. The dotted lines in Figure 6.10 show that an activity is held up because the required resources are being used by a higher priority job, e.g., the first activity of the second job could start on the first day. But it does not start until day 13 due to the fact that resource 1 is being used by job 1 during the first 12 days.

In actual practice scheduling boards can be loaded with colored bars. Each resource is identified by a color. One color may be used instead of the dotted lines to imply held up because of resource. Another color instead of the dashed lines to imply float.

This procedure will yield possible starting date for each activity, the critical path for each project, and information on most critical resources. Expediting the projects can be accomplished by an increase in the tight resources.

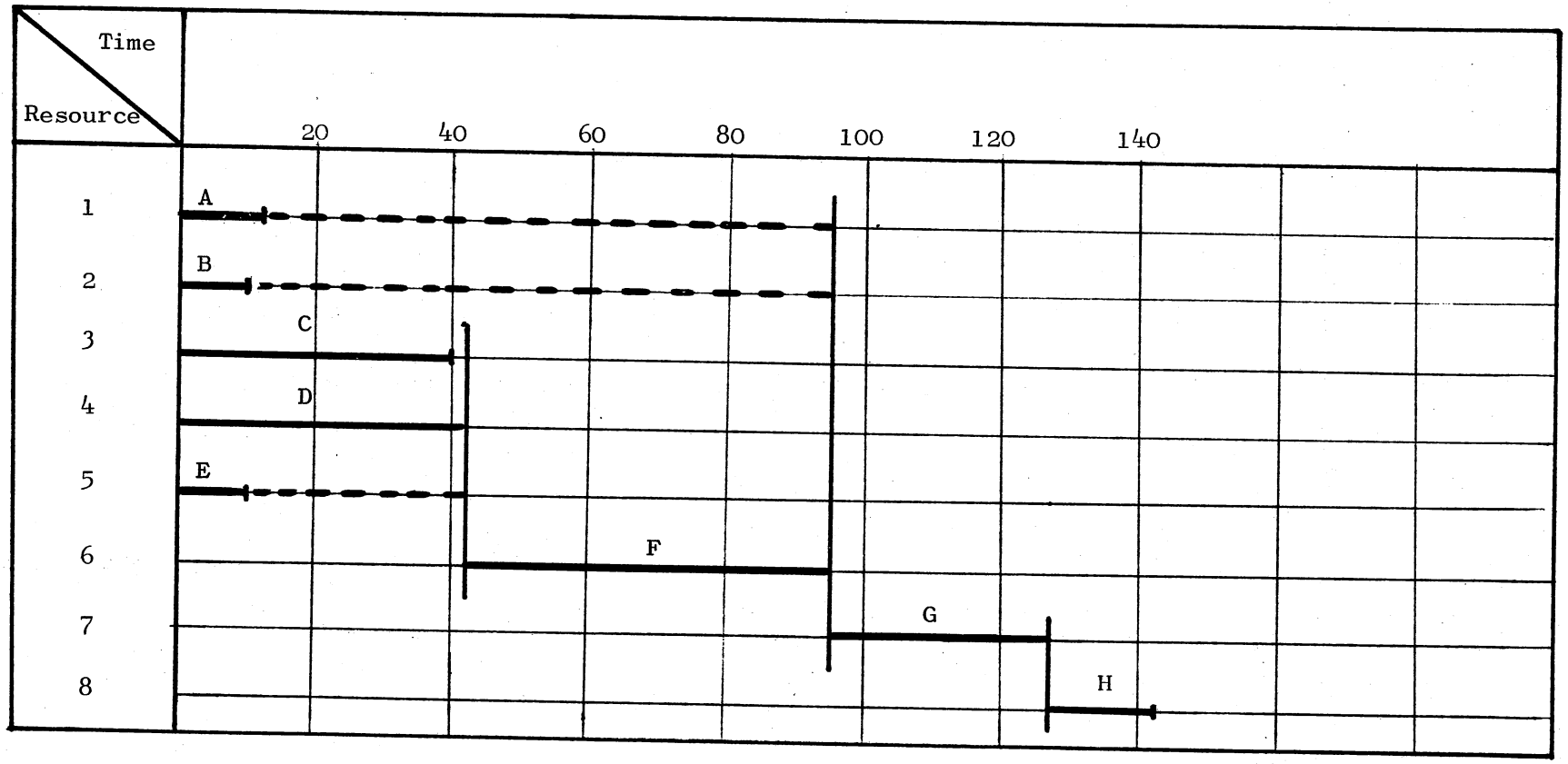


Figure 6.8. Schedule for Project 1
(No Resource Constraint)

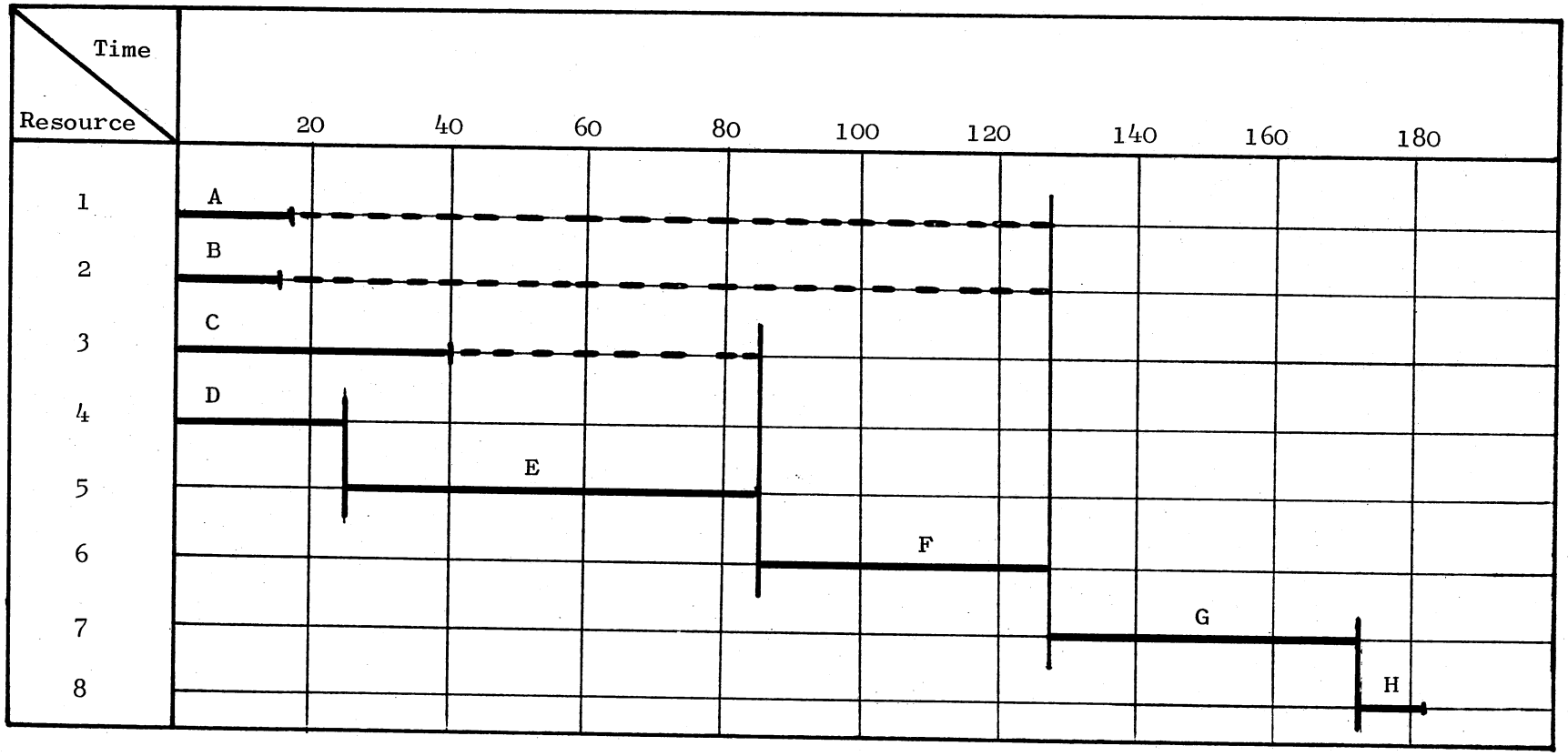


Figure 6.9. Schedule for Project 2
(No Resource Constraint)

TABLE 6.1

DATA FOR EXAMPLE 1

Activity	Resource	Duration - Days	Precedence
A	1	12	---
B	2	10	---
C	3	40	---
D	4	42	---
E	5	10	---
F	6	53	C,D,E
G	7	32	F,A,B
H	8 & 9	15	G

TABLE 6.2

DATA FOR EXAMPLE 2

Activity	Resource	Duration - Days	Precedence
A	1	17	---
B	2	15	---
C	3	40	---
D	4	25	---
E	5	60	D
F	6	42	C,E
G	7	45	F,A,B
H	8	10	G

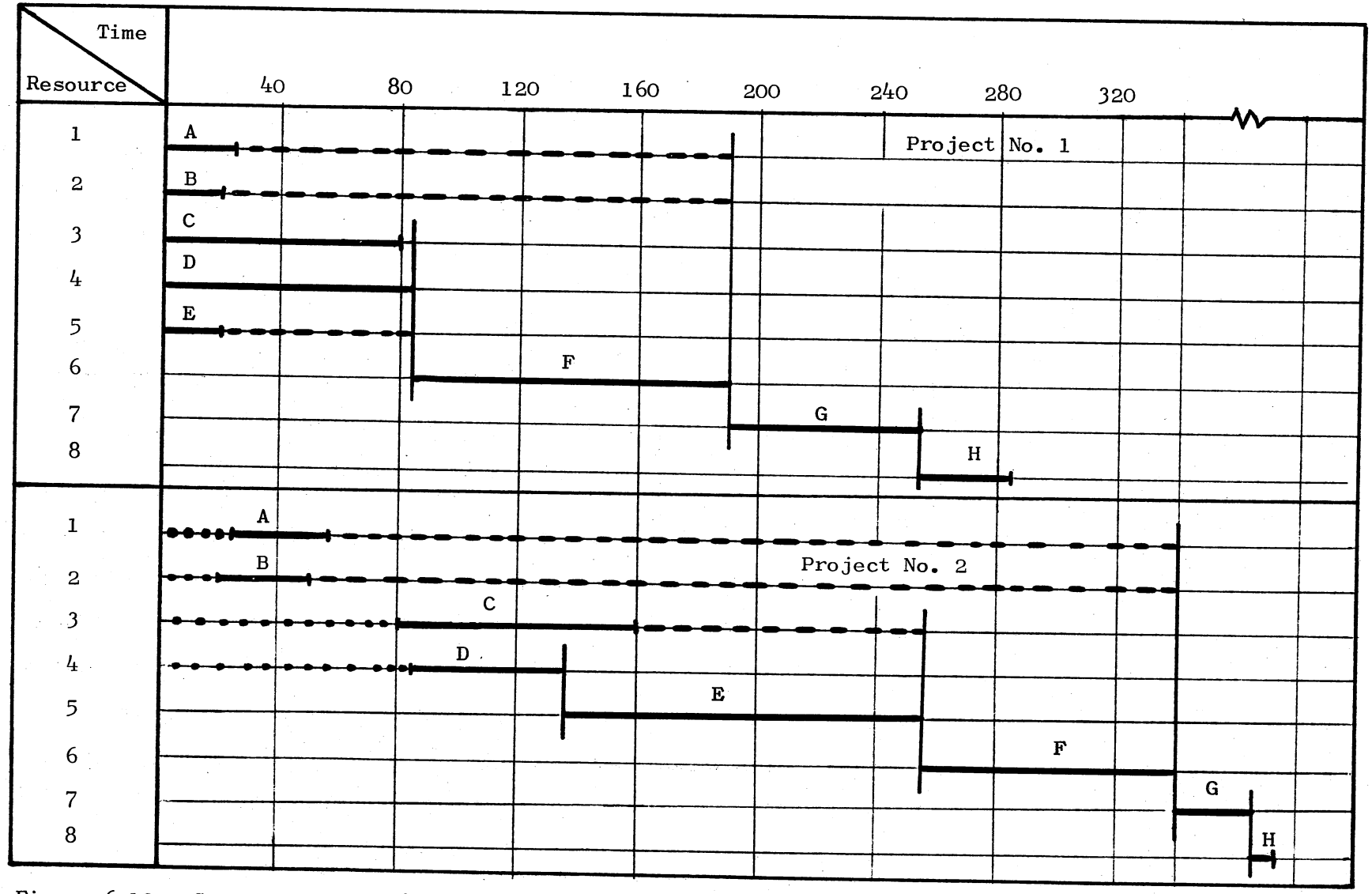


Figure 6.10. Schedule for Projects 1 and 2 Combined (Resource Constraints Considered)

CHAPTER VII

EFFECTIVENESS

The effectiveness of the project planning and implementation system should be assessed at three levels:

1. Subsystem level where it should be established that each subsystem is accomplishing its objectives efficiently.
2. Project level where efficient implementation of each project should be assured.
3. National level where the effectiveness of the whole system should be assessed.

The first two levels should be performed by the management of each subsystem (project managers in case of projects) and the general management of the National Planning Organization (NPO). In each case the objective of control is to make sure that the duties assigned to each subsystem (or project group) are carried out efficiently. Different control schemes could be used to ensure that the assigned duties to each subsystem are performed properly. Some of these methods were discussed for the project level in the previous chapter. Other management control methods for the subsystem levels could be found in management literature. For example [5, 41, 42]. It is very important that control schemes be based upon new behavioral concepts which advocate participative decision making. These methods are being found more effective as well as humane. In addition, adoption of such methods greatly enhances

the development of human resources which should be of primary concern in development planning.

In this chapter the assessment of effectiveness at the national level, i.e., measurement and evaluation of the results of all development projects considered together will be discussed. Special attention will be directed to use of social indicators which will cover a wide range of variables relevant to the development objectives of the developing countries.

Any measure of effectiveness, regardless of level and kind, is meaningful with respect to some criteria only. In case of development planning the degree of success of the plans in overcoming underdevelopment causes is the measure of effectiveness. The plans are effective if and only if the underdevelopment gap in all areas is eliminated or remedied to a satisfactory degree which measures up to the expenditures incurred. Assessing effectiveness should start concurrent with goal setting. At the goal setting phase indicators for goal outputs should be developed, defined and their unit of measure and method of measurement determined. In general the following steps are required to assure effectiveness:

1. Definition of effectiveness criteria including indicators of goal outputs and their units and methods of measurement.
2. Actual measurement. This should be done both before and after implementation of projects.
3. Comparison of the value of goal indicators and determination of any improvements, and comparison of the improvements to expectations which will indicate the degree of effectiveness.

4. Application of negative or positive feedback to modify, maintain or improve goal outputs according to future expectation.

Implementation of these steps is most difficult if a true measure of change in all areas of development objectives is to be found. Until now measuring change at level of a national society has been entirely in economic terms, what Gross [9] calls national economic accounting. However, if it is required to find the impact of a national development plan, then it is, also, required to go beyond national economic accounting. Since development is not an economic process exclusively, its measures cannot be exclusively economic either.

7.1 National Economic Accounting

National economic accounting uses GNP and other economic indicators to summarize the economic performance of a nation during a certain period, usually a year. It plays two important roles, analytical and social, in public affairs [9, p. 15]. The first, concerned with technical analysis provides [9, p. 15]:

-- a method of ordering vast quantities of information on monetary aspects of economic phenomena,
-- a doorway through which one can enter and explore a vast domain of social phenomena, including those that are but imperfectly reflected in economic terms,
-- some indication of possible interrelations among various policies and programs.
-- a language for the expression of many important objectives and aspects of performance, and
-- an impetus to fact-orientation by policy makers and the collection of desirable data.

The social role of national economic planning provides [9, p. 16]:

-- a dramatic way of expressing objectives, one that capitalizes on present-day 'number magic',

- -- stimulus to the formulation of objectives by providing professional legitimation of various desires and aspirations,
- -- a unifying language for a professional elite of trained economists, and
- -- opportunities for economists to win limited access to central points of power, thereby often bringing into the public service people with a greater variety of social backgrounds and with a dedication to the possibility of more rational efforts at decision-making.

These factors and the fact that economic statistics are very tangible and easy to manipulate are responsible for the prominence of national economic accounting. Indeed, until a few years ago no attempt was made to challenge the supremacy of the economic indicators. Based on the superficial idea of economic man, only economics was considered to be important. In the developing countries it was believed that underdevelopment is an economic phenomenon and hence nearly all attempts at development planning were directed toward economic development. Reaching a prescribed increase in GNP annually was thought to be the key to development. But as pointed out at the outset of this study development is not limited to economics only. Furthermore, use of economic or any other indicators should be a means to design of better plans. However, in most developing nations due to emotions and often ignorance of political leaders (this is not restricted to developing nations!) these indicators have become tools for advancement of political causes. Many falsifications and other misuses are normal practice. In a developing country the experts spend a great deal of time to prepare a national development plan. They estimate a possible 7-7½ percent growth in GNP during the duration of the plan. But the leader of the country does not find this rate suitable and asks for a

growth rate of over 10 percent. The poor planners go back and prepare a revised plan, probably an inflated one, that provides the dictated annual growth rate.

Of course such practices cannot be prevented by inclusion of non-economic indicator. But application of other indicators in addition to economic indicators can lead to a more realistic representation of the state of a nation. The newly developed field of social indicators provides a good opportunity that is worth exploring. Social indicators provide the additional measures, besides economic indicators, required to assess the state, accordingly degree of development, of a nation.

7.2 Social Indicators

In search for the domain and benefits of national economic accounting a new field called social systems accounting [9] is emerging. The basic premise of this field is to extend the concepts of economic indicators such that a variety of social indicators are developed and used to cover the social as well as economic and other aspects of a nation. The basic aim of such indicators would be to incorporate the important factors overlooked by the economists. For example, although economists generally agree that manpower and human skills are the most important of all resources, there is no satisfactory way to incorporate these resources in monetary terms which is the domain of economic indicators. Even if such an incorporation was possible, one could not see the true dimensions and significance of these factors.

Therefore, for purposes of social systems accounting which attempts to summarize the state of a society at a point in time more variables from more areas of national life should be observed and evaluated.

The whole range of such indicators is so formidable that no comprehensive coverage could be attempted. Fortunately exhaustion of every variable is not required. Very selective procedures should be used to choose the strategic factors of each area and define relevant indicators. Each indicator so selected should cover a wide range of variables. Further, great attention should be paid to precise definitions, units, methods of measurements, and the kind of inferences that may be drawn from the observed values of these indicators. Biderman [43] quite elusively points out the dangers associated with improper use of indicators where adequate understanding of the contents of the indicators is lacking. The design and use of indicators should be in relation to goals. This is most important in case of development planning. When the development goals are established, indicators of goal outputs should be defined and their application and meaning clearly specified. Otherwise much confusion and misunderstanding will cause them to become useless.

At present many statistics exist that can be used as indicators. In Chapter III it was mentioned that Sawyer [10] lists 236 variables for 82 countries. United Nations compiles data on these variables and others regularly [20, 21, 22, 23]. Biderman [44] has tabulated national goals for the United States as stated by Presidential Commissions in 1933 and 1966. He lists 111 goals in 11 areas. He, also, states whether any indicators exist and source that collects data about the indicators. A summary of these are given in Table 7.1. United States Department of Health, Education, and Welfare provides 25 indicators on these subjects:

-- Population and vital statistics such as marriages, deaths by

TABLE 7.1

GOALS AND GOAL INDICATORS

Goal Area	No. of Goals	No. of Indicators
Individual	6	4
Equality	21	9
Democratic Processes	11	9
Education	9	5
Arts and Sciences	10	6
Democratic Economy	9	5
Economic Growth	9	6
Technological Change	9	1
Agriculture	5	1
Living Conditions	13	8
Health and Welfare	9	9

Source: Biderman, A. D. "Social Indicators and Goals," in R. A. Bauer (ed.) Social Indicators. Cambridge, Mass.: The M.I.T. Press, 1966, pp. 147-152.

age group and major causes, infant and maternal mortality, etc.

-- Health such as major illnesses, mental patients, medical care prices, health facilities, etc.

-- Educations such as educational construction, enrollments, etc.

-- Welfare and income maintenance such as income, credit, consumer prices, labour force, unemployment insurance, manpower development and training, etc.

This abundance of possibilities poses serious threats. One may become overwhelmed in comprehensiveness, while selectivity should be leading. Especially when it is possible to be comprehensive by use of some strategic factors which cover a wide range of concern. The fact that development planning should cover a very large range of problems makes this selectivity-comprehensiveness question even more important. To measure the effectiveness of development project a set of indicators covering economic, social and other aspects of development should be carefully selected. Such indicators may be called development indicators.

7.3 Development Indicators

As mentioned in Chapter III the development objectives of the developing countries are many and diverse. In order to assess progress resulted from projects in development objective areas it is required to measure the improvements resulted in each goal area. In other words some kind of development indicators are required to show changes realized due to implementation of a development plan. These indicators

should be comprehensive enough to cover all development objectives. At the same time they should not be so numerous as to make data collection, analysis and synthesis impractical or highly expensive. The aim should be to obtain the greatest possible amounts of useful information from the smallest possible number of indicators and data.

Some considerations in selecting such indicators are [9, 10]:

1. Selectivity-comprehensiveness. This point is related to the discussion above and consists of:
   a. The necessity that planners and executors should concentrate their efforts on strategic factors where great gains are possible rather than dispersing their efforts.
   b. The need for comprehensiveness so that no goal area is underrepresented.
2. Conceptual relevance. Only variables highly correlated to the phenomena under consideration need be considered.
3. Prior use. This facilitates comparison and integration with previous findings.
4. Representativeness. Data about some indicators is more readily available than others. If there are two indicators and one of them is to be selected, the one which can be described by available data should be preferred. However, this consideration should not discourage development and use of new indicators wherever such indicators will improve the representation considerably.
6. Objectivity. Attempts should be directed to use of indicators that can be described by quantitative data or

easily quantifiable data. This should not mean that qualitative data must be disregarded. On the contrary subjective judgements should be used wherever they render better understanding and representation. But this should be done with extra caution. Subjective judgements are more susceptible to bias.

7. Reliability. It is very important that the data be reliable. Inflating or deflating some data happens frequently in both developing and developed countries. But it is more usual in the developing nations where some leaders find their satisfaction and prestige in good annual statistics.

Selection of development indicators is a job that should be undertaken for each particular application, i.e., each country should do it in conjunction with its development objectives. The definitions, units, and methods of measurement of such indicators should be determined concurrent with each goal. However, there are some indicators that seem to be general and relevant to the general objectives of developing countries. Data about most of these are being compiled by the U.N. or some of its agencies [20, 21, 22, 23]. Table 7.2 lists some of such indicators. These indicators can be a good starting point for particular cases. They should be redefined, refined and specified carefully prior to use. It is very crucial to make sure that all people concerned understand the content and applicability of each indicator, so that pitfalls of the kind Biderman [43] cautions against could be avoided.

TABLE 7.2

TYPICAL DEVELOPMENT GOALS AND GOAL INDICATORS

Goal Area	Typical Goal	Typical Goal Indicators
Agriculture	To increase agricultural production and productivity.	Cultivated land area/Available land area Agricultural production/GNP. Agricultural production/Agricultural population. Agricultural exports/Agricultural exports + imports. Etc.
Arts, Sciences, and Culture	To achieve and maintain a high level in arts, sciences, and culture.	Number of artists (painters, composers, poets, writers, etc.), scientists (physicists, mathematicians, chemists, etc.)/population. Book titles published/population. Foreign college students/population. Library circulation/population. Newspaper circulation/population. Foreign visitors/population. Etc.
Economic Base	To establish a sound economic system.	GNP/population. Fixed capital formation/GNP. Industrial production/GNP. Agricultural production/population. Potential natural resources. Imports/Imports + exports. Raw materials/exports. Leading export/exports.
Education	To provide adequate education for the populace.	Illiterates over 10 years age/population. All students/5-24 years age group. 18-24 years age group in college/All 18-24 years age group. Primary school population/primary school teachers. Same for secondary and higher education. Performance indices for primary and secondary school students based on standard tests, etc. Number of teachers in each

TABLE 7.2 (Continued)

Goal Area	Typical Goal	Typical Goal Indicators
		category who attend development seminars, refresher courses, etc. Government expenditure for education/ total government expenditure. Female students/total students.
Employment	To provide meaningful job opportunities for the working population.	Employed labor force/potential labor force. Female workers/labor force. Child workers/working labor force.
Health and Safety	To provide healthy and safe living conditions for all citizens.	Mean life expectancy at birth. Number of persons with chronic disabilities. Infant mortality rate. Medical care prices. Polutants. Various crime rates.
Housing	To provide adequate housing for the populace.	Portion of people living in inadequate housing units. Portion of people living in unsatisfactory neighborhoods.
Income Distribution	To attain and maintain equitable incomes for all citizens.	Number of people below a properly defined poverty level. Ratio of income of the highest 10 percent to the lowest 10 percent. Number of people near poverty level. Female wages/male wages.
Industrialization	To industrialize the nation and boost industrial productivity.	Industrial production/GNP. Industrial production/ industrial workers.
Natural Resources	Adequate development and use of natural resources. Prevention of wasteful use of such resources.	

TABLE 7.2 (Continued)

Goal Area	Typical Goal	Typical Goal Indicators
Politics	To achieve and maintain a viable, democratic political system responsive to the needs of the people.	Freedom of opposition. Local political autonomy (local officials elected or appointed). Freedom of press.

CHAPTER VIII

CONCLUSIONS AND COMMENTS

The basic purpose of this study was to outline a proper methodology for planning and implementation of projects in developing countries. At the very outset the need for systems approach was recognized and emphasized. In Chapter II the overall system was presented. In the subsequent chapters the main phases of the system of project planning and implementation were elaborated upon. In this concluding chapter the author summarizes his personal impressions of the underdevelopment phenomena and outline under what circumstances the proposed methodology will be successful.

Underdevelopment can be overcome only when a comprehensive program with clear, relevant objectives is developed and implemented. The basic strategic factor of underdevelopment is underdevelopment of human resources. Although some attention has been given to this factor, it has usually been overshadowed by economic considerations. Economic considerations, as necessary as they are, cannot lead to development if other factors are overlooked. One of the virtues of national economic accounting was stated to be provision of access for the economists to the central positions of power. This is true in case of developing countries. Indeed this access has become too excessive. Most of the top positions of government and especially development planning are filled by economists. Most of the literature on development planning

is by the economists. Of course their attention to the subject is appreciable; however, this leads to excess emphasis on economical aspects of development, whereas development is a comprehensive phenomenon covering all aspects of life. Another point is that these economists have been usually trained in a developed nation. When they return to the country they embark upon programs that are more related to economic theories of the West than the needs of the people of the developing country. Therefore the emphasis of this study has been development planning based upon the actual needs of the people as expressed by the people themselves, not as conceived by some economist or politician. This point has been emphasized over and over in this study because it is believed that this is the central problem of development planning. The systems approach and the scientific method require a correct definition of the problem under study. In the case of development planning such a definition is irrelevant except in relation to the actual needs of the country. The actual needs of the country cannot be determined except by the people of the country.

Another aspect of underdevelopment which needs due attention is the relationships of the government and the people, especially the educated portion of people who are mainly youths. This problem is related to the economic emphasis and the underdevelopment of human resources. In most of the developing nations some form of authoritarian government is in force. Educating the people requires a major shift in authority relationships. Since such shifts are not pleasant to the ruling classes, there is a continuing clash between the so called intellectuals and the governments. One result of this phenomenon is emphasis on economic development rather than human resources development.

Building dams and highways does not produce intellectual dissentients, but a university does! Therefore, in order to embark on a true development program major change of attitude regarding authority relationships should occur in the governing classes. This means that the idea that government is undertaking development programs as a benevolence to the people should be replaced by the idea that it is a duty of the government to undertake such programs as a service to the people. After all governments are supposed to be servants of the public! Without this change in attitude human resources development will produce intolerable conflicts which will require considerable expenditure of resources either for supression of dissent or not paying enough attention to the development of human resources, which without it no real development would result.

Yet another important point to be considered is that development planning should be carried out professionally and especially free of political considerations. This means that underdevelopment problems should be looked upon scientifically and scientific solutions should be sought for them.

With these considerations in mind, the framework developed in this study could be successfully used for planning and implementation of development projects. Of course this work does not provide a manual. Further study and research are required to prepare manuals for each country. Preparation of such manuals should preferably be done by local experts with help from the UN or other consultants. The contents of this study could provide a guide for preparation of such manuals.

A point to be considered in the use of this methodology is that the approach requires a centralized information system, while the actual

decision-making process should be decentralized as much as possible. In fact, the decision making about the local activities must be left to the local people.

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APPENDIX

SOLUTION OF THE PROJECT SELECTION PROBLEM

The concepts of zero-one goal programming problem have been developed by Lee [45]. Here a modification of Lee's procedure will be used to solve the project selection problem. The procedure is an extension of the basic zero-one programming algorithm developed by Balas [46] and the backtracking procedure of Glover [47].

The Balas' method requires that all the solution combinations to be enumerated either explicitly or implicitly. This is done by first putting all the decision variables equal to zero and then introduce those variables that improve the solution until all possible combinations are exhausted. The same approach could be used for solving a zero-one goal programming problem. Since in a goal programming problem the higher priority goals should be satisfied first, i.e., the deviations comprising the first priority level should be minimized first, the second priority next and so on. Therefore, at each iteration those variables that improve the priority level under consideration most should be introduced into the solution until all possible combinations are exhausted. Further, in the project selection problem, only those variables should be considered that do not increase the value of the first priority level. Because if this level is not maintained at its minimum (zero) the solutions thus obtained will be infeasible. The method and its concepts are best illustrated by solving the project

selection problem of section 5.3.2 as given by (5-39). The problem is repeated here for ease of reference.

Minimize: $P_1(d_7^- + d_7^+ + d_8^- + d_8^+ + d_9^+) + P_2(d_4^- + d_4^+) + P_3(d_1^- + d_2^-) + P_4 d_3^-$

$$+ P_5 d_5^+ + P_6(d_6^- + d_6^+)$$

S.T.

$$500x_1 + 200x_2 + 650x_3 + 1000x_4 + 250x_5 + 100x_6 + 300x_7 + d_1^- - d_1^- = 1500$$

$$10x_1 + 20x_2 + 10x_3 + 0x_4 + 15x_5 + 20x_6 + 10x_7 + d_2^- - d_2^+ = 40$$

$$50x_1 + 100x_2 + 50x_3 + 10x_4 + 20x_5 + 20x_6 + 20x_7 + d_3^- - d_3^+ = 100$$

$$100x_1 + 90x_2 + 150x_3 + 180x_4 + 80x_5 + 70x_6 + 100x_7 + d_4^- - d_4^+ = 300$$

$$10x_1 + 7x_2 + 8x_3 + 12x_4 + 8x_5 + 6x_6 + 8x_7 + d_5^- - d_5^+ = 30$$

$$25x_1 + 30x_2 - 5x_3 + 25x_4 + 20x_5 + 15x_6 + 18x_7 + d_6^- - d_6^+ = 80$$

$$x_1 + x_2 + d_7^- - d_7^+ = 1$$

$$x_3 + x_4 + x_5 + d_8^- - d_8^+ = 1$$

$$- x_3 + x_6 + d_9^- - d_9^+ = 0$$

All $x_i = 0, 1$

All $d_i \geq 0$

The following notation will facilitate the presentation of the solution [45].

Let:

A = the set o all solution variables

V_j = the set of those variables that have been assinged a value of 0 or 1 at the jth iteration. A + sign indicates the variable has a value of 1. A - sign implies the variable has a value of 0.

$A - V_j$ = the set of free variables that may be considered at the jth iteration

I_j = the set of variables which may improve the solution at the jth iteration

U_j = the value of goals at various priority levels at the jth iteration

IMP_j = the improvement resulting from entering the corresponding elements of I_j

First let all the decision variables = 0 and define the various sets defined above as follows:

Iteration 0.

A = (1, 2, 3, 4, 5, 6, 7)

(For simplicity the variables are represented by their su subscripts.)

VO = Φ (Φ indicates an empty set)

A - VO = (1, 2, 3, 4, 5, 6, 7)

UO = (2, 300, 1540, 100, 0, 80)

The values of U are calculated by solving the constraint equations for d_i's and subsequently computing the value of the expression within the parentheses of each priority level. These calculations for this step are as follows:

Since all X's are zero then we have:

$d_1^- - d_1^+ = 1500$ yields $d_1^- = 1500$, $d_1^+ = 0$

$d_2^- - d_2^+ = 40$ yields $d_2^- = 40$, $d_2^+ = 0$

$d_3^- - d_3^+ = 100$ yields $d_3^- = 100$, $d_3^+ = 0$

$d_4^- - d_4^+ = 300$ yields $d_4^- = 300$, $d_4^+ = 0$

$d_5^- - d_5^+ = 30$ yields $d_5^- = 30$, $d_5^+ = 0$

$d_6^- - d_6^+ = 80$ yields $d_6^- = 80$, $d_6^+ = 0$

$d_7^- - d_7^+ = 1$ yields $d_7^- = 1,\ d_7^+ = 0$

$d_8^- - d_8^+ = 1$ yields $d_8^- = 1,\ d_8^+ = 0$

$d_9^- - d_9^+ = 0$ yields $d_9^- = 0,\ d_9^+ = 0$

Always either d_i^- or d_i^+ is zero.

The above values of d's then is used to calculate the values of each priority level:

$$P_1 = (d_7^- + d_7^+ + d_8^- + d_8^+ + d_9^+) = (1 + 0 + 1 + 0 + 0 + 0) = 2$$

$$P_2 = (d_4^- + d_4^+) = (300 + 0) = 300$$

$$P_3 = d_1^- + d_2^- = (1500 + 40) = 1540$$

$$P_4 = d_3^- = 100$$

$$P_5 = d_5^+ = 0$$

$$P_6 = d_8^- + d_8^+ = 80$$

The first priority goal should be minimized first. Constraints 7 and 8 contribute to this level. Therefore these two constraints should be inspected to form I_0.

$$I_0 = (1, 2, 3, 4, 5)$$

$$IMP_0 = (1, 1, 1, 1, 1)$$

Next it should be determined which variable should be entered, i.e., given a value of 1. This is done by first considering whether positive or negative deviations contribute to the value of the objective function at this priority level and then summing the coefficients of each variable in the constraints under consideration. If d^-'s are positive then the variable with largest sum should be entered. If d^+'s are negative then the variable with lowest sum should be entered.

In this case d_7^- and d_8^- are positive. Therefore the variable with largest positive sum should be entered. All sums of coefficients are equal. Therefore a tie exists. The tie can be broken arbitrarily or with respect to the next priority level. Let's arbitrarily enter X_1.

Iteration 1.

$$V_1 = (+1)$$

$$A - V_1 = (2, 3, 4, 5, 6, 7)$$

$$U_1 = (1, 200, 1030, 50, 0, 55)$$

Now only constraint 8 contributes to P_1 and

$$I_1 = (3, 4, 5)$$

$$IMP_1 = (1, 1, 1)$$

$$\vdots$$

Again there is a tie. Enter X_3.

Iteration 2.

$$V_2 = (+1, +3)$$

$$A - V_2 = (2, 4, 5, 6, 7)$$

$$U_2 = (0, 50, 370, 0, 0, 60)$$

The first priority goal is completely satisifed now. This implies that there is at least one feasible solution for the project selection problem. In order not to lose feasibility, in subsequent step when a variable is chosen to be entered it should be entered if it does not increase the value of P_1. This is not required in a general zero-one goal programming problem. It is the characteristics of the project selection problem which make this necessary. Because it was stated that the constraints contributing to the first priority level, such as

mutually exclusive and contingent constraint, cannot be moved without loss of feasibility, i.e., any solution not on these constraints is not feasible.

With these considerations now the second priority level P_2 should be considered. Only constraint 4 is involved in this level. d_4^- has a value of 50. Therefore any free variable with a coefficient greater than zero but less than 100 improves the solution. Any variable with a coefficient greater than 50 makes d_4^+ positive and therefore increases the value of P_2. But up to 100 the value of d_4^+ will be less than 50, the present value of goal, and therefore is an improvement. With these considerations

$$I_2 = (2, 5, 6, 7)$$

$$IMP_2 = (10, 20, 30, 0)$$

The greatest improvement is due to X_6^-. Check if entering X_6 increases P_1. No. Enter X_6.

Iteration 3.

$$V_3 = (+1, +3, +6)$$

$$A - V_3 = (2, 4, 5, 7)$$

$$U_3 = (0, 20, 250, 0, 0, 45)$$

No further improvement is possible for P_2. There are no variables with coefficient between zero and 40.

Consider P_3.

At this stage only constraint 1 contributes to P_3

$$I_3 = (2, 4, 5, 7)$$

$$IMP_3 = (200, 1000, 250, 300)$$

Check if entering X_4 increases P_1? Yes. Check if entering X_7 increases P_1. No. Enter X_7.

Iteration 4.

$$V_4 = (+1, +3, +6, +7)$$

$$A - V_4 = (2, 4, 5)$$

$$U_4 = (0, 120, 50, 0, 2, 27)$$

Now any of the free variables when entered increases the value of P_1. Therefore

$$I_4 = (\Phi)$$

Since I is empty the backtracking procedure should start. The backtracking proceeds as follows. Inspect the set V_j to find the utmost right positive element. Make this element negative. Then make any elements to the right of it free variables and repeat the above procedure. Here the utmost right element of V_4 is 7. Therefore 7 is made negative and any elements to the right of 7 should be dropped from V_j to become free variables. There are no such elements.

Iteration 5.

$$V_5 = (+1, +3, +6, -7)$$

$$A - V_5 = (2, 3, 4)$$

$$U_5 = (0, 20, 250, 0, 0, 45)$$

$$I_5 = \Phi$$

Now 6 is the utmost right positive element. Make 6 negative. Drop 7 from V.

Iteration 6.

$$V_6 = (+1, +3, -6)$$

$$A - V_6 = (2, 4, 5, 7)$$

$$U_6 = (0, 50, 370, 0, 0, 60)$$

$$I_6 = (7)$$

Enter 7.

Iteration 7.

$V_7 = (+1, +3, -6, +7)$

$A - V_7 = (2, 4, 5)$

$U_7 = (0, 50, 60, 0, 0, 42)$

$I_7 = \Phi$

Make 7 negative.

Iteration 8.

$V_8 = (+1, +3, -6, -7)$

$A - V_8 = (2, 4, 5)$

$U_8 = (0, 50, 370, 0, 0, 60)$

$I = \Phi$

Make 3 negative, drop 6 and 7.

Iteration 9.

$V_9 = (+1, -3)$

$A - V_9 = (2, 4, 5, 6, 7)$

$U_9 = (1, 200, 1030, 50, 0, 55)$

$IMP_9 = (1, 1)$

Enter 4.

Iteration 10.

$V_{10} = (+1, -3, +4)$

$A - V_{10} = (2, 5, 6, 7)$

$U_{10} = (0, 20, 30, 40, 0, 30)$

$I_{10} = (2, 5, 6, 7)$

2, 5, and 6 increase P_1.

Enter 7.

Iteration 11.

$V_{11} = (+1, -3, +4, +7)$

$A - V_{11} = (2, 5, 6)$

$U_{11} = (0, 80, 20, 20, 0, 12)$

$I_{11} = \Phi$, since entering any of 2, 5, or 6 increases P_1.

Make 7 negative.

Iteration 12.

$V_{12} = (+1, -3, +4, -7)$

$A - V_{12} = (2, 5, 6)$

$U_{12} = (0, 20, 30, 40, 0, 30)$

$I_{12} = \Phi$

Make 4 negative. Drop 7 to become free.

Iteration 13.

$V_{13} = (+1, -3, -4)$

$A - V_{13} = (2, 5, 6, 7)$

$U_{13} = (1, 200, 1030, 50, 0, 55)$

$I_{13} = (5)$

Enter 5.

Iteration 14.

$V_{14} = (+1, -3, -4, +5)$

$A - V_{14} = (2, 6, 7)$

$U_{14} = (0, 120, 765, 30, 0, 35)$

$I_{14} = (7)$

Enter 7.

Iteration 15.

$V_{15} = (+1, -3, -4, +5, +7)$

$A - V_{15} = (2, 6)$

$U_{15} = (0, 20, 455, 10, 0)$

$I_{15} = \Phi$

Make 7 negative.

Iteration 16.

$V_{16} = (+1, -3, -4, +5, -7)$

$A - V_{16} = (2, 6)$

$U_{16} = (0, 120, 765, 30, 0, 35)$

$I_{16} = \Phi$

Make 5 negative.

Iteration 17.

$V_{17} = (+1, -3, -4, -5)$

$A - V_{17} = (2, 6, 7)$

$U_{17} = (1, 200, 1030, 50, 0, 55)$

$I_{17} = \Phi$

Make 1 negative.

Iteration 18.

$V_{18} = (-1)$

$A - V_{18} = (2, 3, 4, 5, 6, 7)$

$U_{18} = (2, 300, 1540, 100, 0, 880)$

$I_{18} = (2, 3, 4, 5)$

$IMP_{18} = (1, 1, 1, 1)$

Enter 2.

Iteration 19.

$V_{19} = (-1, +2)$

$A - V_{19} = (3, 4, 5, 6, 7)$

$U_{19} = (1, 210, 1320, 0, 0, 50)$

$I_{19} = (3, 4, 5)$

$IMP_{19} = (1, 1, 1)$

Enter 3.

Iteration 20.

$V_{20} = (-1, +2, +3)$

$A - V_{20} = (4, 5, 6, 7)$

$U_{20} = (0, 60, 660, 0, 0, 55)$

$I_{20} = (6, 7)$

Improvement in $P_2 = (50, 20)$

Enter 6.

Iteration 21.

$V_{21} = (-1, +2, +3, +6)$

$A - V_{21} = (4, 5, 7)$

$U_{21} = (0, 10, 550, 0, 0, 40)$

$I_{21} = 7$

Enter 7.

Iteration 22.

$V_{22} = (-1, +2, +3, +6, +7)$

$A - V_{22} = (4, 5)$

$U_{22} = (0, 110, 250, 0, 0, 22)$

$I_{22} = \Phi$

Make 7 negative.

Iteration 23.

$V_{23} = (-1, +2, +3, +6, -7)$

$A - V_{23} = (4, 5)$

$U_{23} = (0, 10, 550, 0, 0, 40)$

$I_{23} = \Phi$

Make 6 negative.

Iteration 24.

$V_{24} = (-1, +2, +3, -6)$

$A - V_{24} = (4, 5, 7)$

$U_{24} = (0, 60, 660, 0, 0, 55)$

$I_{24} = (7)$

Enter 7.

Iteration 25.

$V_{25} = (-1, +2, +3, -6, +7)$

$A - V_{25} = (4, 5)$

$U_{25} = (0, 40, 1150, 0, 0, 37)$

$I_{25} = \Phi$

Make 7 negative.

Iteration 26.

$V_{26} = (-1, +2, +3, -6, -7)$

$A - V_{26} = (4, 5)$

$U_{26} = (0, 60, 660, 0, 0, 55)$

$I_{26} = \Phi$

Make 3 negative.

Iteration 27.

$V_{27} = (-1, +2, -3)$

$A - V_{27} = (4, 5, 6, 7)$

$U_{27} = (1, 210, 1320, 0, 0, 50)$

$I_{27} = (4, 5)$

$IMP_{27} = (1, 1)$

Enter 4.

Iteration 28.

$V_{28} = (-1, +2, -3, +4)$

$A - V_{28} = (5, 6, 7)$

$U_{28} = (0, 30, 320, 0, 0, 30)$

$I_{28} = (7)$

Enter 7.

Iteration 29.

$V_{29} = (-1, +2, -3, +4, +7)$

$A - V_{29} = (5, 6)$

$U_{29} = (0, 70, 10, 0, 0, 12)$

$I_{29} = \Phi$

Make 7 negative.

Iteration 30.

$V_{30} = (-1, +2, -3, +4, -7)$

$A - V_{30} = (5, 6)$

$U_{30} = (0, 30, 320, 0, 0, 30)$

$I_{30} = \Phi$

Make 4 negative.

Iteration 31.

$V_{31} = (-1, +2, -3, -4)$

$A - V_{31} = (5, 6, 7)$

$U_{31} = (1, 210, 1320, 0, 0, 50)$

$I_{31} = (5)$

Enter 5.

Iteration 32.

$V_{32} = (-1, +2, -3, -4, +5)$

$A - V_{32} = (6, 7)$

$U_{32} = (0, 130, 1055, 0, 0, 30)$

$I_{32} = (7)$

Enter 7.

Iteration 33.

$V_{33} = (-1, +2, -3, -4, 5, 7)$

$A - V_{33} = (6)$

$U_{33} = (0, 30, 750, 0, 0, 12)$

$I_{33} = \Phi$

Make 7 negative.

Iteration 34.

$V_{34} = (-1, +2, -3, -4, 5, -7)$

$A - V_{34} = (6)$

$U_{34} = (0, 130, 1055, 0, 0, 30)$

$I_{34} = \Phi$

Make 5 negative.

Iteration 35.

$V_{35} = (-1, +2, -3, -4, -5)$

$A - V_{35} = (6, 7)$

$U_{35} = (1, 210, 1320, 0, 0, 50)$

$I_{35} = \Phi$

Make 2 negative.

Iteration 35.

$V_{35} = (-1, -2)$

$A - V_{35} = (3, 4, 5, 6, 7)$

$U_{35} = (2, 300, 1540, 100, 0, 80)$

$I_{35} = (3, 4, 5)$

$IMP_{35} = (1, 1, 1)$

Enter 3.

Iteration 36.

$V_{36} = (-1, -2, +3)$

$A - V_{36} = (4, 5, 6, 7)$

$U_{36} = (1, 150, 830, 90, 0, 85)$

$I_{36} = \Phi$

Make 3 negative.

Iteration 37.

$V_{37} = (-1, -2, -3)$

$A - V_{37} = (4, 5, 6, 7)$

$U_{37} = (2, 300, 1540, 100, 0, 80)$

$I_{37} = (4, 5)$

$IMP_{37} = (1, 1)$

Enter 4.

Iteration 38.

$V_{38} = (-1, -2, -3, +4)$

$A - V_{38} = (5, 6, 7)$

$U_{38} = (1, 120, 500, 100, 0, 55)$

$I_{38} = \Phi$

Make 4 negative.

Iteration 39.

$V_{39} = (-1, -2, -3, -4)$

$A - V_{39} = (5, 6, 7)$

$U_{39} = (2, 300, 1540, 100, 0, 80)$

$I_{39} = (5)$

Enter 5.

Iteration 40.

$V_{40} = (-1, -2, -3, -4, +5)$

$A - V_{40} = (6, 7)$

$U_{40} = (1, 220, 1235, 80, 0, 55)$

$I_{40} = \Phi$

Make 5 negative.

Iteration 41.

$V_{41} = (-1, -2, -3, -4, -5)$

$A - V_{41} = (6, 7)$

$U_{41} = (2, 300, 1540, 100, 0, 80)$

$I_{41} = \Phi$

Since there is no positive elements in V to be made negative, the process ends.

The best solution is that of iteration 21 where

$$X_2 = 1, \quad X_3 = 1, \quad X_6 = 1$$

and

$$U = (0, 10, 550, 0, 0, 40)$$

In this solution priority level 1 is achieved completely and 2 has its

minimum possible value 10. Since $d_4^+ = 10$ the budget should be increased by 10 units. However, if such a solution is not satisfactory the decision-maker can analyze the other solutions and pick another which does not require an increase in the budget. One such solution is found in iteration 10, where:

$$X_1 = 1 \quad \text{and} \quad X_4 = 1$$

In this case the budget is underspent by 20 units. The opportunities for postoptimal analysis of this kind are abundant. The decision-maker can sort the feasible solution in different manners and make a suitable decision.

In a 7 variable problem there are $2^7 = 128$ combinations. This procedure reaches a solution in 41 iterations, less than 1/3 of all the combinations. Of course, in actual situations where the number of decision variables is large a computer is required to do the calculations.

VITA

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