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DEVELOPMENT-PROJECT FORMAT: A DESIGN FOR MAXIMUM INFORMATION

By

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INTRODUCTORY NOTE

The following sections are part of a larger work which relates modern concepts of project design to the needs of the developing countries; these concepts were developed to generate meaningful information on a project and its role in the economy, thus to make the management of the project and the agents of outside support for the project capable of effective action.

The present sections are principally concerned with the structuring of project design in terms of technologically and organizationally meaningful activities. The serviceability and wide applicability of this approach are demonstrated.

In subsequent chapters, the interest will focus on those aspects of the proposed format which make it useful for measuring input demands and money demands and for aggregating several projects into larger wholes on the level of sectoral and national plans.

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CHAPTER 1

PLACING A PROJECT DOCUMENT IN THE INFORMATION-FLOW MATRIX OF A DEVELOPING ECONOMY

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1.1 PURPOSE OF THIS STUDY

The aim of this study is to suggest a format for the presentation of economic development projects which would have as many uses as possible in the several phases through which a project passes, from conception through evaluation, acceptance, and implementation and on to completion. By "format" we mean both the specific terms in which the project is cast (e.g., money expenditures, physical quantities of inputs, types of labor, dates of application of inputs) and the manner of exposition (logical and spatial structure of verbal statements and tabulations). To distinguish clearly between the exposition of a project and the project itself (i.e., the actual activity of, say, building a road), whenever confusion might arise, we shall refer to the former as a PROJECT DOCUMENT. Thus, our aim is to develop a format for project documents that would facilitate analytical as well as managerial operations on projects, on subsectoral and sectoral groupings of projects, and on the whole integrated plan if one exists.

The most important aspects under which a project or group of projects ought to be considered are these:

- Long-run contribution of the project to the objectives of the particular strategy of economic development adopted by the country in question: the enduring, iterative <u>effect</u> of the project on the economy.

- Short-run, immediate impact of the activity of implementation on the economy.

- Efficient programming of the implementation with a view to husbanding the country's scarce resources, human and material.

- Efficient management of the implementation.

- Accumulation of a store of experience for the benefit of future planning and programming, the implementation of each project adding its share of useful benchmarks: unit costs of various typical activities, realistic time period required for these activities, productivity figures for different kinds of manpower, etc.

The format proposed in this study is mainly IMPLEMENTATION-ORIENTED. It is most useful in connection with the analyses and decisions that are made after a project has been approved for implementation. It seeks to facilitate (a) programming, i.e., time-scheduling of detailed activities and applications of physical inputs; (b) assessing the demand for particular scarce resources and thus identifying potential bottlenecks in advance; (c) evaluating the stream of nonrecurrent incomes originating in the execution of the project; and (d) measuring the cost-effectiveness of activities contained in the project.

We believe, however, that this format also offers significant advantages for cost/benefit analysis--i.e., for the initial evaluation of

whether a project's merits justify its selection from the roster of apparently productive projects competing with each other for scarce resources. It is designed to permit easy use of "accounting prices" ("shadow prices"), a device increasingly recommended for gauging the social desirability of projects. It also provides means for projecting a precise timetable of expenditures; this is important for calculating the present value of projects whose implementation is likely to extend over long periods and for calculating probable interest charges on borrowed capital.

The reader is asked to keep in mind this distinction between the two viewpoints from which a project document can be regarded: (1) evaluation before approval and (2) implementation. Certain statements that would appear trivial from the first point of view acquire weight and importance when considered from the second.

Our aim has been to endow the proposed format with a high degree of commonality of information: the very same document can be used as an immediate source of data for operations of economic-analytical, engineering, managerial, and accounting characters at all stages of a project's progress. The economy of this approach for emerging countries, plagued by a scarcity of skilled technicians and administrators, ought to be obvious.

Few people now doubt that the future belongs to methods of presenting information that can be easily adapted to automatic data-processing

techniques. The same holds for methods of communication between the various technicians collaborating in a complex economic development project--engineers, economists, public administrators, managers, and accountants. Not every developing country could start an automatic data-processing system today; in most of them, shortages of trained personnel will prevent this for many years. But it is both desirable and possible to design project formats in such a manner that, when the time is ripe to introduce automatic data-processing, the structure of these documents and of all the accounting associated with them is already prepared for automatic handling within the same computer-logic design. Our format is an attempt in this direction.

1.2 TEMPORARY SIMPLIFYING ASSUMPTIONS

For clarity of exposition, it is necessary to start off with certain unrealistic assumptions. In the first place, our argument will be developed as though the processes of conceiving a development strategy and working out a plan for its realization were conducted in a proper, logical order, with explicitly stated, mutually consistent premises and resulting conclusions. This is clearly not true of real thought processes, individual or social; even if rationality is maintained, a conclusion is often reached by intuition and justified only afterward. Every experienced practitioner of applied

economics is familiar with this discrepancy between the pure principles of his methods and their actual use, and he usually finds a way to make necessary adjustments. Our second assumption is that individual projects are fully worked out by the time they are accepted and incorporated in the development plan. It is furthermore assumed, for purposes of simplification, that circumstances will not arise in the course of implementation which would necessitate reprogramming a project or changing its scope.

These assumptions will be relaxed later to bring us nearer to reality. The exposition will thus proceed, through gradual approximation, from the abstract (ideal) to the concrete (real).

1.3 SOME DEFINITIONS: STRATEGY, PLAN, PROJECT, "EFFECTS" OF A PROJECT, AND "IMPACT" OF A PROJECT

1.31 Strategy. A particular strategy of economic development is understood, in the present context, to be the result of a process of analysis, value judgments, and choices carried through the following steps.

Step One. The present situation of the country in question is defined by a set of INDICATORS: known or estimated values of certain observables, chosen as representative indices of the total situation. These might include: an inventory of known resources; population figures, distribution of population among various classes of productive activity; gross

national product, outputs of various branches of the economy; numbers of teachers, students, and classrooms, of illiterates; numbers of doctors, nurses, and hospital beds, of the sick, and so on. There will also be indicators obtained by relating primary figures to one another: gross national product per capita, output per acre, productivity per worker, percentage of illiteracy, and so on.

Step Two. The government makes certain value judgments: for a given sacrifice of resources, a rapid increase in production is more desirable than a rapid increase in health (or vice versa); health has an immediate precedence over education (or vice versa); the long-suffering unemployed poor have precedence over self-employed and middle-income people (or vice versa). The fact that in most cases these judgments are not explicitly made or that they simply evolve by default does not obliterate their implicit existence. (A nearly explicit, and often highly controversial, judgment concerns the degree of sacrifice to be borne by the present generation in favor of future ones.)

Step Three. On the basis of an economic, technological, and socio-psychological analysis of the present state of things (as defined in Step One) and of the value judgments (as established in Step Two), the government defines what it considers a desirable situation at the end of a

chosen time interval reaching, say, five, ten, or even twenty-five years into the future. This desirable situation is defined by DEVELOPMENT OBJECTIVES: values of various indicators, differing from present values to the extent to which the government considers the changes both desirable and feasible and also consistent with one another.

Establishing these new, desirable values of indicators involves government choices with respect to each of them against all others taken singly, severally, or jointly.

The degree of detail in which the development objectives are expressed may vary according to the extent to which the government believes it ought to influence the structure and relative composition of the economy. At one extreme, the objectives may contain not much more than the average rate of growth of the gross national product, on the assumption that its most desirable composition should be determined by an unfettered play of market forces, once latent entrepreneurial and managerial talents have been stimulated by appropriate governmental policies. More often, if not always, the objectives will indicate that the government has made a choice, for example, as to changing proportions between agriculture and industry, between imports and domestic production, as to characteristics of an educational system consistent with these changes, and so on. The objectives may even specify the future distribution of incomes. One can probably say

that the more detailed the objectives, the greater the need for governmental intervention.

For objectives to be truly meaningful, they ought to be expressed in terms of exactly the same indicators as those used to describe the present situation, so that there will be complete comparability between the present and the postulated future. This may be very difficult to achieve, however, in countries where statistics and accounting are still rudimentary. Also, indicators appropriate at one stage sometimes become too aggregative at further stages. (For example, indicators of unemployment in the United States have become much more complex as awareness has grown of the importance of such factors as color, education, and age as causes of unemployment.)

Perfect comparability of the postulated situation with the actual situation and, later, of the postulated progress with the realized progress clearly cannot be achieved. Nevertheless, it is of great importance not to introduce unnecessary confusion by making such easily avoidable errors as, for example, stating agricultural objectives (and postulated effects of development projects) in terms of additional acreage and earnings from agricultural exports while describing the present agricultural situation in terms of productivity per acre, workers employed, etc.

Step Four. Once the objectives of economic development are established, a strategy leading to the realization of these objectives has to be determined. A STRATEGY is a design for using the causal relations supposed to exist between variables of a social system in such a manner as to achieve the desired aims. The substance of a government's activities will vary according to the strategic principles it chooses.

Suppose, for example, the government of an underdeveloped country sets as one of its principal objectives the industrialization of its now largely primitive subsistence-farming economy. One possible strategy would be to concentrate directly on investments in the industrial infrastructure, on construction of industrial estates, on long-range credit facilities for factory construction, on protective tariffs for import-substituting manufacturing, on tax exemptions for new enterprises of the desired types, etc. Another strategy, more indirect, would be to concentrate on the development of agricultural markets, on commercialization of the greatest percentage of farming activities, on assuring self-sufficiency in food, and on general education. This latter strategy would reflect a belief that the emergence of a healthy internal market, composed of commercial farmers, for industrial goods would provide the best stimulus for activation of latent industrial and entrepreneurial talents; that the achievement of self-sufficiency in food would release the foreign exchange

necessary for imports of industrial equipment; and, finally, that general education would help industry to create a new class of efficient workers.[1] Although both strategies would have the same final objective, each would try to achieve it through manipulation of different groups of technological, economic, and social variables.

Thus, depending on the strategy chosen, the objectives and activities of the government will be defined and programmed and its achievements measured in terms of different indicators.

Strategy should be capable of being translated into discrete activities. Some of them will be fiscal and financial. Some will consist of preparation and passage of legislative measures (e.g., modernization of chattel mortgages, land titles, perhaps land reform in the case of the agriculturally oriented strategy of our example). Some will consist of direct performance by agencies of the government (or their contractors) of projects involving direct inputs of labor and materials, some of them resulting in permanent fixed assets.

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[1] See Douglas S. Paauw and John C. H. Fei, The Open, Dualistic Economy: Patterns of Development (Washington, D. C.: Center for Development Planning, National Planning Association, August, 1966), Field Work Report #8 (M-8793). Mimeo.

1.32 Plan. A PLAN of economic development, in the broadest meaning of this concept, is, first, a translation of a strategy of development into fully operational terms and, second, an elaboration of general recommendations into detailed, discrete activities.

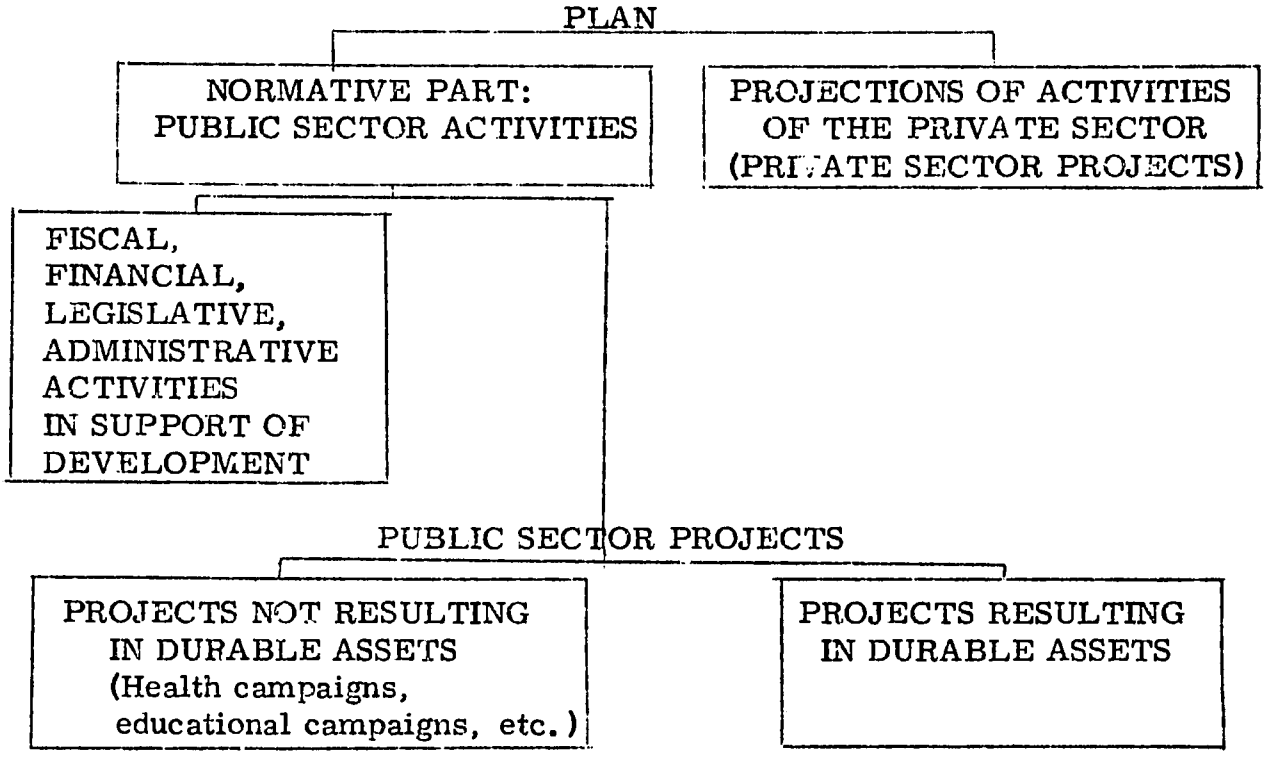
Structurally, a plan is composed of two parts: ENDS and MEANS.

The ENDS of a plan are nothing more than the particular desired values of indicators, in terms of which the economic situation of a country is expressed. These values relate to a particular point in time, say, five or ten years ahead, or they may be expressed, with greater precision, as time series at annual intervals. Insofar as the economy of the country contains a private sector free to make its own decisions, the values of indicators will be of the nature of projections: values expected to be attained, account being taken of what the behavior and motivation of the private sector are believed to be and of the expected influence of governmental development activities on its future behavior. With respect to the governmental sector, the future values of indicators are of a normative nature: it is a duty of the apparatus of government to attain them. (Needless to say, this supposed duty may be difficult or impossible to satisfy if the future values are set without regard to reality.)

The MEANS of a plan are the discrete activities which are expected to bring about the achievement of the desired ends. The same distinction between projections and normative stipulation will apply to these activities, depending on whether they belong to the private or public sectors.

The justification for recommending some activities rather than others is the degree to which they are believed able to contribute to bringing the values of indicators nearer the levels postulated as objectives of the plan.

The following is a diagrammatic way of expressing the various activities forming a plan, as described above.



This study is concerned with public-sector projects, especially those resulting in durable assets. Admittedly, the creative role played by fiscal, financial, legislative, and administrative activities of government agencies in support of economic development is exceedingly important--in many cases probably more important than that of so-called projects. Nevertheless, the sheer bulk of "projects" in the context of a developing economy and the fact that they constitute one of the principal channels through which progress-oriented technological and managerial practices can be introduced into a traditional and stagnant economic milieu make it very much worthwhile to investigate both the way they can best be implemented and their influence (immediate and long-run) on income streams composing the national product.

1.33 Project. For the purpose of this study, a PROJECT is defined as a unit of governmental activity:

a. forming a distinct subject of responsibility which can be assigned to a physical or moral person;

b. capable of having its own accounting.

Different groupings of projects--on subsectoral, sectoral, or regional levels--can be considered as subsectoral, sectoral, or regional plans. They add up to the national plan.

1.34 Effect and Impact. It is of utmost importance, in the perspective of this study, to introduce at this time an operational distinction between two ways in which implementation of a project affects an economy.

The EFFECT of a project is the changes brought about in an economy by a project once it has been implemented. Thus, the effect of constructing an irrigation system, upon its completion, will be:

a. a permanent stream of outputs: water supply of a determined value rendered annually to the farming units in the area benefitting from the project;

b. a permanent stream of inputs required for the operation of the irrigation system (personal services of attendants and maintenance workers, supplies and materials for operation and maintenance, equipment for replacement, etc.).

The IMPACT of a project lies in the changes in the immediate state of the economy and its income-producing streams by the very activity of implementing the project. Thus, the impact of implementing the above-mentioned irrigation project will be:

a. employment of a certain number of skilled and unskilled construction manpower, and some other types of manpower, and resulting income streams;

b. use of certain amounts of (locally produced or imported) materials, supplies, and equipment, and resulting income streams;

c. perhaps certain capital grants, transfers, etc.

1.4 MULTIPLE USES OF A PROJECT DOCUMENT

1.41 The preceding section (1.3) has defined and discussed in some detail the principal concepts involved in the process of rational and conscious planned development: objectives; strategy; the plan, its ends and means; projects, their effects and impact. Earlier, in Section 1.1, we indicated five different aspects under which projects ought to be considered. We can now outline certain characteristics of format which are necessary to make possible a meaningful and fruitful use of a project document in each of these five aspects.

1.42 Contribution of a Project to Objectives of the Plan. This contribution will be measured under the headings of EFFECT and IMPACT (see above, Section 1.34).

To assess the impact of a project, it is necessary that the inputs foreseen for the implementation of the project be specified in the project document in very considerable detail, according to the same classifications of goods and services that are used in the country's national accounts and in

its labor statistics and, presumably, according to which the objectives of the plan are defined. Only if this commonality of classifications is observed, will it be possible to calculate what different income streams will flow from the implementation of the project into different branches and sub-branches of the economy (and abroad), what industries will be stimulated (progress-oriented or traditional ones), what goods in which quantities and what kinds and skills of labor will be in demand. Also, only this commonality of classification will permit calculation of the aggregate impact of various groupings of projects and, finally, of the whole plan itself. Similar commonality of detail will be required in assessing the effect of projects, for similar reasons.

In the absence of such a commonality of classification, the only way to aggregate projects would be on the most general level of total monetary costs. On this level, however, the effect and impact of a project on the structure of the economy in question cannot be discerned.

It is also clear that, if "shadow prices" of certain materials or labor are to be used in assessing a project's contribution to the objectives of the plan, the format of project documents ought to show all inputs in great detail and the classification must be common both for project documents among themselves and for project documents, national accounting, and labor statistics.

1.43 Efficient Programming of Implementation. A country's development plan will typically contain a large number of projects, each of them involving a variety of inputs, material and human. Total annual demand of all projects for all inputs may, in monetary terms, balance the available annual financing. But the timing of aggregate demands for particular strategic inputs, the supply of which may be rigidly limited or uncertain, must be carefully scheduled if bottlenecks, on the one hand, or wasteful slack, on the other, are to be avoided. The evils of bottlenecks in strategic inputs (e.g., cement, structural iron and steel, certain scarce skills, and, generally, imported goods) are well known: suspension of projects; waste and deterioration of partly finished works; demoralization and/or dispersal of manpower; loosening of administrative discipline. The evils of slack are less dramatic, but they, too, involve diminution of the country's potential growth--through unnecessarily large inventories and underemployment of scarce skills.

An efficient system of plan programming must therefore be able to aggregate the demands of all projects for specific strategic inputs, in the form of projected time series (most probably in monthly and annual intervals). In this manner, potential bottlenecks in scarce materials, skills, and foreign exchange can be identified in advance and the implementation schedules can be rephased so as to keep the demands for inputs at all times within the capacities of supply.

Once again, we see how important are both detailed classification of inputs within projects and commonality with the national accounts and labor statistics.

1.44 Efficient Management of Implementation. It is a long way from even the most admirable idea of a project on paper to its actual implementation in the real world. Many a worthwhile project has turned into a failure only because that great gap--between the concept in some persons' minds and its translation into reality by other persons--was not bridged by an efficient management system. Implementation of a project is a complex cooperative undertaking, involving people on many different levels of education and competence and in various relations to the project. Certain crucial responsibilities are given to persons who cannot be expected to follow closely and understand all the intricacies of execution: placing advanced orders for supplies and materials, assuring the availability of labor, disbursing of funds by superior financial authority, periodic inspections by supervisory authorities, and so forth. If all these manifold activities are to take place with a minimum of coordination, without crippling administrative friction and without catastrophic cumulative delays, the project document must serve as a clear, unambiguous blueprint for all concerned, simple enough for managerial personnel at all levels of

sophistication (or of lack of it) to understand and follow, using their basic common sense for interpretation.

There is a growing consensus among experts and civil servants that, for purposes of their execution, governmental development plans ought to be translated into annual development budgets and that individual projects ought to appear as basic accounting units in these budgets. Great progress has been made during the last ten or twenty years in the art of budgeting along these lines: concepts and rules have been developed for "performance budgeting," "program budgeting," and, lately, for the "Planning-Programming-Budgeting" concept involving an ambitious use of systems analysis. For several years, the technical assistance efforts of the United Nations have been spreading these techniques among the emerging nations.

With these developments in view, we can state some other requirements that should be satisfied by a project document in order that it be truly serviceable in all aspects of the implementation of a project:

- The format ought to be such that, without laborious reformulations and recalculations, each project can be considered as a budget subheading (in the manner accepted in "performance budgeting"), subdivisible according to budgetary classifications as well as according to national-accounting and labor classifications.

- The format ought to allow for easy scheduling of orders for materials, supplies, equipment, and contractual services.

- Each item of projected expenditure in the project document ought to be stated in a manner that would permit the accountant and the disbursing officer on the project to use it as a clear criterion for approving or rejecting demands for funds during the actual implementation. In other words, the project document ought to constitute the "credit side" justifying the future expenditures to be debited to the project.

- The project document ought to convey enough information to auditors and technical inspectors to enable them to judge whether implementation is on time, whether the results measure up to the stipulated level of quality, and whether the use of inputs remains within the stipulated limits.

1.45 Accumulation of Experience: Feedback. The format ought to facilitate application of cost accounting with respect to the distinct activities into which a project can be analyzed. Most projects will be composed of fairly standard, modular activities. For example, an irrigation project can be analyzed in terms of such component activities as: earth-moving (reservoirs and canals), masonry and concrete works, building of access roads, etc. It is imperative that the structure of both the

project document and the accounting of actual implementation reflect the technological structure of the project, so that, by proper use of cost accounting, the unit costs of these standard modular activities can be calculated. These unit-cost figures (such as, for example, the cost of a mile of access road) should be used for comparisons between various projects and within large and complex projects, with the aim of increasing the efficiency of execution.

1.5 IMPORTANCE OF COMMONALITY OF INFORMATION

A project proposal is a conditional promise: for certain specified amounts of inputs applied at a stipulated time in a stipulated manner, it promises to realize a certain part of the country's development objectives. Redemption of this promise depends on harmonious and efficient collaboration of the many persons who contribute to the progress of the project. Between the starting point, the proposal, and the ultimate completion there extends a long chain of persons and institutions engaged in different phases and aspects of the project--deciding on its worthiness and role in the development effort, arranging its programming, participating in its actual execution, in supervision and auditing, assessing the effect and impact of the project, evaluating the efficiency of execution, and establishing benchmarks for future reference.

It is a sad waste of time and energy of scarce trained personnel if the information formulated for one stage of this process is not adaptable for use in other stages without difficult and time-consuming calculations. And yet, this is what much too often happens. Consider the many admirable proposals for irrigation, electric power, natural resources development, transportation, etc., which we find in ministries of developing countries, technical-assistance offices, and development-finance institutions. Could many of these be translated readily into schedules of annual development budgets? Does their format permit an aggregation with other projects to show the total demand for specific scarce materials or skills during given periods? Do they indicate timetables of the rhythm of expenditure? Are they properly structured for cost accounting of standard component activities? Does their structure allow us to discover the impact of implementation on various income streams in the country?

What happens in practice is that many analytical operations, highly recommended by the theory of planning and project-making, are never performed. They are always on the agenda of planning institutions, but people simply never get around to them. Among these victims are rigorous cost accounting and calculations (ex-ante or ex-post) of impact on gross national product. Other operations, like annual budgeting, scheduling of financial flows, and identifying potential bottlenecks are done, or rather

improvised, by civil servants and administrators who, to the best of their abilities and under great strain, try to distill the required information from documents which are not structured appropriately. The result is, at best, a great waste of scarce skills; at worst, disastrous technical or financial breakdowns.

The way out of this situation and toward more efficient management of economic development is to structure the "soft-ware" of plan-making, the project document, so that it embodies all information needed through all phases, from the ex-ante evaluation to the ex-post assessment of implementation. This information should be easily accessible for different analytical and accounting operations, without prohibitive cost in terms of time, skill, and energy. We believe that the format suggested in this study provides a departure in this direction.

The following table, indicative rather than exhaustive, shows the great variety of viewpoints and operations, both analytical and decision-making, connected with evaluation and implementation of a development project. It clearly illustrates the need for commonality of information and the great savings in skilled human resources that are bound to result from it.

POINTS OF VIEW INVOLVED IN PREPARATION, EVALUATION, AND IMPLEMENTATION OF AN ECONOMIC DEVELOPMENT PROJECT

INDIVIDUALS AND THEIR FUNCTIONS	INFORMATION SOUGHT	
1. Persons conceiving and preparing new projects	Cost- and quantities-of-inputs data from the experience of already implemented projects (benchmarks)	
2. Persons evaluating submitted projects (Cost/Benefit analysis), recommending and deciding their rejection or adoption and their priority rank	-Input components -Output components -Foreign exchange components	(For eventual shadow pricing and for identification of eventual secondary benefits or drawbacks)
	-Functional classification* of expenditures -Time-profile to assess the influence of changes in the rate of interest applied	
3. Persons interested in the lasting EFFECT of projects/programs/plan on the composition of GNP (Aggregation of projects)	-Input components -Output components	Expressed according to national accounts classification

POINTS OF VIEW INVOLVED IN PREPARATION, EVALUATION, AND IMPLEMENTATION OF AN ECONOMIC DEVELOPMENT PROJECT (Continued)

INDIVIDUALS AND THEIR FUNCTIONS	INFORMATION SOUGHT
4. Persons interested in the immediate IMPACT of the process of implementation of the aggregate of projects being implemented on the equilibrium of aggregate supply and demand within short-run periods	-Economic classification* of expenditures (to detect danger of inflation) -Physical input component aggregate (to detect bottlenecks and/or foreign-exchange difficulties)
5. Persons interested in the qualitative (modernizing) IMPACT of the project/ projects on the activities comprising the GNP	-Physical classification of inputs
6. Persons responsible for translating the plan into an annual DEVELOPMENT BUDGET	-Timing of money flow -Amenability to program (performance) budgeting
7. Managers of projects and their superior authorities, accounting supervisors of operations.	-Financial management data -Criteria for making funds disposable
8. Engineers, agronomists, etc., executing the project; also, technical inspection personnel	-Full specification of projected operations

*See U. N., A Manual for Economic and Functional Classification of Government Transactions (New York: United Nations, 1958). UN Doc. No. ST/TAA/M/12 (Sales # 58.XVI.2)

CHAPTER II

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APPENDIX A A1

STRUCTURING A PROJECT DOCUMENT IN TERMS OF ACTIVITIES

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2.1 ACTIVITIES: GROUPINGS OF INPUTS

The preceding pages were devoted to an outline of various demands for information that ought to be satisfied by a properly formulated project document. It was shown that the information required will be of many different kinds, depending on the technical and political functions of the persons who implement the project in question and those who will ensure that it is implemented in a manner most satisfactory to the nation's economy. It was also shown that the dearth of skilled technical and managerial personnel in developing countries makes it of utmost importance that a project document satisfy, to the highest possible degree, the commonality of information requirements of all these persons; in other words, that all necessary information is explicitly given in a single document properly structured with that purpose in view.

We shall now start to outline an appropriate method of formulating a project document and show how this method satisfies the various information needs we discussed previously.

One of the first things that must be decided is the PRINCIPLE OF GROUPING OF INPUTS to allow a reasonably simple structure of the project document. The logic of the structure must be such that it could grow in detail and sophistication with the progress of skills of the project

planning and implementing organizations, without the need to change its original logic and definitional base.

The most general statement of inputs to a project could be expressed in a single figure: the total cost envisaged. The most detailed statement would be a very long list (hundreds or thousands of pages long, for some very large and complex projects), showing all kinds of inputs; e.g., one-inch nails would be differentiated from one and one-eighth inch nails, and so on for every article or service. These two extremes of information are indeed necessary for certain activities connected with the project--the former for the overall financial decisions, the latter for the actual physical execution according to the detailed blueprints. However, most managerial decisions will require only that there be available (but available at the managers' fingertips) intermediate groupings and sub-groupings of the physically heterogeneous inputs that are to be applied at different points in time.

During the past decade, almost universal recognition has been accorded to a principle of grouping which permits one to start at highly summary levels of basic information and to differentiate progressively down to finer and finer detail, in terms of both qualitative characteristics of inputs and their interrelations in time.

This is the principle of structuring the project document in terms of ACTIVITIES, expressed as sets of inputs (goods and services) related to an operationally defined intermediate or final purpose. The most outstanding application of this principle is the Program Evaluation Review Technique (PERT), a method which now dominates the field of project management and, in its many variants (some of them highly sophisticated), is pushing ahead the frontier of managerial innovation.[1]

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[1] Although PERT is relatively recent among managerial techniques, its literature is already very large: a bibliography published three years ago (Bibliography, PERT and Other Management Systems and Techniques [Washington, D. C.: PERT Orientation and Training Center, Bolling Air Force Base, June 1963]), covering mainly the subject of PERT for 1957 through June 1963, contained 702 entries. The rhythm of publication has probably not slowed down since. However, most of this literature goes beyond our interest in both scope and sophistication. The present writer has found the following publications very useful:

--Robert W. Miller, Schedule, Cost and Profit Control with PERT (New York: McGraw-Hill, 1963);

--U. S. Air Force, Aeronautical Systems Division, Program Evaluation Review Technique (ASD Exhibit ASCER 64-1) (Ohio: Wright-Patterson Air Force Base, Nov., 1964);

--U. S. Air Force, USAF PERT, Vol. I: PERT-Time System Description Manual (Washington: Andrews Air Force Base, Sept., 1963);

--U. S. Air Force, USAF PERT, Vol. III: PERT-Cost System Description Manual (Washington: Andrews Air Force Base, Dec., 1963).

The concept of activity, characterized by a final or intermediate result of a production process, has also gained wide currency in economic analysis.[2]

The most important recent development in the budgeting system of the United States, the "Planning-Programming-Budgeting System" (PPBS), which has become the overall methodological objective of the U. S. Bureau of the Budget, bases its philosophy on grouping of costs in relation to their operational purposes.[3]

The first step in structuring the complex mass of inputs that will be absorbed by implementation of any project is to identify three fundamental groups of activities, into one of which must fall any effort and any material product involved:

1. Direct Activities
2. Service Activities
3. Managerial Activities

The structuring of a project document on different summary levels in this way will be explained presently by means of two simplified

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[2]For example, see Alan S. Manner and Harry M. Makowitz (eds.), Studies in Process Analysis, Economy-Wide Production Capabilities, Monograph 18, Cowles Foundation (New York and London: John Wiley, 1963), particularly Chapters 1, 2, 3, 12, and Appendix.

[3]David Novick, ed. Program Budgeting... Program Analysis and the Federal Budget, A RAND Corporation-Sponsored Research Study (Washington, D. C.: Government Printing Office, 1965).

examples. One of them is a project which, on implementation, results in a permanent capital asset: an irrigation project. The other is a project, the objective and expected result of which is, hopefully, to consist in the very process of implementation, bringing about change but leaving no material assets: a literacy campaign.[4]

2.2 IRRIGATION PROJECT: PHYSICAL DESCRIPTION

The River flows through a hilly area from north to south. Within the area shown on Map 1, it first passes through several miles of a rather narrow and steep-sided, rocky and sterile Valley A; then it flows through the middle of the large Circus B, formed by concave slopes of steep, barren hills and leaves the circus through the short, narrow, deep Gorge C. On leaving the gorge it enters the bottom of the long and wide Valley D. Valley D is limited on the west by the steep eastern flank of Hill Range E, which runs from north to south and forms the western bank of the river. The valley rises gently toward the east, meeting, at its eastern limit, the rim of the Plateau F. The northern peak of Plateau F is lower than the bottom of Circus B and descends very gradually toward the

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[4] A practitioner of PERT will notice, inter alia, this main definitional difference between our method and the prevalent PERT methods: our concept ACTIVITY covers what is usually defined by two concepts, 1) ACTIVITY and 2) EVENT.

south, paralleling, on a higher level, the gradual descent of Valley D. A national highway, already built on Plateau F, passes relatively close to Gorge C on the east.

Valley D, between the river and the rim of Plateau F, has good agricultural soil. It is not intensely cultivated because of insufficient moisture in its present unimproved state; normal rainfall supports only enough growth for some grazing and a little low-intensity farming. The high quality of the soil and the proximity to an important urban market, however, would justify much more intensive cultivation if water were available.

Hydrographic data on the flow of the river and the natural circus formation immediately to the north suggest possibilities of irrigation. It has been calculated that damming up the river at Gorge C and using Circus B as a natural reservoir would assure enough water supply for intensive, year-round cultivation of a considerable part of Valley D, from its northern end just below the gorge to the east-west line drawn from point G to point H.

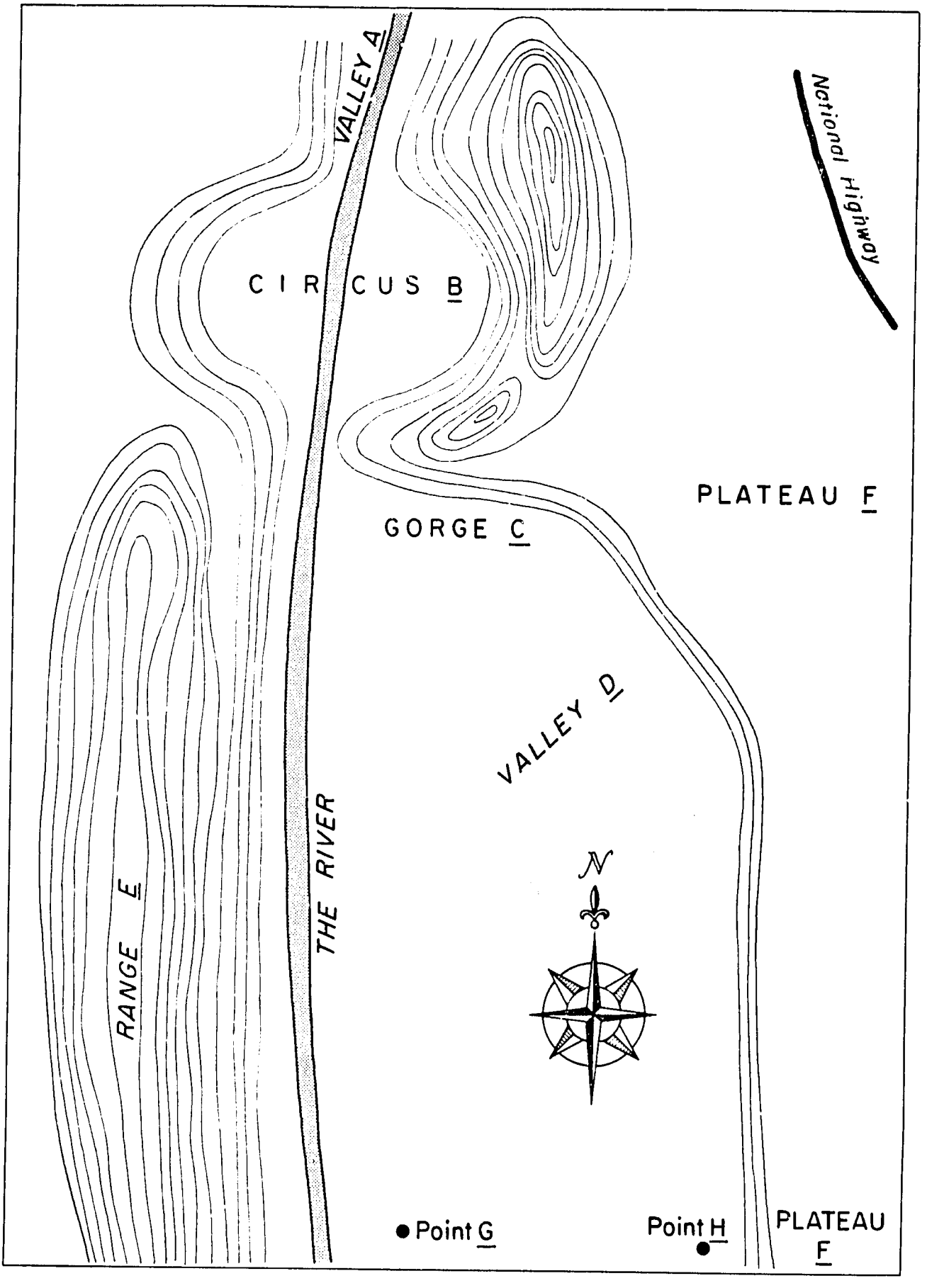
Map 1 shows the area under consideration in its present state.

The proposed irrigation system would involve the following changes in the present water course:

- damming the river at Gorge C, thus raising the water level and converting Circus C and Valley A into a reservoir;

MAP I.

AREA OF THE PROPOSED IRRIGATION PROJECT



- cutting a new outlet through the south-southeast wall of the circus into Plateau F and constructing a main canal which would run in a south-southeasterly direction along the rim of the plateau, parallel to Valley D, to point H, from where it would descend across the valley to join the river at G;

- constructing a system of primary laterals running perpendicularly from the main canal into the valley and a system of secondary laterals (perpendicular to the primary ones) for distribution of water to individual properties in the valley.

Map 2 shows the essential elements of the proposed system.

The project would call for the construction of the following works, which will require regular maintenance and operation once the project is completed and its temporary organization disbanded.

1. Access Roads

   a. from the highway (on Plateau F) to Gorge C;

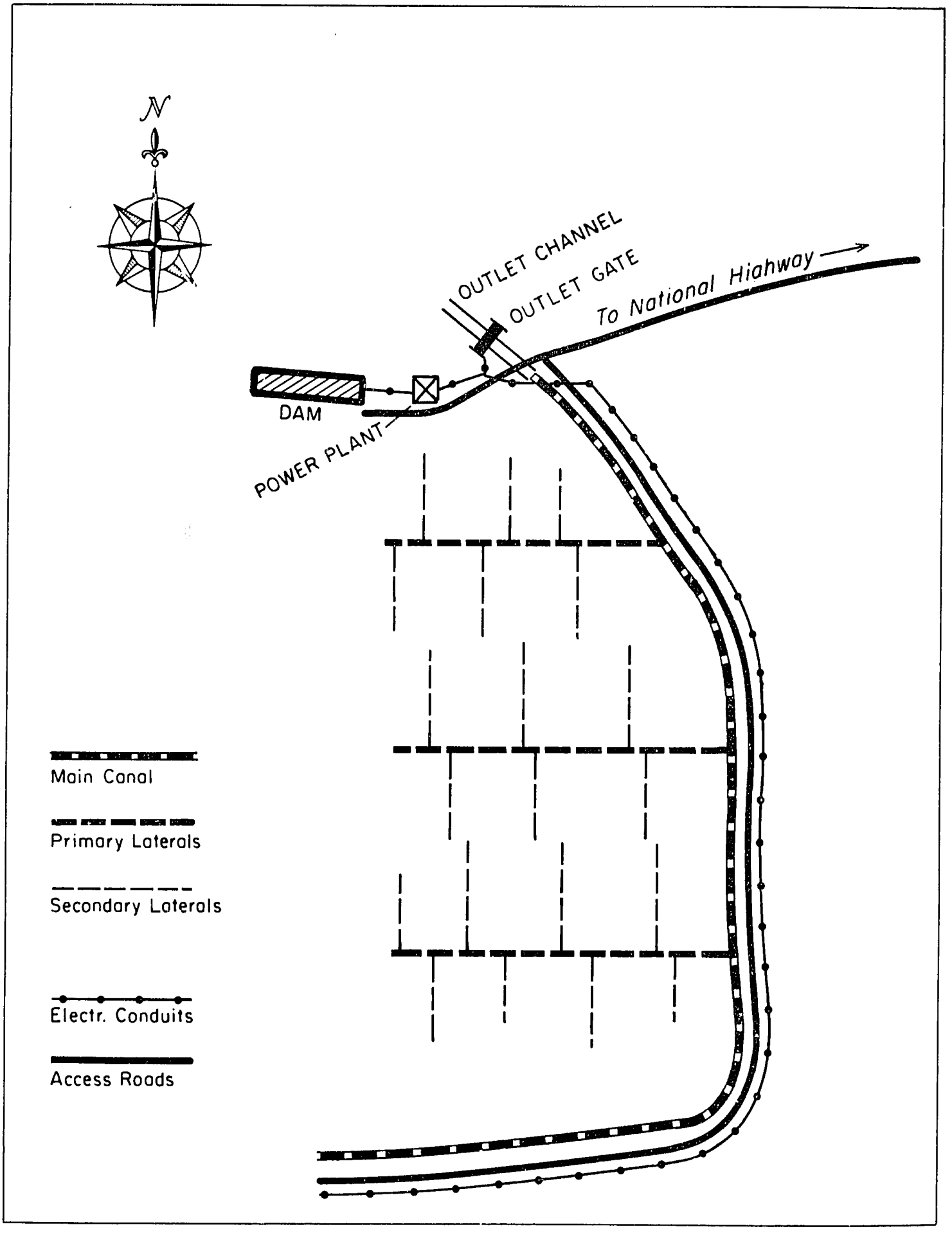
   b. along the entire length of the future primary canal.

2. Dam at Gorge C, with a mechanically adjustable spillway for excess water.

3. Stabilization of the slopes of Circus B and similar improvements to counteract silting and ensure the permanence and good service of the reservoir.

MAP 2.

ELEMENTS OF THE PROPOSED IRRIGATION SYSTEM



4. Outlet channel, from the inside of Circus B onto Plateau F, controlled by a mechanically operated outlet gate.

5. Main canal on the rim of Plateau F, thence to point H and from H to G.

6. Primary laterals.

7. Secondary laterals.

8. Small diesel-power plant, near the dam site, to furnish electric power for:

a. the spillway on the dam;

b. the outlet gate from the reservoir to the main canal;

c. the electricity line along the main canal.

9. Electric conduits from the power plant to the dam, the outlet gate, and along the main canal.

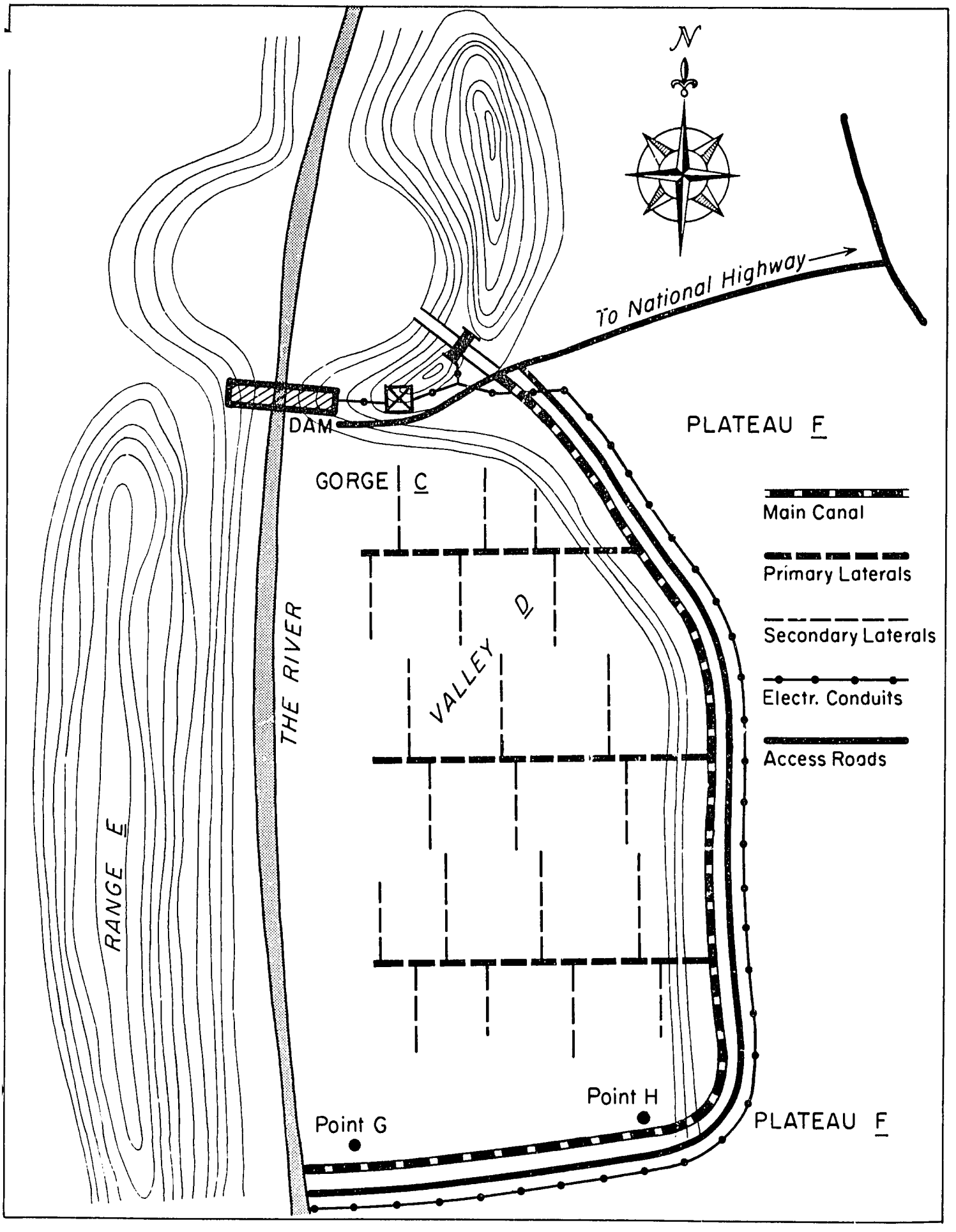
An additional, but impermanent, item of earthwork will also be needed. In order to construct the dam it will be necessary to dig a temporary diversion channel through which the river will flow until the dam and the outlet onto the plateau are ready for operation.

Map 3 shows the elements of the proposed system in their topographical configuration.

We may now proceed to structuring the project document in terms of activities.

MAP 3.

THE PROPOSED IRRIGATION PROJECT



2.3 DIRECT ACTIVITIES

In projects which result in durable capital assets, or in durable improvements in the physical environment, direct activities are defined by discrete elements and sub-elements of various levels of these assets and/or improvements. The division starts from the highest technologically and organizationally meaningful summary level; it then descends through intermediate levels to the detail of ultimate work packages into which the project management sees fit to program the tasks of execution.

Thus, for the irrigation project in question there will be four Direct Activities (code number 1) of the highest summary level:

Direct Activity 1.1 Reservoir system

" " 1.2 Water-transmission system

" " 1.3 Electric power system

" " 1.4 Access roads

It is easy to see how, within these highest-summary-level activities, defined by discrete groupings of the physical assets in which they result, activities of the next summary level can in turn be identified by the component parts of the major items. For example, Direct Activity 1, the reservoir system, can be subdivided as follows:

Direct Activity 1.10 Reservoir system

- Direct Activity 1.11 Land improvement (profiling and stabilizing of slopes above and below the expected water level).

" " 1.12 Storage dam

" " 1.13 Outlet and primary gate (releasing water into the canal system).

" " 1.14 Temporary diversion channel (to permit construction of the dam across the permanent river bed).

" " 1.15 Filling reservoir with water.

" " 1.16 Testing the whole system.

In turn, on the next summary level, we can distinguish still more detailed components:

Direct Activity 1.100 Reservoir system

Direct Activity 1.110 Land improvement

- Direct Activity 1.111 Profiling the slopes.

- " " 1.112 Stabilizing certain rocks on the slopes by cementing, etc.

- " " 1.113 Stabilizing soft slopes by planting trees and bushes.

There is no need for further elaboration of this point. It should be quite clear that the grouping of activities on successive summary levels, as explained above, permits an uninterrupted chain of technological and organized subdivision from the most general definition of the project, at one extreme, to the lowest identifiable work package, at the other. Several other direct activities of various levels are indicated on Figures 3, 5, and 6.

2.4 SERVICE ACTIVITIES

Activities belonging to the service group are defined by their function in the process of implementing the whole project rather than by their relation to discrete fixed assets constituting the outcome of the project (or to discrete nonmaterial objectives in the case of projects that do not result in fixed assets). A typical Service Activity will be the supply of electric energy, by means of a temporary power plant and transmission-distribution lines on the construction site, for power-driven construction equipment, for general lighting, and for temporary offices of construction supervisors. In a project's cost-accounting system, the cost of these activities will be pro-rated among the Direct Activities on the basis of the government's usual criteria.

A relatively short list of typical (quasi-modular) activities will be nearly sufficient to cover Service Activities relevant for the implementation of a great majority of projects in all important branches of public-sector development projects:

- Operation and maintenance of stores and final disposal of unused supplies;

- Operation, maintenance, and disposal of the temporary production plant (stone crushers, concrete mixers, etc.) and of repair shops;

- Operation and maintenance of other equipment;

- Operation and maintenance of general facilities (temporary offices, construction workers' camp, kitchens, dining rooms, etc., temporary heating plant, lighting plant, incinerator, etc.);

- Transportation and communication;

- Temporary roads and improvements;

- Maintenance of general property (lands and structures on the project site which are not used in the project implementation but which will remain the property of the project once it is implemented);

- Construction, wreckage, and salvage of temporary structures involved in all above-mentioned Service Activities.

It is easy to see how the Service Activities can be divided into component activities on lower summary levels.

In the process of project programming and implementation, the Service Activities must be conceptually separated from one another and, above all, from Direct Activities. Their correct programming and successful implementation is a necessary condition for programming and implementation of Direct Activities.

2.5 MANAGEMENT ACTIVITIES

The purpose of the Management Activities is to assure that the ultimate objective--implementation of the project through correct accomplishment of Direct and Service Activities--is achieved. Their contents and their importance for the success of any undertaking are well known and sufficiently described in the specialized literature. Appendix A presents a classification--one of many possible and plausible ones--of these activities to demonstrate that they are amenable to PERT-type programming even on rather low summary levels.

Management Activities, like others, absorb inputs of various kinds and at various time-points (although the composition of inputs is much more biased toward highly skilled personnel services). From the cost-accounting point of view they are treated similarly to Service Activities: their cost is ultimately imputed to discrete assets resulting from the implementation of the project.

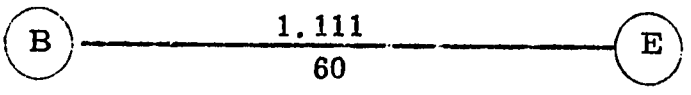
2.6 PROGRAMMING NETWORKS

2.61 PRINCIPAL CONCEPTS

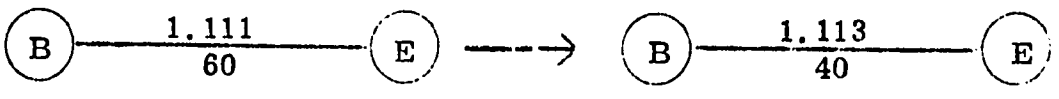
The next step is to present graphically the causal and temporal relationships among the various activities by means of a NETWORK, or diagram. (It must be observed that there is nothing in the diagrammatic presentation that could not be expressed by verbal and numerical description. In fact, of course, the computer calculations of PERT networks are done in alpha-numeric language. However, for an overall comprehension of the problem of any given project, the graphic tool of networks is indispensable and unsurpassable for clarity. It has become a most valued programming tool and perhaps the sharpest single device enabling one to cut through details and complexities to the essentials.)

Each activity will be represented by a segment of a straight line, limited by two circles marked, respectively, B and E, for Beginning and End. The length of the line does not correspond to the time interval taken by the activity; it is dictated purely by convenience. The time interval expected to be taken by the activity will usually be noted in small figures

below the line. Thus, for example, Direct Activity 1.111, "profiling the slopes of the reservoir," assumed to take sixty (60) days, will be represented as below:



A conditional relationship between the end of one activity and the beginning of another, i.e., a relationship in which the latter activity can be started only if the former has ended, is indicated by an arrow, the direction of which indicates the direction of the relationship. For example, Activity 1.113, "stabilizing soft slopes" (40 days), can take place only after Activity 1.111, "profiling the slopes" (60 days), is accomplished. This is shown thus:



The arrow means that Activity 1.113 can be (B)egun only, and only if, Activity 1.111 has been (E)nded.[5]

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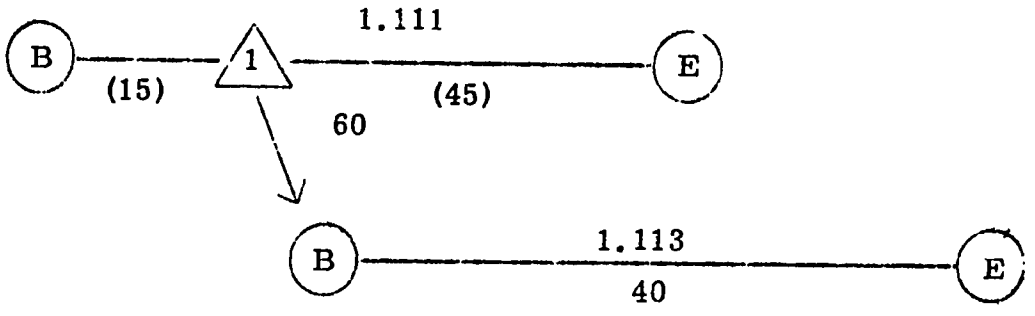
[5]The arrow of our diagram corresponds to what is known as "dummy activity" in more sophisticated versions of PERT.

It may happen that an activity can start when another is only partially accomplished. Suppose that Activity 1.113 can start when Activity 1.111 has been under way for 15 days because we expect that by that day progress on profiling will allow the stabilizing to start. Say, we expect that by the 15th day a certain ravine caused by erosion will have been filled with heavy rock and terraced. We shall call that stage a "Milestone" and shall indicate it by a triangle marked with an appropriate code number. Thus, if the code number of our milestone is taken to be, say, 1, the new graphic configuration will be as follows:



2.62 PROJECT NETWORK: HIGHEST SUMMARY LEVEL

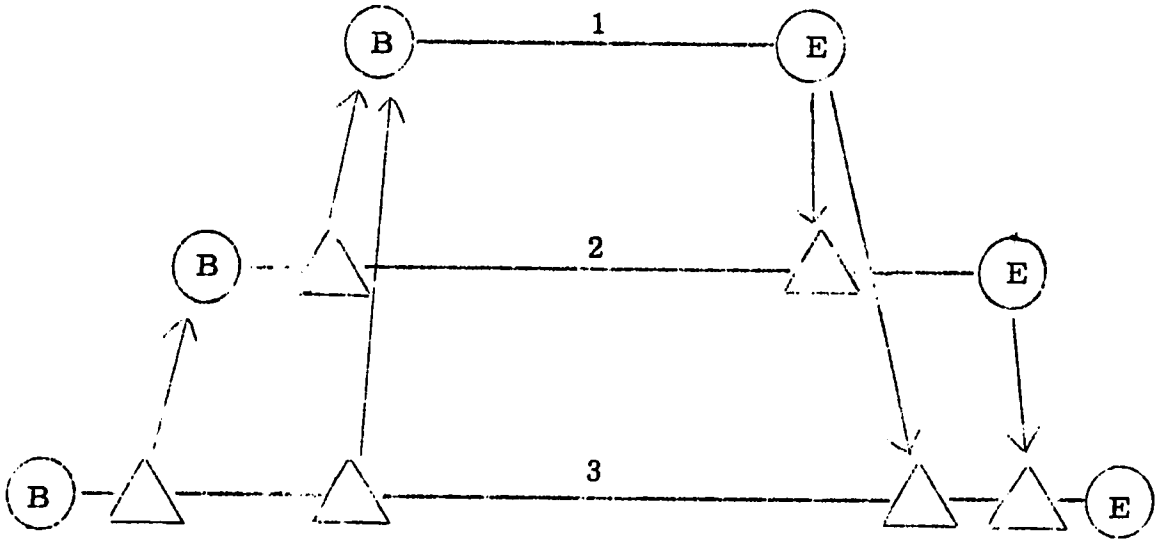
We can now start sketching our network of activities for implementation of the proposed irrigation system. Following accepted practice, we will disregard, for the moment, the time-lengths of various

activities and concentrate, rather, on their sequential relationships in order to establish clearly the causal order necessitated by technological and topographical considerations. Once that is done, we can consider the problems of time intervals involved.

First of all, we ought to establish the sequential relations between the direct, service, and management activities on the highest (one-digit) summary level (Figure 1):

FIGURE 1

SEQUENTIAL RELATIONSHIPS BETWEEN DIRECT ACTIVITIES, SERVICE ACTIVITIES, AND MANAGERIAL ACTIVITIES



Code 1: Direct Activities
Code 2: Service Activities
Code 3: Managerial Activities

The actual contents of the milestones need not be specified. They denote the reaching of certain stages of work that mean "green light" for other operations.

Even this most simplistic presentation of the relations among various groups of activities calls our attention to the fundamental truths (or rather, truisms) that at least certain service activities must precede the beginning of direct activities; that service activities cannot be entirely terminated until all direct activities are terminated; that certain management activities must be underway for any other activity to begin and that, in turn, certain management activities cannot end until all other activities are fully terminated--the residual managerial responsibility! These statements are so evident that they are easily forgotten in practice, with deplorable results for the execution of projects and for the morale of all concerned.

2.63 PROJECT NETWORK: LOWER SUMMARY LEVELS

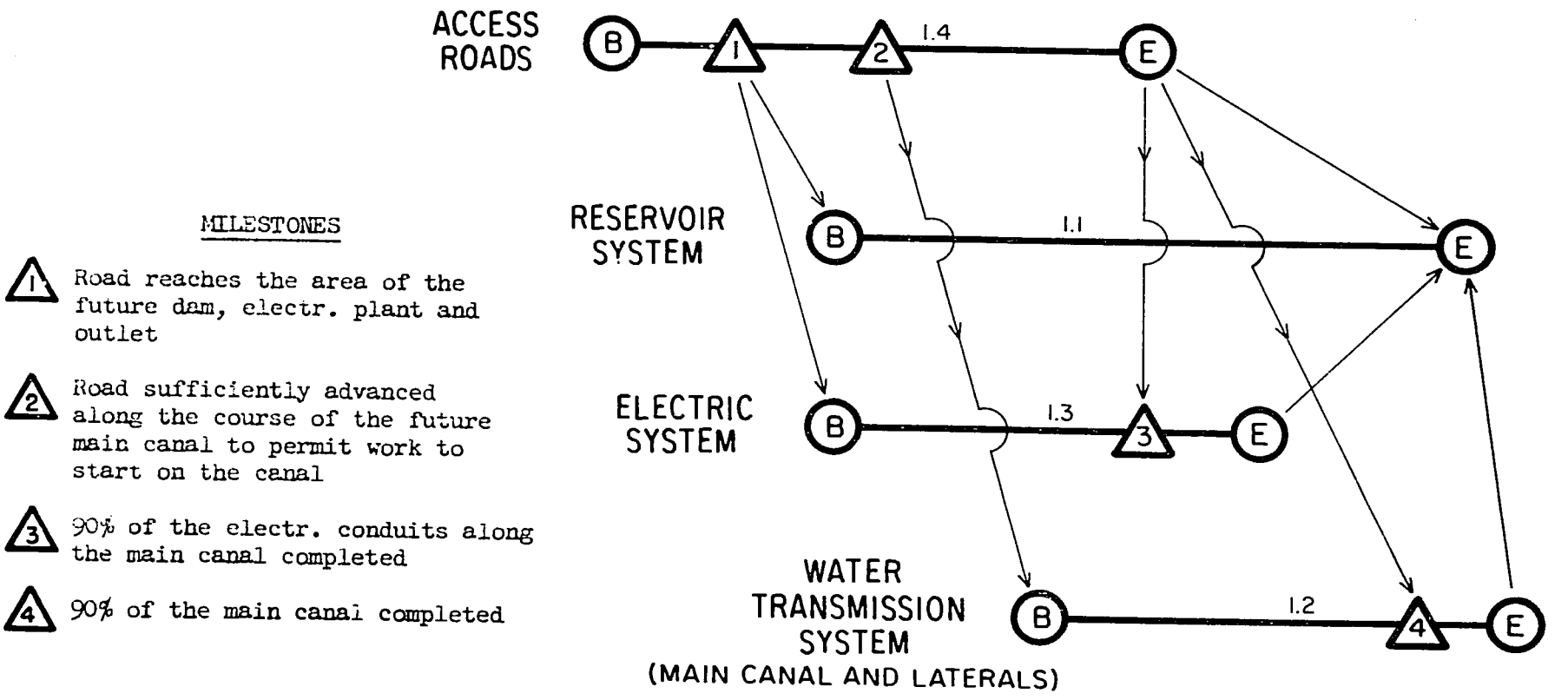
2.631 Direct Activities Network

Let us now turn to the direct activities of our irrigation project. Even the next (two-digit) summary level reveals some crucial sequential relationships among the activities of that group. These are shown in Figure 2.

First, we notice that completion of various stages of Activity 1.4 (access roads) is the necessary condition of execution of other activities. Clearly, any delay in this activity would snowball into delays

FIGURE 2.

DIRECT ACTIVITIES IN THE IRRIGATION PROJECT
TWO-DIGIT-LEVEL NETWORK



in all the others. Milestones 1, 2, and 3 mark the stages of road completion prerequisite to the beginning of work on the reservoir system, electric system, and water-transmission system. The water-transmission system cannot be completed until the road paralleling the course of the canal is completed. Only then can the junction of the canal with the river be executed.

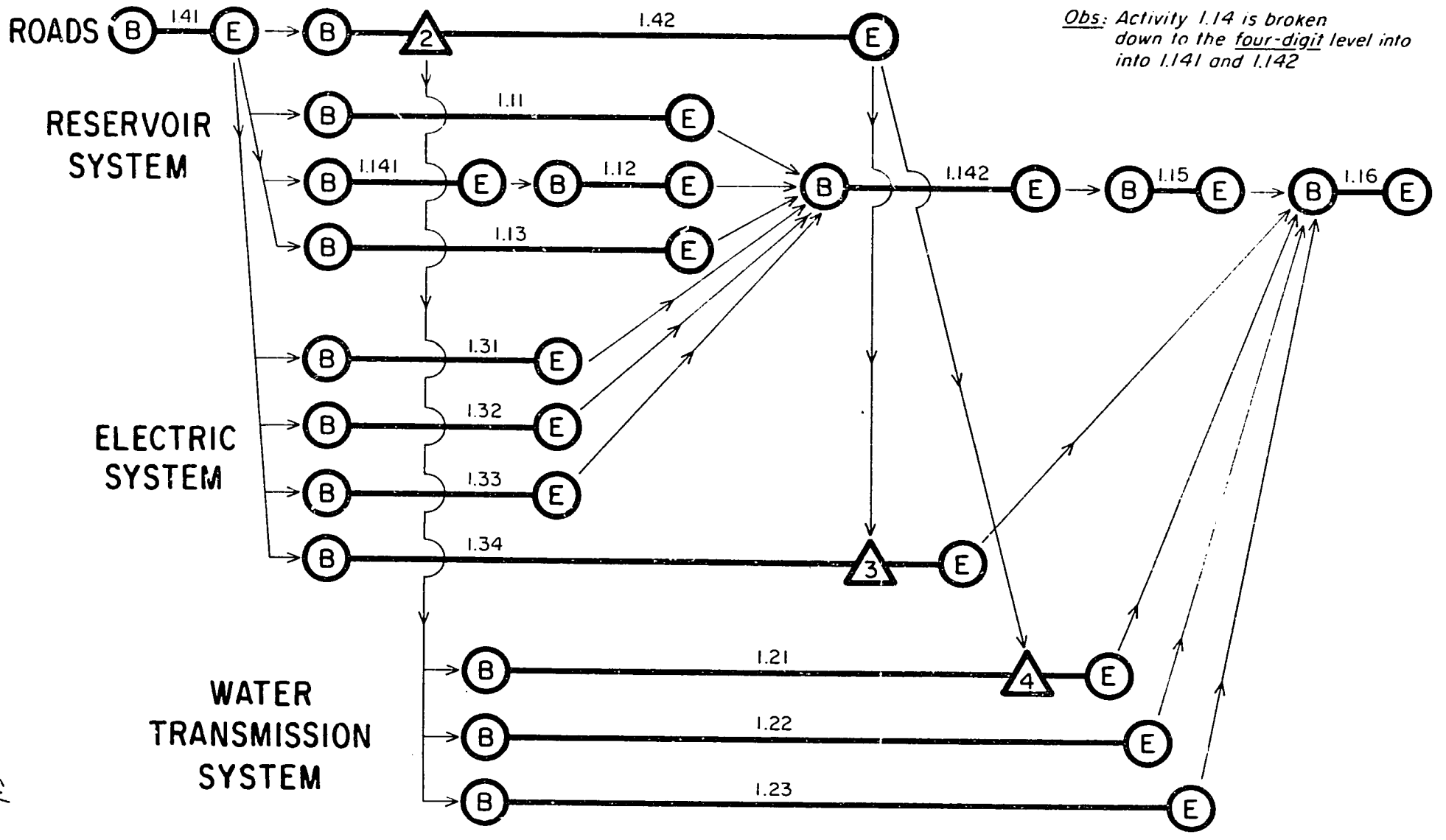
Second, Activities 1.1 (reservoir system) and 1.2 (water-transmission system) cannot be fully completed (i.e., the reservoir, the canal, and the laterals cannot be made operational) until Activity 1.3 (electric power system) is completed, electric power being required to operate the spillway on the dam and the outlet gate and to illuminate the primary canal.

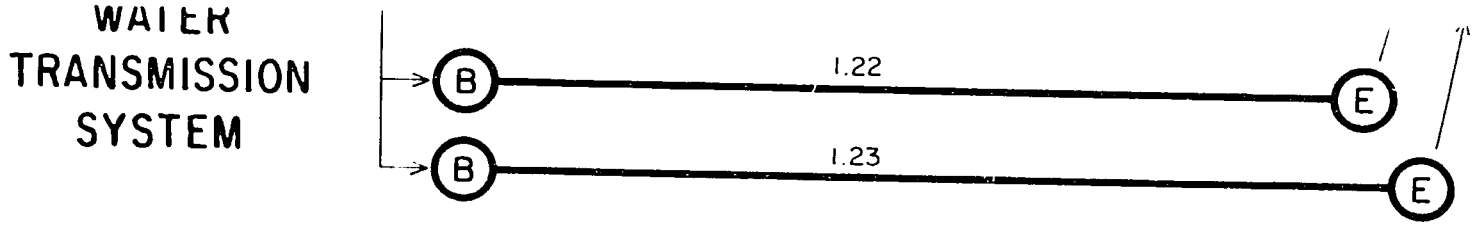
The last summary level we shall discuss here is that of three (and four) digits, shown in Figure 3.

Some new, important interrelationships can be discovered on that level. Apart from the role of the access road, already indicated, we notice another constraint: the crucial importance of the work on the temporary diversion channel (1.141, constructing, and 1.142, filling) for the fundamental element of the whole system: the dam, of course, cannot be started until the river water is temporarily redirected. In turn, the obliteration of the diversion channel (1.142), without which the system

FIGURE 3.

DIRECT ACTIVITIES IN THE IRRIGATION PROJECT
THREE-DIGIT-LEVEL NETWORK





EXPLANATIONS TO FIGURE 3

1.1 RESERVOIR SYSTEM

- 1.11 Land improvement
- 1.12 Storage dam
- 1.13 Outlet and primary gate
- 1.14 Diversion channel (temporary)
  - 1.141 construction
  - 1.142 obliteration
- 1.15 Filling reservoir with water
- 1.16 Testing and adjusting the system (including coordination with the functioning of the main canal and the laterals)

1.2 WATER TRANSMISSION SYSTEM

- 1.21 Main canal
- 1.22 Primary laterals
- 1.23 Secondary laterals

1.3 ELECTRIC POWER SYSTEM

- 1.31 Power plant
- 1.32 Transmission to the dam
- 1.33 Transmission to the outlet gate
- 1.34 Transmission along the main canal

1.4 ACCESS ROADS

- 1.41 From national highway to the dam-outlet-power plant area
- 1.42 From above area, along the main canal to its junction with the river

MILESTONES

2 (as in Figure 2): Road 1.42 sufficiently advanced to permit work to start on the main canal and on the electric conduit along it

3 - - - - - - - - - 90% of activity 1.34 (electric conduit along the main canal) completed

4 - - - - - - - - - 90% of activity 1.21 (main canal) completed.

OBSERVE:

1) Milestone 1, which appeared in Figure 2, does not appear in Figure 3 because, when a distinction is made between the two roads (1.41 and 1.42), this milestone is replaced by the (E)nd of road 1.41

2) The meaning of arrows between the (E)nd of 1.42 and 3 and 4 is that the construction of the road along the canal must be at all times sufficiently ahead (10%) of the construction of the canal itself and of the electric conduit along it in order to afford a margin of safety for an uninterrupted execution of the two latter activities

cannot be made operational, can be undertaken only after the work on the outlet gate (1.13) is completed; otherwise, the rising water level would prevent completion of that work. Finally, the dam and the outlet gate cannot be considered completed and operational until the power plant (1.31) and transmission lines to the dam (1.32) and the outlet gate (1.33) are ready so that power is available for regulating the flow of the river.

We shall not carry this graphical analysis to lower summary levels, where additional relationships of temporal dependencies would be revealed. On the three- and four-digit level, our network already shows with sufficient clarity the tremendous importance of proper synchronization of various component activities if waste of resources--especially those of skilled manpower and of perishable and semi-perishable materials (think only of storing seeds, chemicals, or cement in damp tropical regions!)--is to be avoided. A thorough study of a project's networks on all levels of managerial decision, a habit of considering intra-managerial interfaces in terms of the temporal and causal relationships implied in these networks, could contribute enormously to development of a sense of meaningful participation and collaboration among managerial personnel at different levels by bringing out clearly both each man's contribution to the whole project and his role in helping others to fulfill their tasks on time.

The networks also show with striking clarity the importance of timely procurement of inputs needed in various activities, and they help to identify the strategic nexuses where a shortage of inputs would result in bottlenecks, possibly paralyzing the entire project. Thus, the use of networks as a tool for programming orders and procurements can be invaluable.

2.632 Service Activities Network

Enough analytical detail was given in the foregoing discussion of direct activities to allow us to treat the subject of the service activities (code number 2) more sketchily. We shall not, therefore, proceed beyond the two-digit summary level. On that level we distinguish four activities:

2.1 General facilities: office space, workers' quarters, light, heating, security, etc. (Operation and Maintenance.)

2.2 Equipment: earth-moving, construction, transportation, etc. (O & M.)

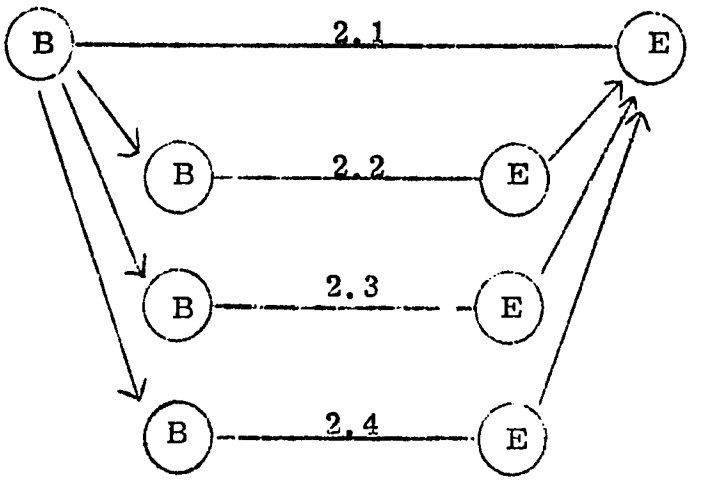
2.3 Stores of supplies and materials (O & M.)

2.4 Production plant and shops: rock-crushing, concrete-mixing, repairs, etc. (O & M.)

Figure 4 shows the simple network of relationships within this group.

FIGURE 4

SERVICE ACTIVITIES IN THE IRRIGATION PROJECT
TWO-DIGIT-LEVEL NETWORK



2.1 General Facilities
2.2 Equipment (O&M)
2.3 Stores (O&M)
2.4 Production Plant and Shops (O&M)

The only temporal relation of dependence appearing in the two-digit network is an obvious one: some of the general facilities (a minimum of office space, living quarters, utilities, security, etc.) must be present and operating in order for other service activities to start. Also, a minimum of operating general facilities must outlast, at least

for a short while, the completion of other activities, so that the whole service role can be terminated neatly.

The simplicity of the two-digit-level network does not preclude, of course, the existence of much more complex dependent relationships on lower summary levels. Surely, the sub-network of setting up the temporary production plant and shops (2.4) should contain a number of tight sequences of various lower-digit activities. The operation of earth-moving and transport equipment (for supply of rock, gravel, etc.) will also depend on operation of the plant.

2.633 Management Activities Network

As mentioned earlier, management activities (code number 3) will not be discussed in detail. Instead, they will be treated as a simple activity--i.e., on the one-digit summary level. Appendix A contains a tentative networking of management activities and certain ideas on the flow of information within a project's management.

2.64 INTEGRATED PROJECT NETWORK: STRATEGIC INTERFACES

Figure 5 represents an integration, on the two-digit level, of three activity groups composing the project. This level clearly reveals the existence of INTERFACES within and at the borders of the project.

In the present context, an "interface" is defined as a relationship between two agents, physical or legal, at least one of which bears responsibility for execution of some, or all, activities of the project. This relationship may involve such activities as a transfer of information, a transfer of responsibility, the handing over of material assets, consultation in areas of mutual concern, or a legally valid transfer of rights.

As long as we consider the project in isolation from its surroundings, interfaces can be found only <u>within</u> the project and they occur between two bearers of responsibilities within it. Examples in this category are:

- transfer, at the proper time, of the responsibility for controlling the water level in the reservoir from the head of the earth-moving team to the head of the dam-construction team;

- flow of orders (information) for future deliveries from the engineering division to the procurement division; and, in the opposite direction, handing over of the machinery where it is received by the procurement division;

- dispatch of drawings (information) from the designers to the road-builders;

- consultation between the head of the production plant and the head of the dam-construction team regarding a shortfall in the supply of concrete.

Breaking down a complex project into work packages, i.e., activities, is logically equivalent to establishing interfaces within the project. It is thus at the same time a most important thing to remember and a near tautology that the essence of good management, especially good "management by exception" (see Appendix A), is so to structure the project as to minimize the friction on the interfaces.

In the present example, Figure 5 shows the simplest, and most crucial, interfaces between the service activities and the direct activities.

1. Establishing of proper stores, of equipment maintenance, and most important, of production plant (preparing concrete mix for the dam, etc.) can be started only after Access Road No. 1 has been completed (Milestone 1).

2. Certain stages of work on the reservoir system, the electric system, and the water-distribution system (Milestones 6, 7, and 8) can start only after the production plant has been in operation for some time and a certain amount of materials (broken rock, gravel, wooden and/or welded elements for transmission lines, etc.) have been accumulated (Milestone 5).

FIGURE 5.

INTEGRATED NETWORK OF THE IRRIGATION PROJECT TWO-DIGIT LEVEL

EXPLANATIONS

1.0 DIRECT ACTIVITIES
- 1.1 Reservoir system
- 1.2 Water transmission system
- 1.3 Electric system
- 1.4 Access roads

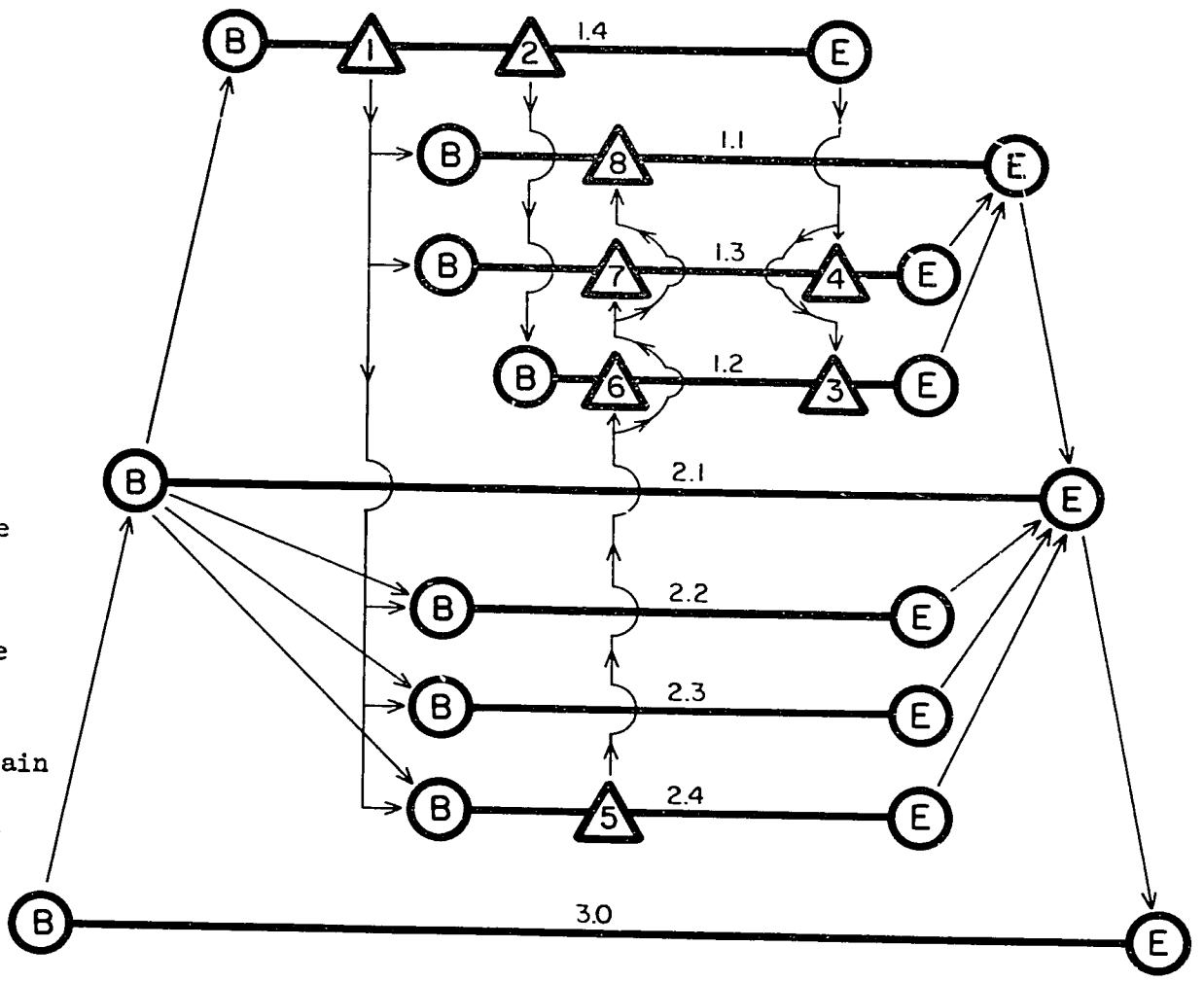
2.0 SERVICE ACTIVITIES
- 2.1 General facilities
- 2.2 Equipment (oper. & maint.)
- 2.3 Stores (oper. & maint.)
- 2.4 Production plant and shops

3.0 MANAGEMENT ACTIVITIES

MILESTONES

1. Road reaches the area of the future dam, electric plant, and outlet
2. Road sufficiently advanced along the course of the future main canal to permit work to start on the canal
3. 90% of the electr. conduit along the main canal completed
4. 90% of the main canal completed
5. Production plant has produced a certain specified amount of materials
6. Use of the above materials starts in Activity 1.2
7. Use of the above materials starts in Activity 1.3
8. Use of the above materials starts in Activity 1.1

Obs: Management activities are shown on a one-digit level (3.0)



Two managerial interfaces form, of course, the alpha and omega of the entire network: the signal to begin and the cutting off of work upon completion.

Once the agents beyond the project are included in our field, the relationships taking place on the boundary of the project can be considered as interfaces of a larger system, a system defined on a higher summary level than the highest summary level of our project. The systems of relationships between the project itself and its suppliers, contractors, and future users (beneficiaries) would all be interfaces of this type. Among others, the following interfaces can be distinguished here:

- transfer of responsibility for maintenance of the irrigation system, upon completion, from the project management to the agency that will administer the use of the water;

- supply of required hydrographic information to the project by an appropriate government agency;

- delivery of ordered goods by suppliers;

- transfer to the project management of elements of the project executed by contractors and the corollary transfer of responsibility for these assets.

2.65 PROJECT CONSIDERED AS A PART OF A LARGER SYSTEM

No project is an island. No project director is a Robinson Crusoe. While it is true that the organizational boundary drawn around a project (and defined in terms of responsibility for activities of the project and capability of being a discrete object of accounting*) is a useful, efficiency-promoting device, it is equally true that the same project is organically imbedded in the complex matrix of the social economy of which it is a part.

From this surrounding a project draws its inputs, human and inanimate. On this surrounding a project depends for fulfillment of various necessary conditions--legal, socio-educational, and technical--without which proper implementation of the project will not be possible. Finally, on the completion of the project, this surrounding must be capable of absorbing it so that the new benefits the project was meant to create can be realized.

Delays and bottlenecks on the interfaces between the project and its surrounding (suppliers, contractors, local authorities, agencies

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*See Chapter I, Section 1.33.

collaborating with the project, superior authorities, etc.) can easily be, as any experienced project manager has learned by bitter experience, more damaging to timely and efficient implementation of a project than difficulties originating internally. Two examples will amply suffice to illustrate the overwhelming importance of these interface relationships.

Large projects involving operations within a considerable area of land (such as irrigation and other water-resource projects, forest conservation and protection projects, etc.) will very often depend on the passage of special legislation concerning land titles, rights of way, compensation, etc., and on the execution of various, often complex, administrative procedures which, in turn, are conditioned on the same legislation. Uncertainties regarding the passage of laws resulting from the vicissitudes of the political process, where technological requirements often fall victim to the nontechnological criteria operative in this process; slowness and hesitancy of administrative action, often compounded by statutory delays: all these difficulties can play havoc with the most skillfully conceived project scheduling, especially where long lead-times are needed for ordering and procuring strategic equipment.

Again, another kind of extreme sensitivity arises on interfaces of projects which presuppose that, on their completion, there will be in existence a sophisticated organization, the personnel of which will have

been recruited and trained concurrently with the implementation of the project in question, and without which the expected benefits of the project will not be realized and the completed assets will waste and deteriorate. This problem, the problem of phasing fixed-asset projects, in their physical and human-adjustment aspects, into the pattern of the on-going surrounding so as to minimize waste during the transition, is organizationally more difficult to cope with than most internal problems of projects. It is also often harder to analyze, due both to inherent difficulties of a systems-analysis kind and to the hesitation of high-level decision makers to face this problem.

Illustrating again by means of our irrigation project: the completed irrigation system will be of little worth and permanence by itself unless (1) the farmers have been trained in its appropriate use and in proper choice of plants, fertilizers, etc., to benefit from it; (2) an organization has been created to operate the system efficiently and equitably and agents have been trained in their functions; (3) the same or another organization has assumed care of maintenance and replacement of the major assets of the system, of the control of silting, etc. Clearly, these tasks transcend the conventional authority and responsibility of the management of an irrigation project considered as a one-time

engineering undertaking: they involve permanent management centers of agricultural extension, marketing, land use, resources conservation, and so on.

These interfaces between very diverse systems, occurring on their various summary levels, pose crucial tasks of programming, coordination, and decision, involving several management centers and not infrequently requiring intervention by the highest managerial agent: the head of state. The often antiquated legislative, administrative, and budgetary procedures prevalent in most countries, characterized by a lopsided interest in the "brick and mortar" aspect of development projects and a distressing lack of appreciation of the "software" aspect (programming and coordination of activities), have not yet developed effective devices to deal with these formidable inter-systemic problems.

Networking, although it cannot claim to solve all difficulties in this respect (the main part of the solution resting in people's mental structures), is at least a tool by means of which much progress could be achieved. Let us turn again to our irrigation project. Its progress will depend, on the one hand, on the efficiency of its management and, on the other hand, on frictionless coordination of the project's activities with necessary supporting activities of such external agencies as, for example, the Ministry of Justice (to assure the appropriate land legislation before

the physical work begins), the Ministry of Agriculture (to relocate the displaced inhabitants before the scheduled time of raising the water level; to organize a permanent operation-and-maintenance service), Treasury and the Central Bank (to assure cash and foreign exchange throughout the implementation), and so on. It is impossible for the managers of all these agencies, harried by their own difficulties, to be as fully and constantly sensitive to the crucial importance of their appropriate and timely acts for the progress of the project as is the project management. After all, for them the project is an activity outside of their own system or, at best, a small part of their system. There is, thus, a need for a device which would serve as a permanent reminder, which would bring over and again to their consciousness, in a very simple and very dramatic manner, the importance of their timely support and collaboration for the success of the project.

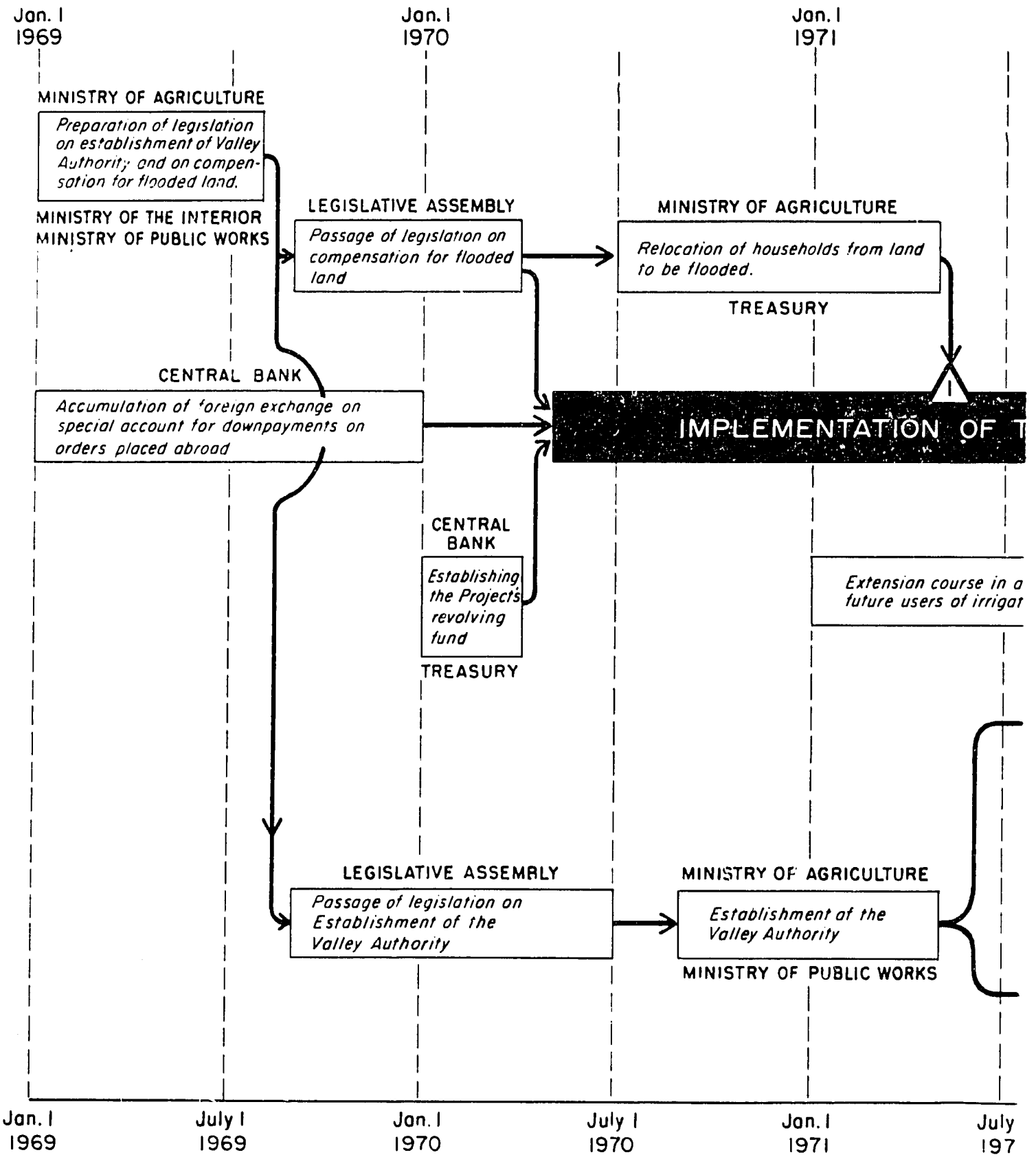
A network, such as shown on Figure 6, could, hopefully, become such a device for demonstrating each agency's role and responsibility in the collaborative process of economic development as reflected in this particular project.

Furthermore, in real life an inter-agency collaboration rarely occurs without frustrating frictions and delays. There is often need for pressure from above to assure coordination between autonomous agencies.

FIGURE 6

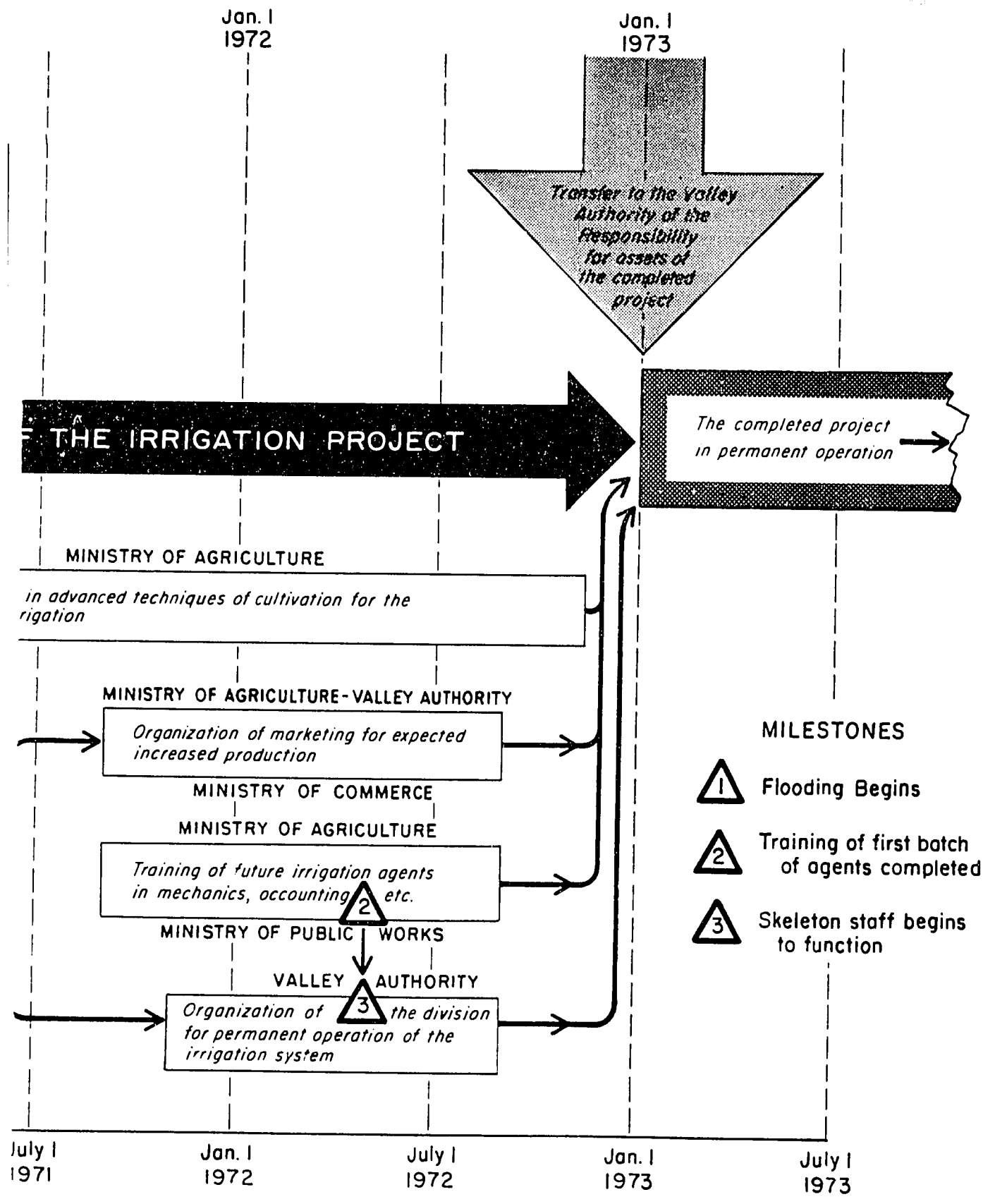
INTEGRATED SYSTEMS

IRRIGATION PROJECT AND SUPPORTING ACT



:MS NETWORK

ACTIVITIES OF OUTSIDE AGENCIES



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In the hands of a minister, prime minister, or head of state, a network like the one on Figure 6 could become a most useful tool in stimulating and catalyzing common action of subordinate agencies on important projects: it would show him at a glance the crucial points of dependence between activities of various agencies; it would localize responsibilities; it would show where he should direct his pressures and encouragements in order to speed up progress toward the success of the project.

2.66 PROGRAMMING TIME INTERVALS OF IMPLEMENTATION: THE CRITICAL PATH

Once the PERT network of sequential relationships among project activities has been established, its usefulness extends throughout all phases of programming and implementation.

The networks we have discussed so far have been "qualitative," in the sense that they showed the consecutive order of conditions to be satisfied throughout the execution of the project (i.e., activities that must be completed so that other activities could begin), without specifying the length of time over which various activities should extend. The next step in the PERT procedure is, thus, to determine the time values that ought to be assigned to each activity at each summary level. These time values are, within limits set by the state of technology, subject to the

programmer's choice. The latter is complex, because a lengthening or shortening of an activity can be achieved not only by a more or less intense use of a given mix of factors of production but also by altering the proportions between these factors. Thus, a stretch of road can be completed faster by making men and equipment work additional hours per day, or by employing more men, or by using more equipment, or by any combination of these measures.

There is clearly a highly challenging maximization problem in determining the most appropriate TIME/RESOURCES pattern implied in the programming of a project and, for projects of substantial size, cost, and length of implementation, there are great economies to be achieved by a good program or great waste that could be caused by an ill-conceived one.

The standard PERT methods apply various computer techniques (all or at least most of them, it seems, iterative in character) to arrive at an appropriate time pattern for a given project. Much work is being done to perfect these techniques and to solve certain special problems. (It is beyond the competence of the present writer to judge how successful that effort has been with respect to the problem of factor-substitution for maximizing efficiency.) For present purposes, however, all we need to know is that such highly sophisticated techniques exist.

Our exposition can be sufficiently supported by a very simple, pencil-and-paper example.

Let us imagine that the persons responsible for programming our irrigation project (most probably the prospective project director and a handful of collaborators), having established the sequential order of activities and having identified the principal causal nexuses, pinpointing potential bottlenecks, move now into the next stage of programming: the time-quantification of the network. Starting from as low a summary level as their experience would suggest, the length of execution of every activity is estimated (according to what the programmers think as most probable), and the appropriate number of working days posted on the diagram, below the activity line.[6]

It is highly recommended, indeed it is a necessary condition of the ultimate success of the project, that these first estimates (and, equally, their further corrections) be made in close collaboration with the managerial personnel of lower level, the persons who will bear the

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[6]Most PERT systems in current use in the United States involve three estimates of the time interval needed to complete an activity: pessimistic, optimistic, and most probable. There is considerable computational complexity involved and much use for computers. For our purpose, with an application in unsophisticated circumstances in view, it seems wisest to forego the sophistications and settle on a single set of values: those considered as most probable.

actual responsibility for executing the component activities on time. The morale of this personnel, their incentive to perform their tasks adequately, will be greatly strengthened by the awareness that they were consulted on this crucial matter and that the whole program has been influenced by the contribution of their professional experience. A man will strive with greater energy and pride to fulfill an objective which he feels is also his commitment, and a measure of his professional skill, than to satisfy a norm which was imposed on him from the outside, without regard to his hard-won experience.

There is an inherent difficulty, however, in the above recommendation. When a project is being programmed (at least on higher summary levels), the managerial personnel who will actually be in charge often have not yet been selected, except for the person slated to be project director and, perhaps, a few of his collaborators. Estimates of time intervals must be made in the form of guesses based on the best available information, without knowledge of who will actually execute the activities in question and what he will think of the adequacy of these estimates. This situation has some characteristics of a vicious circle: on the one hand, the final decision to activate a project and to allocate funds ought to depend on relatively detailed estimates; on the other, such estimates, even in crude form, may be unavailable (especially in a less

developed country) until a certain number of managerial personnel have been recruited and have done a certain amount of analysis and programming.

This difficulty has long been recognized and a number of devices have been used to remedy it. The one most widely used is, of course, the FEASIBILITY STUDY, often prepared by independent consultants. In most cases, however, feasibility studies do not contain enough information to serve as a basis for tight and realistic programming. The U. S. Department of Defense has developed an advanced method by which a project considered as likely, but not certain, to be accepted for execution undergoes a "project definition" in which many of the issues in question may be clarified. This is a costly method, necessary for projects whose staggering costs and sometimes literally astronomical complexities have become the daily fare of developmental effort in the United States. It is an open question to what extent it could be applied in less efficiently organized administrative and technological milieus.

The Economic Programming Center of the National Planning Association has recently evolved a new approach to the problem of advance estimates; it is based on the concept of modular activities and, in our eyes, has very promising possibilities. This approach is discussed later in this study.

At this point, all that can be said is that, in the absence of the persons who will actually be responsible for execution, the programmers ought to consult all contactable professionals possessing appropriate skills and experience in order to arrive at their first estimates of time intervals needed for executing the component activities of the project.

The first estimate of time values will result in a network diagram identical in design with those shown on previous pages, but, in addition, figures of expected time-lengths of execution will be attached to its respective activities. Figure 7 shows such a diagram for the direct activities of our irrigation project on the three-digit level: it is a reproduction of the network shown in Figure 3, with time values in numbers of working days added. (For simplicity, the diagram was limited to direct activities. It will be obvious, however, that the principle used extends itself without difficulty to the integrated network of the whole project.)

We observe that, among various recognizable sequences of direct activities, there is one, running from the beginning of the network to its end, in which the total of all time-lengths of activities forming it is larger than the total of any other sequence. This sequence is shown in the following table.

FIGURE 7.

FIRST ESTIMATE OF TIME VALUES OF DIRECT ACTIVITIES IN THE IRRIGATION PROJECT: THREE-DIGIT-LEVEL NETWORK

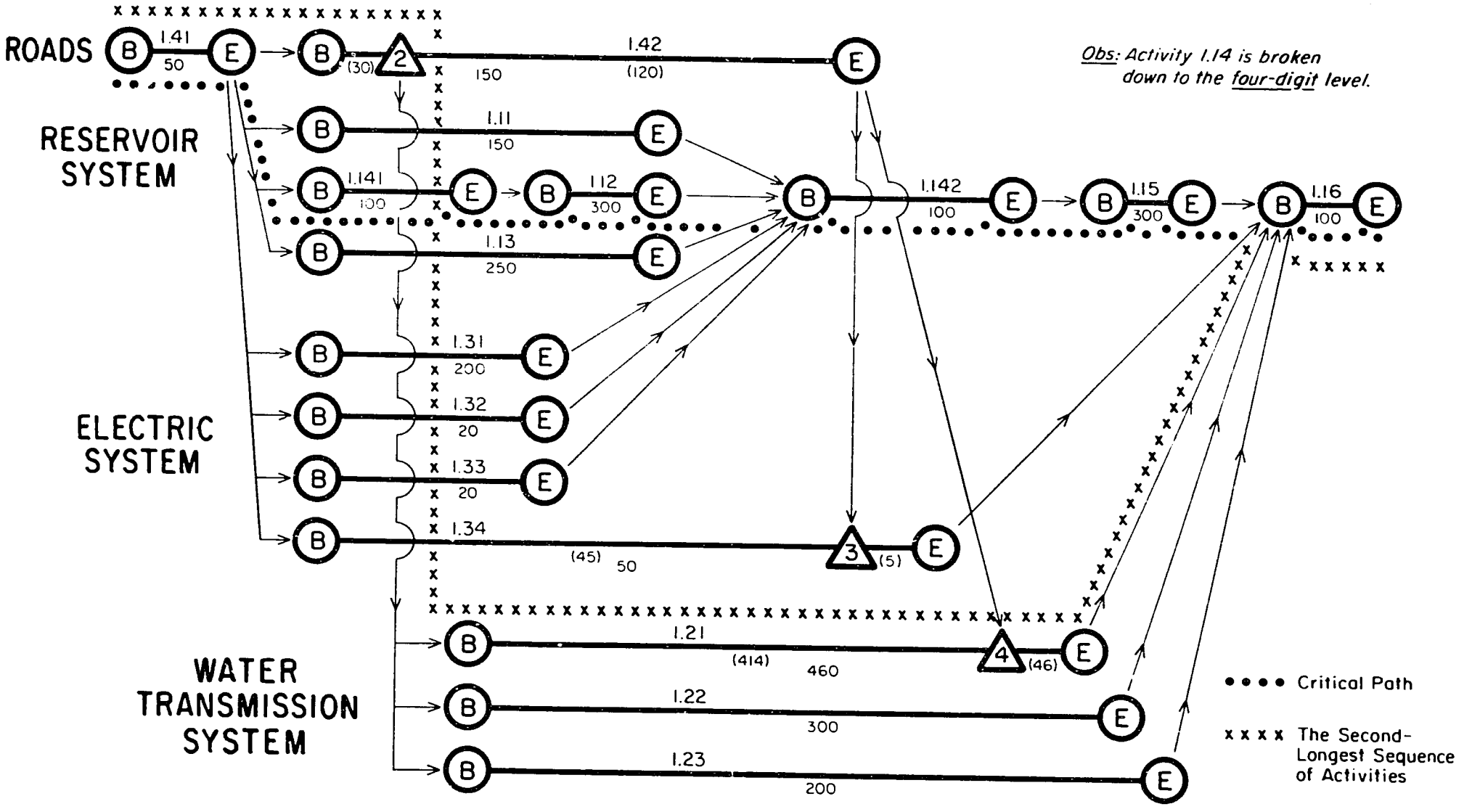


Table 1

THE LONGEST SEQUENCE OF DIRECT ACTIVITIES
IN THE IRRIGATION PROJECT

"THE CRITICAL PATH"
(Calculated from Figure 6)

Activity Code	Time-Length in Working Days
1.41	50
1.141	100
1.12	300
1.142	100
1.15	300
1.16	100
Total	950 days

The sequence shown on Table 1 is marked on Figure 7 with a heavy dotted line. Such a sequence is called the CRITICAL PATH, and it is critically important. It determines the minimum length of time that implementation of the direct activities of the project will take, given the programming implicit in the network.

Let us now find the time-length of the second-longest sequence of activities. This sequence is shown on Figure 7 by an X-ed line, and its duration is calculated below in Table 2.

Table 2

SECOND-LONGEST SEQUENCE OF DIRECT ACTIVITIES
IN THE IRRIGATION PROJECT
(Calculated from Figure 6)

Activity Code	Time-Length in Working Days
1.41	50
1.42 (from beginning to Milestone 2)	30
1.21	460
1.16	100
Total	640 days

The difference in time-length between the Critical Path and the next-longest sequence is called SLACK; in this case, 950 days minus 640 days--i.e., 310 days.

The existence of the slack in this case means that the beginning of Activity 1.21 (construction of the main canal) in principle could be postponed by any length of time up to 310 days (after Milestone 2, the precondition of this activity, had been reached) without delaying the execution of other activities. (In practice, external circumstances, such as a rainy season, could somewhat limit the theoretically perfect elasticity of the slack.)

Similarly, other sequences of activities will show various amounts of slack in comparison with the Critical Path. The Critical Path itself cannot, by definition, contain any slack: the slack is measured with reference to the Critical Path.

A certain amount of slack is normal and unavoidable in any project for various reasons of technology, indivisibilities, seasonal patterns, etc. However, an abnormally large amount of slack--and what is "abnormal" can be decided only by experienced practitioners--would indicate shortcomings in the programming and the possibility of improved scheduling.

If one sequence of activities takes much less time than another, it is sometimes possible to achieve economies by diminishing the application of resources in the "short" sequences and increasing them in the "long" sequences, thus reducing the overall length of the implementation of the project.

This kind of readjustment is an iterative process which may go on as long as the management feels that the resulting marginal economies--i.e., gains in the efficiency of project implementation--justify an additional expenditure of time and effort by skilled engineers, programmers, etc. (and perhaps a delay in starting implementation because more time is being consumed by programming).

In the case now under our consideration, a reprogramming to eliminate the excessive amount of slack in the second-longest sequence could take the form of transferring certain amounts of men and machinery from the work on the main canal (Activity 1.21 - see Table 2) to the diversion channel (Activities 1.141 and 1.142 - see Table 1) and to the construction of the dam (Activity 1.12 - see Table 1). As a consequence, the second-longest sequence would take more time (as we have seen, the existing slack allows that), but the Critical Path would be shortened and, therefore, the entire project could be brought to completion earlier.

Table 3 shows the effect of such a reprogramming.

By stretching out the time taken to execute Activity 1.21 by a hundred days and transferring part of the resources engaged in this activity to activities 1.141, 1.142, and 1.12, it becomes possible to shorten the time of the latter (and, therefore, of the Critical Path) by a total of 80 days (20 + 20 + 40) and thus speed up completion of the entire project.

A technical analysis of the network on Figure 7 might reveal more such opportunities. For example, some resources could be transferred from Activity 1.11 (land improvement of the reservoir), which enjoys considerable slack with respect to the part of the Critical Path formed by Activities 1.141 (construction of the temporary diversion channel) and 1.12 (construction of the dam). In this manner the Critical Path could be shortened further.

Table 3

REPROGRAMMING OF THE CRITICAL PATH AND OF THE SECOND-LONGEST SEQUENCE OF DIRECT ACTIVITIES IN THE IRRIGATION PROJECT
(Compare with Figures 1 and 2)

"New" Critical Path		"New" Second-Longest Sequence	
Activity Code	Length:Days	Activity Code	Length:Days
1.41	50	1.41	50
1.141	80	1.42 (from beginning to Milestone 2)	30
1.12	260	1.21	560
1.142	80	1.16	100
1.15	300		
1.16	100		
Total	870	Total	740

The "New" SLACK enjoyed by the second-longest sequence:
870 - 740 = 130 days.

It may happen that no amount of transferral of resources from slack activities to activities on the Critical Path will shorten the time-length of the latter. This will be the case when the cycle of seasons or biological growth governs the events of the Critical Path, when the

carrying on of the work must await the delivery of heavy machinery manufactured to order for the project, when there are legal delays to passage of a new law, etc. In such situations, the slack may be taken advantage of by simply stretching out the appropriate activities in order to economize resources and/or smooth out the schedule of financing.

The definitively time-adjusted version of the network, although identical in pattern with the first, will now correspond to the revised time intervals assigned to various activities. Its overall time-length may have been shortened or lengthened and, in the course of these shifts, the total amounts of inputs required for the project may also have changed.

The whole preceding explanation of the Critical Path and of relevant time-adjustment techniques was made with reference to a limited illustrative context of direct activities. This was done in order to simplify graphic and numerical exposition. Once, however, this important concept and its uses have been understood, it becomes clear that they are equally applicable to all other activities, both service and management. In fact, it is obvious that the Critical Path <u>for the whole project</u> must start and end with management activities: (1) the decision to start work and (2) the constatation that nothing more remains to be done.

The Critical Path for the whole project will, in most cases, move from certain management activities to activities in the service category to direct activities and thence back and forth before finally coming to rest at the (E)nd of management activities.

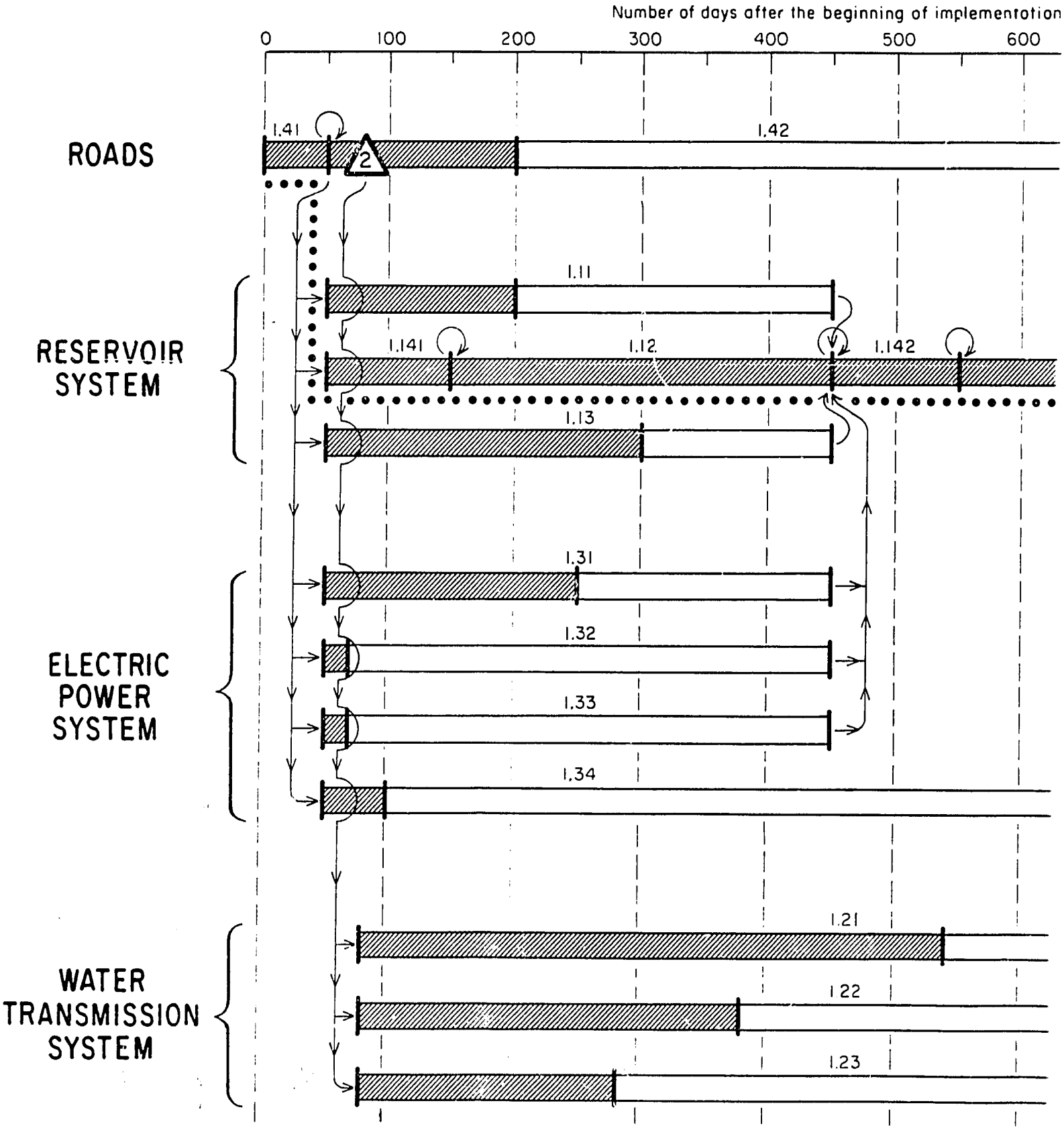
2.67 PRESENTING A NETWORK IN TIME-SCALE

One last step can be made in the graphic presentation to make our network an even more effective and versatile tool for management: to introduce the relative time-scale, as is done on GANTT CHARTS. In this manner, the advantages of both systems of presentation will be unified in a single graph which will show not only the causally determined sequential order of activities but also their expected extension in the calendar scale in a future counted from the postulated beginning of implementation. The latter feature is of special interest for procurement, auditing, and other branches of implementation which require exact knowledge of the lead-times characterizing the ordering or accumulation of certain inputs.

A simple graphic convention concerning the treatment of the slack will be adopted at this stage. Although in actual implementation the slack enjoyed by a given activity may be consummated before the beginning of this activity, or after its completion or intermittently during it, on the network diagram the slack will always follow the activity to which it is related.

FIGURE 8.

DIRECT ACTIVITIES IN THE IRRIGAT
TIME-SCALE NETWORI



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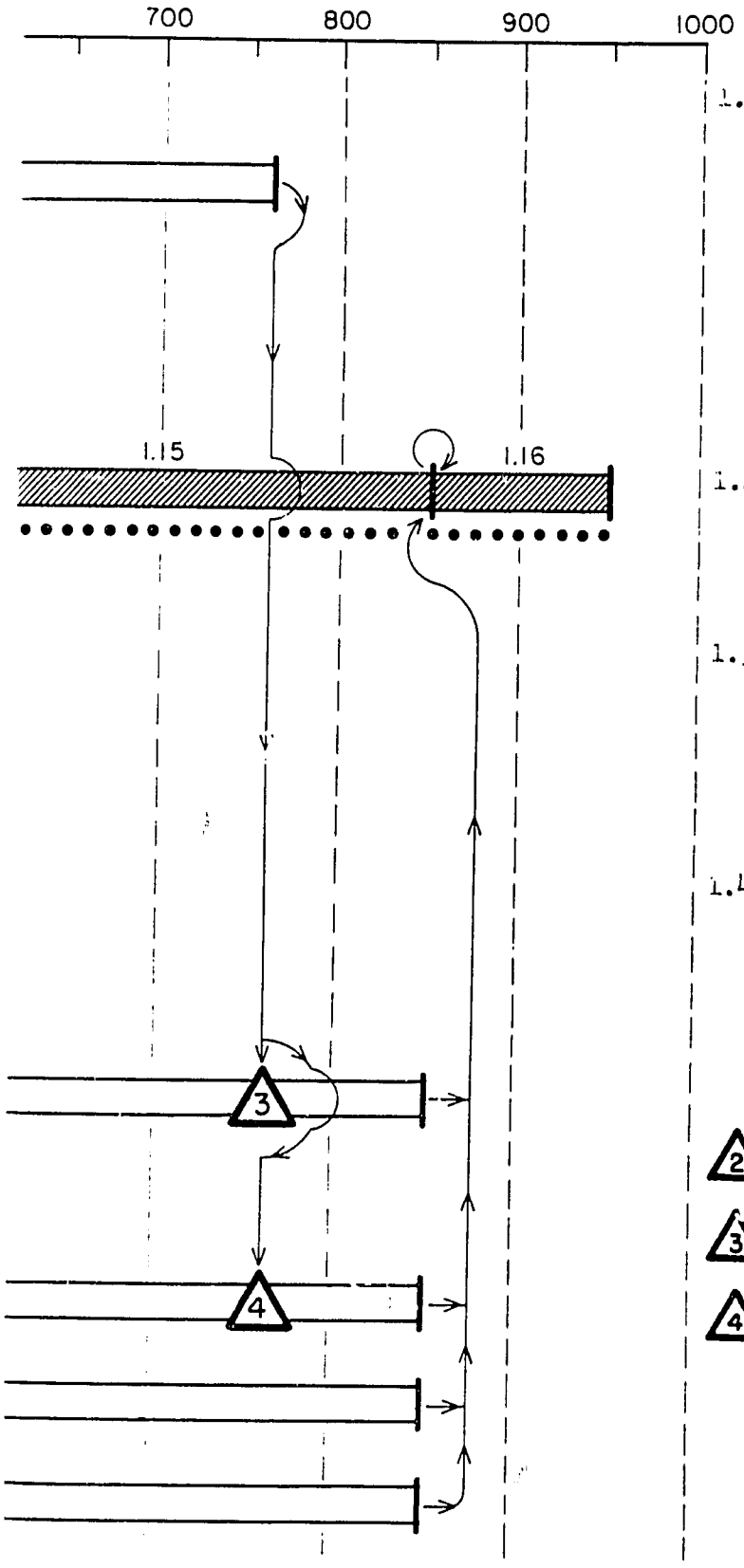


EXPLANATIONS

1.1 RESERVOIR SYSTEM

- 1.11 Land improvement
- 1.12 Storage dam
- 1.13 Outlet and gate to the main canal
- 1.14 Diversion channel (temporary)
  - 1.141 construction
  - 1.142 obliteration
- 1.15 Filling reservoir with water
- 1.16 Testing and adjusting the system (incl. coordination with main canal and laterals)

1.2 WATER TRANSMISSION SYSTEM

- 1.21 Main canal
- 1.22 Primary laterals
- 1.23 Secondary laterals

1.3 ELECTRIC POWER SYSTEM

- 1.31 Power plant
- 1.32 Transmission to the dam
- 1.33 Transmission to the outlet gate
- 1.34 Transmission along the main canal

1.4 ACCESS ROADS

- 1.41 From national highway to the dam-outlet-power plant area
- 1.41 From above area, along the main canal to its junction with the river

MILESTONES

2 Road 1.42 sufficiently advanced to permit work to start on the main canal

3 90% of activity 1.34 (electr. conduit along the main canal) completed

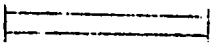
4 90% of activity 1.21 (main canal) completed

CRITICAL PATH

1.41 + 1.141 + 1.12 + 1.142 + 1.15 + 1.16 marked by a dotted line: ••••••••••••••

See also observations 1) and 2), Figure 3.

We shall represent the time scheduled for activities by solid bars:

The slack will be shown by parallel bars: 

Thus, an activity starting on the thirtieth (30th) day after the beginning of the project, scheduled to take fifty (50) days, and enjoying twenty (20) days of slack will be shown as follows:

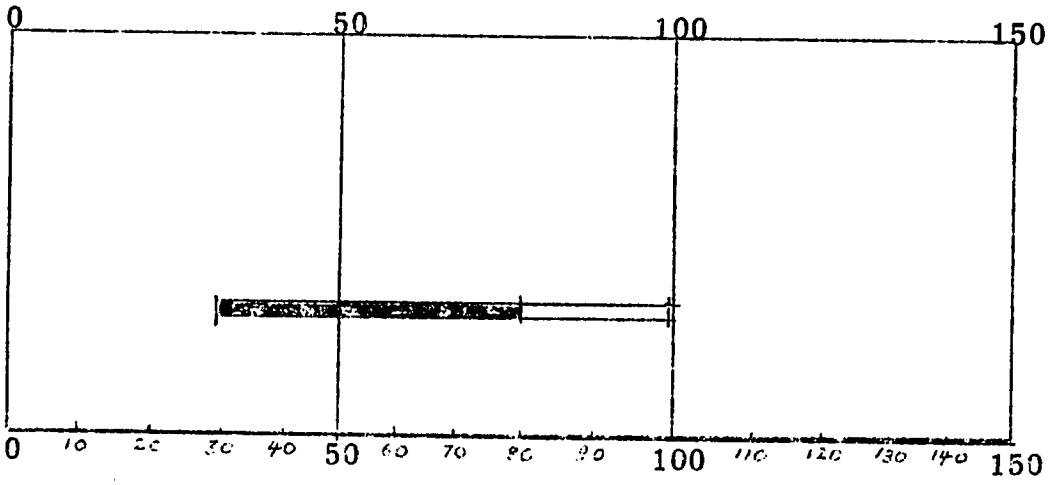


Figure 8 shows the final version of the network for direct activities in the irrigation project drawn according to these principles. (To allow for an easy comparison this version shows the same time intervals as those in Figure 7; it does not incorporate the reprogramming indicated in Table 3.) The horizontal scale of the graph being proportional to relative time intervals, there is no need here for figures denoting the duration of activities which were needed on preceding graphs.

As in preceding presentations of networks, the arrows indicate the relations of dependence between various pairs of activities. However, in the present graphic format, in which every unit of horizontal length stands for a unit of time, no unaccounted horizontal space can be allotted to arrows; the latter must be, therefore, drawn in somewhat tortuous fashion.

2.68 PRACTICAL ADVANTAGES OF NETWORK DIAGRAMS

Enough has been said to indicate the very great usefulness of the PERT-network technique for efficient scheduling of project implementation. In principle, one could obtain similar results by using only language and mathematics. In practice, this would be impossible. The networks, on their various levels of generality, reveal the whole complex pattern of interrelationships among activities of a project, a causality that must be observed and honored in order to bring a project to successful completion. In most cases, these complexities surpass the powers of imagination and retention even of highly competent technicians and programmers. In countries where the tradition of large, technologically complex projects is only now being implanted, the network technique may well become the greatest single tool permitting managerial personnel to grasp the reality of tasks facing them in execution of development projects.

The advanced PERT systems make great use of computers for the process of adjusting the time schedules: in many highly sophisticated projects, computers are almost mandatory because the networks contain so much detail. This stage will be reached one day by projects in the emerging countries. For the time being, however, the main advantages of network programming for these countries lie in its logic and its ability to impress on programmers and managers the crucial role of interdependencies within projects that must be satisfied for successful implementation.

2.7 PROGRAMMING NETWORKS IN PROJECTS WHICH DO NOT RESULT IN FIXED ASSETS

2.71 PECULIARITIES OF THIS TYPE OF PROJECT

There is a very broad class of projects bearing the characteristics of a campaign. Typical examples are: literacy campaigns, campaigns for exterminating certain endemic diseases, concentrated drives to introduce certain agricultural and/or marketing practices, introduction of a cadastral survey in a primitive land-holding system, etc. Since these subjects are, as a rule, also dealt with regularly by educational and health authorities, agricultural-extension agencies, and so on, the demarcation line between "projects" and "regular activities" is difficult to draw and sometimes has to be arbitrary. The characteristics that distinguish

"projects," in most cases, are: nonrepetitiveness; aiming at a more-or-less dramatic breakthrough; and special organizational arrangements made for this specific purpose, usually formalized by a separate chain of command, with a parallel chain of responsibilities, headed by a "project director" or his equivalent. Thus, a literacy campaign will cater to people who have not been able to profit from the regular educational facilities and who in all probability could not do so in future unless a special, dramatic effort is made to reach them. An anti-disease campaign will aim at covering, during one relatively short interval, a very large proportion of the population in order to break the vicious circle of the disease and make it controllable in the future by the regular health facilities.

Practically all projects of this class involve intensive application of certain special skills in a human environment which has hitherto suffered from a severe insufficiency of these very skills and where ignorance, deeply rooted misconceptions, and often generations-old emotional grievances may cause suspicion and even hostility toward the project workers. Hence, the immense role of good motivation among the project personnel and of the right kind of psychological approach in their dealings with the intended beneficiaries of the project.

Paradoxically, it is exactly in this kind of project, loaded with emotional minefields and booby traps, that seemingly "mechanistic" methods of project formulation and programming can often be most useful. Examples of spectacular success, and equally spectacular failure, are easy to find in the campaign-type projects already carried out in different countries or regions. One million-dollar campaign in country A gave excellent results; a similar campaign of the same size in country B ended in nothing. Why? Laborious post-mortems--often acrimonious and involving the settling of political and personal accounts, lacking a clear and relatively objective method of analysis and comparison--will rarely uncover what really went wrong with the project and/or its implementation.

It is our firm belief that a project document (and project implementation reports) clearly structured in terms of activities relevant to the objectives of the project and in terms of the various inputs absorbed by these activities--a PERT-type programming, in other words--could greatly help to locate shortcomings and indicate ways to avoid them in future projects. A comparison of the million-dollar campaign in country A with that in country B could perhaps show that, while total expenditures were equal, relatively small differences in the apportioning of inputs to various activities and small differences in timing accounted for the success in A. Perhaps 5 per cent of total funds needed to be shifted from

the ostensible objective of the campaign (say, the teaching of some new technique) to motivation activities (showing of moving pictures, bringing in an orchestra, etc.) in order to break the emotional ice between the project workers and the population. Perhaps, again, a slip in timing accounted for the failure: if people were properly motivated for vaccination in May but the nurses with their needles arrived only in June, the right feelings and ideas had had time to evaporate; the old misgivings came back and mothers did not bring their children to the dispensary.

However, the utility of the suggested structure of the project document is not limited to finding out afterward what went wrong with a project. Advantages of more positive kinds are even greater. These advantages should, we believe, be vividly clear to anyone who has had a first-hand, real-life experience of the hopes and heartbreaks, rewards and miseries, one lives through in a campaign-type project in one of the underdeveloped regions of the world. Much of the direct force of the argument, which such a person will perceive almost intuitively, gets lost when put on the pages of a technical paper like the present one. We can only hope that the following listing of a few among the advantages claimed for our system will not obscure the real-life urgency behind the words:

- The success of campaign-type projects depends, to a high degree, on timely availability of certain kinds of equipment which are often

scarce in the less developed countries and often have to be rationed by means of formal or informal interagency pools: jeeps for dependable transport, movable audio-visual equipment, mimeographing, duplicating, and offset equipment for preparation of campaign literature, etc. Ordering this equipment from abroad is not only expensive but the delays are sometimes paralyzing. Thus, the use of the articles in question must be scheduled realistically in order to avoid disheartening bottlenecks and a resulting drop in the morale and efficiency of project workers and in the motivation level of the population the project hopes to reach. The PERT-type scheduling of activities offers unexcelled advantages in this field. The principles of this system are so general, and at the same time so open-ended, in allowing for growth of sophistication that they can be applied on extreme levels of simplicity--and still help as much as, probably even more than!, when they are used in production of a supersonic-transport prototype.

- There are very few people gifted with the kind of leadership abilities required to make an outstandingly effective head of a campaign-type project. People who have these special talents are very precious for a country's development and ought to be utilized in a manner that allows their effort to be channelled to where it is most productive. What is not productive--because it distracts a talented director from actual leadership

of the project--is fighting delays in the flow of supplies, materials, and personnel that may result from imperfect or unrealistic programming and scheduling. For such a man to find a ready organizational and conceptual structure of programming which he could easily and quickly fill with the substance of his ideas would mean to multiply his potential productivity by a powerful factor.

- One great source of the frictions that diminish developmental momentum in the public sector is the conflict between the point of view of an enthusiastic prospective project director--inspired by belief in the social importance of the project he promotes, perhaps to the point of overlooking its organizational weaknesses and the resulting danger of failure--and the viewpoint of the coordinating, planning, budgeting agencies which are more apt to identify these shortcomings than to share the project director's enthusiasm. The clash of these differing attitudes results, as often as not, in the planning agency being accused of bureaucracy and formalism, of acting as a drag on the creative energies of "real" workers. These frictions may be irrational, but they are nonetheless real and wasteful. They are also understandable: it is natural for a dedicated man to become impatient with arguments counseling caution, to let his emotions color his attitudes toward these arguments and the people who forward them. His emotions will, in turn, evoke a reaction from his

critics which will not be helpful to rational discussion. A vicious circle of tensions and recriminations can easily start in this way.

Compare this situation with one in which a promoter of a new project is not confronted with a list of critical questions but instead is offered a structural model (best in the form of a manual giving examples and printed, labor-saving forms with proper headings) of a PERT-type project document, is encouraged to state his project proposal in terms of its component activities, their inputs, and meaningful time relationships, and is offered the help of a specialized programmer. We strongly believe that in this second situation the promoter will be led by his own mental processes to ask himself the embarrassing questions, to face the difficulties and the chances of success more realistically. Cannot one hope that he will now be more willing to look to the planning agency for managerial advice and even for constructive criticism? Of course, human nature will remain what it is. But, it is also true that certain situations bring out the worst in a man, while others encourage at least a partial use of rationality, sympathy, even empathy, and consequently of enlightened collaboration.

2.72 NETWORK FOR A CAMPAIGN-TYPE PROJECT

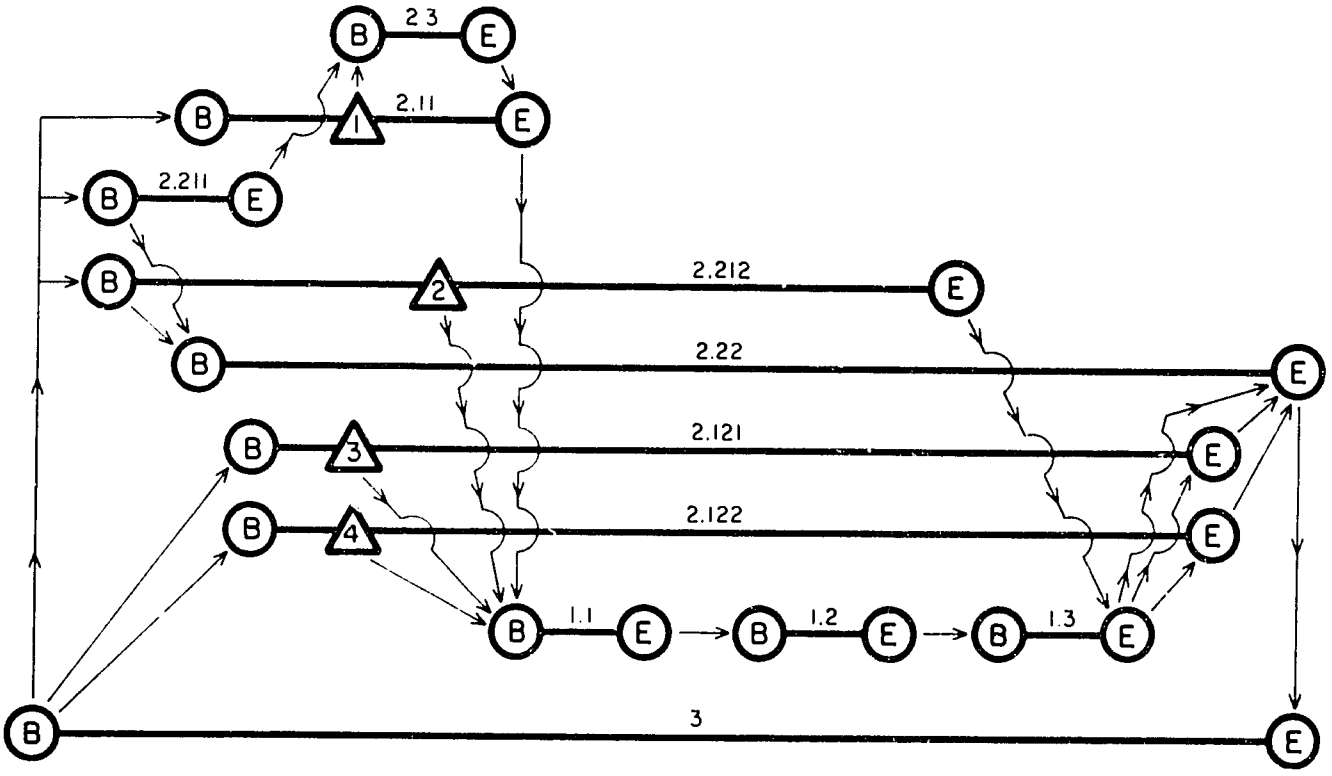
Figure 9 presents a programming network for a typical project of this kind: a literacy campaign. Since no more than a general illustration is intended, the activities of this network are shown in various degrees of detail. As a result, the network is a mixture of one-, two-, three-, and four-digit levels. It may be observed in passing that this technique of mixing various levels of detail in one network diagram is quite legitimate: in the first place, it is not always necessary to consider all details of all activities; second, certain activities are, by nature, less divisible into finer sub-activities than others.

The principal direct activities of this project are: motivation of population; the teaching campaign proper; consolidation of results through prizes, diplomas, and similar psychological means. The service activities contain: procurement of materials and supplies; training courses for future campaign personnel; various phases of logistics and transportation for all phases of both service and direct activities. Figure 9 shows several crucial sequential relationships between various activities that must be observed if the campaign is to succeed without waste and demoralization.

As is clear from Figure 9, most of the comments which have been made earlier with respect to networks of projects resulting in

FIGURE 9.

ACTIVITIES NETWORK FOR A LITERACY CAMPAIGN



EXPLANATION OF CODES

1.0 DIRECT ACTIVITIES

- 1.1 Motivation of population
- 1.2 Campaign proper (teaching)
- 1.3 Consolidation activities (diplomas, prizes, festivities, etc.)

2.000 SERVICE ACTIVITIES

- 2.100 Logistics
  - 2.11 Logistics for training of campaign personnel
  - 2.120 Logistics for the campaign proper
    - 2.121 Feeding and lodging the personnel
    - 2.122 Transport of men and materiel
- 2.200 Materiel
  - 2.210 Purchase, production, & assembly of materiel
    - 2.211 For training of personnel
    - 2.212 For the campaign proper
  - 2.22 Operation and Maintenance of Materiel
- 2.3 Training course for campaign personnel

3. MANAGEMENT ACTIVITIES

MILESTONES

- 1 Logistics sufficiently advanced to allow training course for personnel to start
- 2 Enough materiel assembled to allow the campaign to start
- 3 Feeding and lodging sufficiently prepared to allow the campaign to start
- 4 Transport sufficiently prepared to allow the campaign to start

permanent physical assets are also valid for projects of the campaign type. In fact, as far as the programming of implementation is concerned, very little formal difference exists between the two. The main substantial difference is in the kinds of inputs that are used: the permanent-assets projects demand, of course, much more material inputs, while campaign projects demand mainly skilled service inputs.

Where the formal differences appear is in the phase of cost/benefit calculus. For permanent-assets projects, we shall be very much concerned with projected series of depreciation and of maintenance and operation costs, while the cost/benefit analysis of campaign-type projects will not involve these variables.

2.8 MODULAR CLASSIFICATION OF ASSETS AND ACTIVITIES: FIXED-ASSETS PROJECT

It is a fact of great practical importance, and a very favorable one, that for most projects resulting in fixed assets, save some very rare and unusual ones, most activities, on all summary levels, can be easily identified by such obvious and fairly typical classes of fixed assets or improvements as the ones cited in the preceding example. A few types of fixed-assets systems constitute an overwhelming proportion of public-sector investment expenditures in most national plans of developing nations:

flood control-irrigation-hydro power systems, water-supply systems, sewerage systems, thermal power systems, roads, bridges, harbors, airports, communications systems, school buildings, public health buildings. The same is true with respect to most industrial projects which, despite the bemusing variety of articles they are ultimately to produce, can be reduced to a very manageable number of modular components. Thus, any industrial project will contain some or all of such basic "building blocks" as terrain improvement, basic buildings, water- and power-supply systems, heating and/or refrigeration system, material-moving system, and a few others. Even the machinery and equipment directly used in industrial processing can be reduced to a limited number of basic functional classes, such as crushing, mixing, heating, drawing, drying, and so on.

Clearly, these remarks do not apply to all kinds of projects and, especially, to all industrial projects. They need not. There will always be a class of highly specialized and/or highly sophisticated projects which will require special methods of conceptualization. What is important is that they do apply to the projects that form the great bulk (in both physical and monetary terms) of most developmental activities in most emerging nations. For these countries and these activities, we can thus state the following observations:

1. On the highest summary level--project description--a limited number of definitions exhaust the bulk of fixed-asset systems (water control and use, power production, transport, etc.).

2. The same is true for lower levels into which these summaries can be meaningfully broken down (canal, dam, road, building, etc.; and again, on a still lower level, earthwork, masonry work, roofing, and so on).

This situation comports two immense advantages.

In the first place, it permits an advance toward modular programming of an increasingly large number of development projects. As the technical skills in developing countries augment and as the body of accounting and managerial experience derived from completed projects accumulates, it should become progressively easier for every country and its planning bodies to establish a constantly up-to-date "library" of programming schedules of inputs for the more important and typical modules ("building blocks") which enter into the country's projects--one mile of access road on a plain, one mile of access road in mountains, one mile of irrigation canal, one mile of a typical highway, a culvert, etc. Observe that such modules imply much more than just standard unit cost: they indicate the physical inputs and their timing. As a result, one can

expect considerable savings of time and effort for programmers who, operating with pre-programmed "building blocks," will be spared the necessity of starting from elementary calculations over and over again for every project they begin.

In the second place, meaningful cost-accounting comparisons can be made for typical unit costs between different parts of a complex project and, what is even more important, between various projects. This comparing of performance on one project with performance on another is the key element in every drive for efficiency; its role in public accounting and auditing is beyond need of explanation.

The most interesting and encouraging example of breaking down a very large and important class of economic development projects into a quite limited and manageable number of subclasses (on different summary levels) of typical fixed assets is provided by the accounting system of the U. S. Department of the Interior's Bureau of Reclamation. That organization carries on projects in the development of water resources--a domain of utmost importance for all developing countries. The philosophy and the operation of the Bureau's budgetary and accounting system was

explained at a U. N. workshop devoted to "performance budgeting."[7]

On the highest summary level, the Bureau divides its projects into five basic groups:

Multipurpose	Plant
Irrigation	Plant
Electric	Plant
Municipal and Industrial	Water Plant
Other	Plant

The next two summary levels are fourteen "property classes" and some thirty "plant accounts."[8] Table 4 shows, in matrix, and somewhat simplified, form, the relations between them. It can be easily inferred from this table how the classification can be extended to still lower summary levels through splitting the "plant accounts" according to the technical and/or functional characteristics of their component items.

How does the Bureau's classification system tie in with the technique of PERT-network programming?

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[7] Frank W. Krause, Division of Financial Management, U. S. Bureau of the Budget, "Performance Budgeting for Capital Projects (An Illustrative Application)." Working paper for U. N. Economic Commission for Latin America, Workshop on Problems of Budget Reclassification and Management in South America, 3-15 September 1962, Santiago, Chile. Published as UN Doc. No. E/CN. 12/BRW. 2/L. 5 Add. 1, 28 May 1962. (mimeo)

[8] U. S. Department of the Interior, Bureau of Reclamation, Reclamation Instructions, Series 450, "Cost Authority and Cost Classification" (450-3-2/24./65), and Series 460, "Uniform Classification of Accounts" (especially 463-13-12/10/64). For the sake of conciseness, our presentation omits certain of the Bureau's details and refinements.

TABLE 4

"Property Classes" and "Plant Accounts": U.S. Bureau of Reclamation
(A Simplified Summary)

PLANT ACCOUNTS	PROPERTY CLASSES													
	Reservoirs & Dams	Diversion Works	Pumping & Pump. Gener. Plant	Deep Wells	Canals & Conduits	Laterals	Drains	Devel. Farms	Channels Levees & Flood Works	Power Plants	Transm. Lines Switch yards & Substa.	Distri. Lines & Substa.	Gen. & Other Prop.	Intangible Plant
Intangible plant														x
Interest dur. Construc.														x
Land & Rights	x	x	x	x	x	x	x	x	x	x	x		x	
Relocation of Existing Property	x	x	x	x	x	x	x	x	x	x	x	Not currently used	x	
Clearing Lands	x	x	x	x	x	x	x	x	x	x	x		x	
Structures & Improvements	x	x	x	x	x	x	x	x	x	x	x		x	
Roads & Bridges	x	x	x	x	x	x	x	x	x	x	x		x	
Reservoirs	x	x												
Dams	x	x												
Waterways	x	x	x	x				x		x				
Canals					x									
Canal Structures					x			x						
Canal Protective Works					x			x						
Laterals						x								
Lateral Structures						x		x						
Lateral Protective Works						x		x						
Drains							x		x					
Drain Structures							x	x	x					
Pumps & Prime Movers			x	x	x	x	x	x	x					
Pumping-Generators			x											
Waterwheels, Turbines & Generators										x				

TABLE 4 (Continued)

PLANT ACCOUNTS	PROPERTY CLASSES													
	Reservoirs and Dams	Diversion Works	Pumping & Pump. Gener. Plant	Deep Wells	Canals & Conduits	Laterals	Drains	Devel. Farms	Channels Levees & Flood Works	Power Plants	Transm. Lines Switch yards & Substa.	Distri. Lines & Substa.	Gen. & Other Prop.	Intangible Plant
Accessory Electric Equip.	x	x	x	x	x	x	x		x	x				
Misc. Equipment	x	x	x	x	x	x	x	x	x	x	x		x	
Other Tangible Property													x	

IN ADDITION, THE FOLLOWING PLANT ACCOUNTS ARE USED:

Station Equipment
Towers and Fixtures
Poles and Fixtures
Overhead Conductors and Devices
Underground Conductors and Devices
Underground Conduit

All these appear as "plant accounts" in the "property class" "Transmission Lines, Switchyards and Substations"

Office Furniture and Equipment
Transportation Equipment
Stores Equipment
Laboratory Equipment
Communications Equipment
Tools, Shop and Garage Equipment

All these appear as "plant accounts" in the "property class" "General and Other Property"

OBS: As mentioned, this table presents the Bureau's system in somewhat simplified form: a few separate plant accounts have been compressed under generic headings in order to reduce the size of the table.

Let us suppose that someone is entrusted within the Bureau with programming a network for an irrigation project, similar to the one we have been using as our illustrative example. The "property classes" of the Bureau's system provide him immediately with definitions of direct activities of the first level of generality. They will be, say, as follows:

Direct Activity	1.1	Reservoirs and dams
" "	1.2	Canal
" "	1.3	Laterals
" "	1.4	Power plant
" "	1.5	Transmission lines
" "	1.6	General property (access roads)

The next lower level of generality in the network will be obtained by expressing each of the above activities in terms of its component activities, defined functionally or technologically by the Bureau's "plant accounts." Thus, Direct Activity 1.1, "Reservoir and dam," will be analyzed into:

Direct Activity	1.11	Land and rights
" "	1.12	Reservoir
" "	1.13	Dam
" "	1.14	Accessory electric equipment
" "	1.15	Miscellaneous equipment

to use only some of "plant accounts" that the Bureau suggests for this "property class."

Observe now the tremendous advantage that has been achieved by this uniformity between the definitions of activities in the network design

and the definition of "property classes" and "plant accounts," on their respective levels of generality: a compatibility has been established between the physical programming of inputs and the accounting of these inputs, especially the cost accounting of standard items of "plant accounts." The cost of implementing various activities on different levels is being progressively and automatically registered and accumulated on appropriate accounts and can be communicated to whomever needs the information. The actual timing of inputs applied to activities can easily be compared with the programmed schedules, and efficiency of implementation can be estimated while the work is still in progress. We have here a practical example of the advantages of commonality of information for various persons and agencies cooperating in different aspects of project implementation. Anyone who has witnessed, or had to mediate in, frictions and difficulties arising from the lack of compatible definitional structures between the technical and the accounting aims of a project (or of any enterprise, for that matter) will appreciate the blessings of that commonality.

The Bureau's classification system is not a unique departure in the direction of a standardized plan of accounts using the technological function of field assets as the principle of definition. Indeed, as Table 5

shows, the entire federally supervised electric power industry in the U. S. is using an almost identical classification.[9]

Examples of this trend toward country-wide (even continent-wide) and industry-wide standardization of fixed-assets classes could be given in large numbers for such important divisions of the economy as railroads, civilian airports, and others. Where the federal authorities do not impose a compulsory system, voluntary agreements on guidelines can be sought as, for example, in the case of municipal and private airports.[10]

The developing countries are just now in the stage of establishing the many managerial systems which will determine and control their future investment and production efforts. The logical structure of these systems will help or hamper, depending on how well conceived they are. Now, while they are still being formed, is the time to strive to endow them with as much clarity and serviceability as possible. Lack of uniformity now will surely lead to confusion later, when projects multiply and forces of tradition and routine start asserting themselves in a maturing administrative and technological establishment.

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[9] Federal Power Commission, Uniform System of Accounts Presented for Public Utilities and Licensees (Class C) Subject to the Provisions of the Federal Power Act. Effective January 1, 1961. (Washington, D. C.: U. S. Government Printing Office, 1961.)

[10] See Joseph M. Cunningham, Airport Accounts, available from Municipal Finance Officers Association of the United States and Canada, 1313 East 60th Street, Chicago 37, Illinois, 1962.

Table 5

ELECTRIC PLANT ACCOUNTS PRESCRIBED BY THE FEDERAL POWER COMMISSION

1. Intangible Plant

301 Organization
302 Franchises and consents
303 Miscellaneous intangible plant

2. Production Plant

A. Steam Production

310 Land and land rights
311 Structures and improvements
312 Boiler-plant equipment
313 Engines and engine-driven generators
314 Turbogenerator units
315 Accessory electric equipment
316 Miscellaneous power-plant equipment

B. Hydraulic Production

330 Land and land rights
331 Structures and improvements
332 Reservoirs, dams, and waterways
333 Water wheels, turbines, and generators
334 Accessory electric equipment
335 Miscellaneous power-plant equipment
336 Roads, railroads, and bridges

C. Other Production

340 Land and land rights
341 Structures and improvements
342 Fuel holders, producers, and accessories
343 Prime movers
344 Generators
345 Accessory electric equipment
346 Miscellaneous power-plant equipment

3. Transmission Plant

350 Land and land rights
351 Clearing land and rights of way
352 Structures and improvements
353 Station equipment
354 Towers and fixtures
355 Poles and fixtures
356 Overhead conductors and devices
357 Underground conduit
358 Underground conductors and devices
359 Roads and trails

4. Distribution Plant

360 Land and land rights
361 Structures and improvements
362 Station equipment
363 Storage battery equipment
364 Poles, towers, and fixtures
365 Overhead conductors and devices
366 Underground conduit

Table 5
(Continued)

4. Distribution Plant

367 Underground conductors and devices
368 Line transformers
369 Services
370 Meters
371 Installations on customers' premises
372 Leased property on customers' premises
373 Street lighting and signal systems

5. General Plant

389 Land and land rights
390 Structures and improvements
391 Office furniture and equipment
393 Stores equipment
394 Tools, shop, and garage equipment
395 Laboratory equipment
396 Power-operated equipment
397 Communication equipment
398 Miscellaneous equipment
399 Other tangible property

A vigorous effort now to introduce and make acceptable uniform programming categories within each country's planning, accounting, and statistical establishment and at the same time to achieve as much international uniformity as possible is bound to bring a rich reward in the future. The Fiscal and Financial Branch of the Department of Economic and Social Affairs of the United Nations has been developing an important body of principles in budgetary classification and management with the objective of introducing a uniform international system of program and performance budgeting.[11] A conceptual basis has thus been laid for the next logical step--a uniform system of project programming and accounting.

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[11] U.N. Department of Economic and Social Affairs, "A Manual for Programme and Performance Budgeting," working paper for the UN Economic Commission for Latin America, Workshop on Problems of Budget Reclassification and Management in South America, 3-15 Sept. 1962, Santiago, Chile. UN Doc. No. E/CN.12/BRW.2/L.5, 14 May 1962 (mimeo).
U.N., Report of the Workshop on Budgetary Classification and Management in Central America and Panama, San Jose, Costa Rica, 18 to 30 September 1963 (New York: UN, 1964.) UN Doc. No. ST/TAO/Ser.C/66.
U.N., Report of the Inter-Regional Workshop on Problems of Budget Classification and Management in Developing Countries, Copenhagen, Denmark, 31 August-11 September 1964 (New York: UN, 1964) UN Doc. No. ST/TAO/Ser.C/70.

A widely (if possible, internationally) accepted system of classification of fixed assets involved in typical projects in domains of basic importance (natural resources, transportation, health, etc.) offers very promising possibilities. It would be a most valuable tool for the (often inexperienced) programmer who approaches the difficult task of breaking down a complex project into component activities on several levels of detail in order to establish a programming network; it would provide him with a "technological grammar" based on the accumulated experience of thousands of technicians, enabling him to express organizationally and functionally the proposed process of implementation. It would greatly increase the comparability between different projects of similar types and, thus, would facilitate the spread of innovation and of the constantly accumulating experience. Finally, it would greatly increase the compatibility of network structures with those of conventional cost accounting and thus would facilitate the search for efficiency and elimination of waste.

2.9 MODULAR CLASSIFICATION OF ACTIVITIES: CAMPAIGN-TYPE PROJECT

The basic similarities among projects of the campaign type are quite sufficient for most of them to be expressed in a fairly limited number of quasi-modular activities, exactly as was the case with fixed-assets

projects.

It ought to be observed that, in many cases, projects of the predominantly campaign type will also comport implementation of certain fixed assets, and vice versa. For example, community development campaigns, campaigns for organizing rural youth into 4-H groups, etc., will often leave behind wells, access roads, improved animal shelters, and so forth. On the other hand, an irrigation project will contain campaign-type activities like educating the future beneficiaries in proper practices of water use, of administering the flow of water, and of developing appropriate systems of accounting for water charges. This mixture of fixed-assets results and no-fixed-assets results causes no difficulty whatever either from the viewpoint of programming the inputs (PERT, etc.) or from the viewpoint of cost accounting. The strength of the proposed method of structuring project documents in terms of activities on various summary levels consists exactly in its ability to combine most diverse kinds of activities into a unified whole, while preserving the analytical distinctions of function, kinds of inputs, and timing.

The following classification should be a step in the direction of developing a standard list of "building blocks" for campaign-type projects:

DIRECT ACTIVITIES

Motivation activities

(daily contact with people; home visits, etc.; formal and semiformal talks, lectures; moving pictures, slides, and similar audiovisuals; direct mail, inserts in press, radio, television, etc.; concerts, dances, sing-songs, etc.; distribution of diplomas, prizes, etc.)

Transfer-of-knowledge activities

(lectures and lecture courses; demonstration lectures; seminars and laboratory sessions; field sessions; correspondence courses, home visits, etc.)

Transfer-of-attitudes activities

(organizing cooperative efforts such as the War on Poverty, digging a communal well, building a school, access road, family-planning clinics, etc.)

Prophylactic and preventive medical activities

(vaccination, distribution of medications, x-ray tests, etc.)

Accumulation-of-information activities

economic and legal data (cadastral surveys, agricultural samplings, industrial census, housing surveys, etc.)
Sociological data (folklore, religion, magic, etc.)
geophysical data (mapping, mineralogical surveys, etc.)

(N.B. All these activities may, and frequently should, result in regular follow-up activities. However, if the latter take place, they usually become part of current activities of public administrations and not discrete projects.)

SERVICE ACTIVITIES

Transport of men and materiel

Lodging of personnel

Feeding of personnel

Procurement of materiel and supplies

Storage and maintenance of materiel
(transport of medical equipment, audiovisual equipment, etc.)

Procurement of lecture rooms, meeting halls, etc.

Preparation of motivational and teaching material

Printing, mimeographing, tape recording, filming, etc.

Motivation and training of project personnel

MANAGEMENT ACTIVITIES

See Appendix A

APPENDIX A

MANAGEMENT ACTIVITIES

The concept of managerial activity expounded here is based on the philosophy of "MANAGEMENT BY EXCEPTION." This philosophy has become increasingly popular in technologically advanced enterprises.

Fundamental to it is the value judgment that (save in circumstances of extreme danger and urgency, as in repelling an enemy attack, where normal criteria are suspended) it is better for an individual to have an opportunity to exercise his creative talents than for him not to be permitted to do so.

In a more empirical vein, the philosophy goes on to hypothesize that, through giving everyone an opportunity to exercise his creative talents, such vast resources of latent ingenuity, natural gifts, and even, occasionally, genius are released, and so strong a motivation to use them is aroused that the productivity of a system organized in such a manner is greatly increased in comparison with one in which production is directed entirely by strict orders from above. To what extent this hypothesis has been proved is not easy to say: one would have to be very unobservant not to recognize that, in this extremely complex area, the values held by researchers and their personal emotions greatly color the results of their

research; many "proofs" leave much to be desired in the realm of objectivity. This much can be said, however: the hypothesis in question seems to be more and more liked by more and more persons and is becoming more and more generally accepted as proved.

The principal characteristic of "management by exception" in practice is that, in the relationship between any two management levels, the higher level makes decisions affecting the jurisdiction of the lower level only in order to establish the objectives to be achieved by latter and the principles of performance according to which the operations are to be executed (rules of quality, labor relations, etc.).

In other words, the higher level of management takes the initiative in establishing the plan within its jurisdiction. It is called for further decisions only by exceptions--when the objectives cannot be met without breaching the previously established principles of performance or when jurisdictional difficulties appear between different divisions of subaltern management.

The PERT programming system, with its emphasis on ordering various activities according to their discretely and operationally stated objectives and with its technique of subdividing the objectives down through several levels of member activities, lends itself readily to a system of management by exception. Indeed, both concepts have their roots in the

intellectual and ideological movement started decades ago with Frederick W. Taylor's work on the organization and productivity of labor.

The foregoing observations will be helpful, we hope, in establishing a context for the following, not over-precise, outline of the basic branches of management activities.

1. DEFINING THE CONTENTS OF THE PROJECT

In principle, the contents of a project should have been well defined before it was approved and turned over to the management selected to implement it. In practice, however, the decision to implement is often made before the project's definition is fully worked out, and it remains to the project management to sharpen its outlines. Also, it is not exceptional that the objectives and contents of a project have to be redefined midway through implementation, either because external circumstances have changed considerably (unexpected shortages, lack of foreign exchange, major political changes, large alterations in complementary or competitive branches of the economy) or because new information internal to the project has turned up (encountering unexpected geological layers, accidental discovery of minerals, evidence of major malfeasance, etc.).

The task of defining the contents of the project, from the viewpoint of the highest management, consists of two interrelated parts:

a. Broad definition of objectives; e.g., to build, within the period of t years, an irrigation system consisting of x, y, z, with respective capacities of m, n, o, etc.

b. Rules for deciding on the detailed specifications fitting into this broad definition. These specifications descend ultimately to the lowest detail of design, quality of inputs, and quality of the finished product. It is, therefore, necessary to establish, even if only implicitly and tacitly, the cut-off level of actual active planning of detail by the various echelons of management.

2. PROGRAMMING

a. Establishing the work breakdown on various summary levels and defining the resulting activities.

b. Establishing criteria of optimization (i.e., criteria of efficiency) to be observed in the implementation of the project in question.

c. Estimating amounts of inputs on various summary levels.

d. Scheduling the timing of application of inputs.

Programming may follow various patterns, including the following, singly or in combination:

- All programming, down to the lowest level of detail, is done before implementation starts. No difficulties are encountered during implementation, so there is no need to reprogram throughout the entire work.

- All programming, down to the lowest level of detail, is done before implementation starts. It becomes apparent in the course of implementation that certain programming assumptions were incorrect. It is thus necessary to reprogram the work. This may happen again and again throughout the implementation.

- By the beginning of implementation, programming is completed only for higher summary levels. More detailed levels are programmed while the project is underway. There are again possibilities of successful implementation of the original programming or of a necessity to reprogram.

- Another reason for reprogramming may be a change in the "STATEMENT OF WORK TO BE DONE" (i.e., the definition of the contents of the project), caused by a modification of the objectives by the superior authorities (e.g., decision to augment or to diminish the scope of the project).

3. ESTABLISHING THE HIERARCHY OF DECISION AND RESPONSIBILITY ON ALL LEVELS OF MANAGEMENT AND WORK FORCE.

Included in this category are the decision as to the hierarchy of disciplinary action and the channels of recourse.

4. ESTABLISHING STANDARDS OF PERFORMANCE FOR VARIOUS LEVELS OF THE WORK FORCE.

5. ESTABLISHING THE SYSTEM OF COLLECTING, PROCESSING, EVALUATING, CIRCULATING, AND STORING DATA RELATED TO THE IMPLEMENTATION OF THE PROJECT.

a. data identification, authentication, documentation, and reporting.

b. data processing
   i) accounting: control accounts
      information accounts
      (cost accounting and financial flows)
   ii) other: physical performance, quality control.

c. tests and criteria for data evaluation (standards for quality control, ratios for financial management, target unit costs for cost accounting, etc.).

d. flow-pattern for data reporting and data evaluation on various summary levels--for various levels of management, for outside authorities, and for the public.

e. system of data storage and retrieval.

f. defining the area of investigations (geological, hydrological, land tenure, sociological, etc.) to be conducted parallel to implementation of the project; establishing the channels to communicate the information thus obtained to relevant management levels; setting criteria to evaluate this information and to utilize it in the implementation of the project.

6. ASSURING READY AVAILABILITY OF FACTORS OF PRODUCTION

a. Personnel recruiting, training, and administering;

b. Bargaining salaries and wages;

c. Procurement of materials, supplies, and equipment;

d. Acquisition of capital assets and rights;

e. Contracting out parts of the work;

f. Awarding grants, subsidies, and contributions;

g. Assuring a flow of funds, adequate and synchronized with programmed operations.

These activities can never be entirely programmed in advance because they involve, up to the moment of their consummation, an element of negotiation and on-the-spot managerial decision. Thus, even if scheduled in advance and to a large extent standardized, they will always contain a residuum of managerial involvement.

7. LIAISON: ACTIVITIES TO ASSURE A COOPERATIVE ATTITUDE BY OUTSIDE AGENCIES AND PERSONS AND TO ASSURE THE OPENNESS OF CHANNELS OF COMMUNICATION WITH THEM.

8. ESTABLISHING STANDARDS OF QUALITY AND QUANTITY; MINIMIZING WASTAGE.

a. Establishing quality criteria and quality-control procedures for inputs and outputs.

b. Establishing incentives for maximizing output, effecting economies, and generating improvement ideas.

9. ASSURING EMPLOYEE MORALE.

a. Establishing criteria for personal advancement.

b. Issuing exhortions and commendations and exercising overall disciplinary authority.

c. Foreseeing latent interpersonal tensions and mediating in cases of frictions.

10. PROTECTION AGAINST LOSSES AND DAMAGES

a. Negotiating and awarding indemnities for losses suffered by outside agencies and persons.

b. Provisions against calculable risks (insurance, etc.).

c. Provisions against foreseeable obligations that may result from the implementation of the project and from damages caused by the work (temporary or permanent water pollution, damage to wildlife and natural beauty, silting of waterways, etc.).

d. Protection from weather, fire, theft, violence, etc.

e. Legal protection for the parent organization responsible for the project and for the project staff in the exercise of their duties.

11. INTERNAL AUDIT

Assuring that the audit system covers all project activities in all their aspects in a relevant manner. Assuring the communication channels for timely use of audit results. Occasional, unexpected participation of the management in audit activities.

12. SUPERVISION OF IMPLEMENTATION

In the "management by exception" system this category of activities dissolves itself into all other activities treated above.

13. ACTIVITIES TO ASSURE AN ORDERLY AND SATISFACTORY TRANSFER OF AUTHORITY AND RESPONSIBILITIES UPON COMPLETION OF THE PROJECT.

a. Preparation of final drawings, plans, and specifications.

b. Preparation of the final inventory.

c. Identifying all obligations due by and to the project.

d. Identifying pending legal actions.

e. Collecting all useful information (manuals, instructions, etc.) for future managers and operators.

f. Assuring physical protection of assets until the agreed date of transfer.

g. Establishing the responsibility in case of delays.

14. ACTIVITIES TO MAKE EVALUATION POSSIBLE

Preparation, safeguarding, and transfer to an appropriate agency of all data of accounting, cost accounting, and technical reporting, in a form which will permit:

i. evaluation of actual results as compared with the project proposal.

ii. evaluation of actual results as compared with other projects.

iii. establishment of technical and cost benchmarks to serve in programming future projects.