AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY
Batch 52

1. SUBJECT CLASSIFICATION
A. PRIMARY: TEMPORARY
B. SECONDARY:

2. TITLE AND SUBTITLE
Development-project format,a design for maximum information

3. AUTHOR(S)
Grasberg,Eugene

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1967	189p.	ARC 338.G767a

7. REFERENCE ORGANIZATION NAME AND ADDRESS
NPA

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*
(In Working paper M-9117) (Chapts.1 and 2,of a work comprising nine chapts.,given in summary only)

9. ABSTRACT
(Development R&D)

10. CONTROL NUMBER	11. PRICE OF DOCUMENT
PN-AAD-074	
12. DESCRIPTORS	13. PROJECT NUMBER
	14. CONTRACT NUMBER: Repas-9 Res.
	15. TYPE OF DOCUMENT

AID 590-1 (4-74)

PN-AAD-074
Repas. 9 Res.

DEVELOPMENT-PROJECT FORMAT: A DESIGN FOR MAXIMUM INFORMATION

(Summary of Chapters 1 and 2
and Chapters 3-9)

Including a chapter on modular programming
by Robert M. Waddell and Eugene Grasberg

by

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M-9117
September 1967

DEVELOPMENT-PROJECT FORMAT: A DESIGN FOR MAXIMUM INFORMATION

Summary of Chapters 1 and 2

PRINCIPAL REQUIREMENTS OF A PROJECT FORMAT

A project document should satisfy several requirements if it is to be truly serviceable in all aspects of the implementation of a project:

- The format should be such that, without troublesome 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 should allow for easy scheduling of orders for materials, supplies, equipment, and contractual services.

- Each item of projected expenditure in the project document should be stated in a manner which will 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.

- The project document should convey enough information to auditors and technical inspectors so that they are able 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.

- The format should facilitate the application of cost-accounting to the distinct activities into which a project may be analyzed.

Table S-1 shows the different interests involved in evaluation and implementation of an economic development project.

STRUCTURING OF A PROJECT IN TERMS OF ACTIVITIES

We identify three fundamental groups of activities, and any effort or material product involved in a project must fall into one of these groups:

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

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 has programmed the tasks of execution.

TABLE S-1

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
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

As an example, let us take an irrigation project which involves the construction of an artificial reservoir by the means of damming a river. 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.

Within these highest-summary-level activities, 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, these activities can be subdivided into their components of lower summary level, and so on.

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 usual criteria.

Management Activities

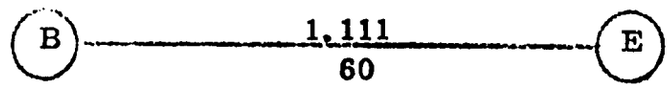
Management Activities, like others, absorb inputs of various kinds at various time-points, although the composition of inputs is much more biased toward highly skilled personnel services. From the cost-accounting

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.

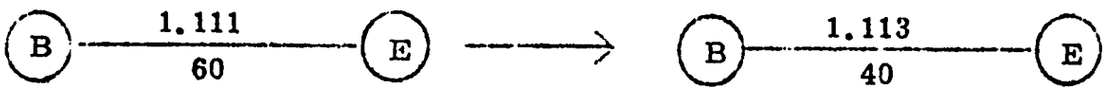
PROGRAMMING NETWORKS

A simplified version of PERT was developed for use in situations where skilled programming personnel is very scarce and only simple techniques can be used. This version, however, is an open-ended one: in the measure, as the personnel grow in skill and experience, and as circumstances permit, it can be made more sophisticated and include computerized techniques. Moreover, even in its simplest form, it allows for application of the CRITICAL PATH METHOD.

Each activity will be represented by a segment of a straight line and limited by two circles marked (B) and (E), respectively, 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 the arrow 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:



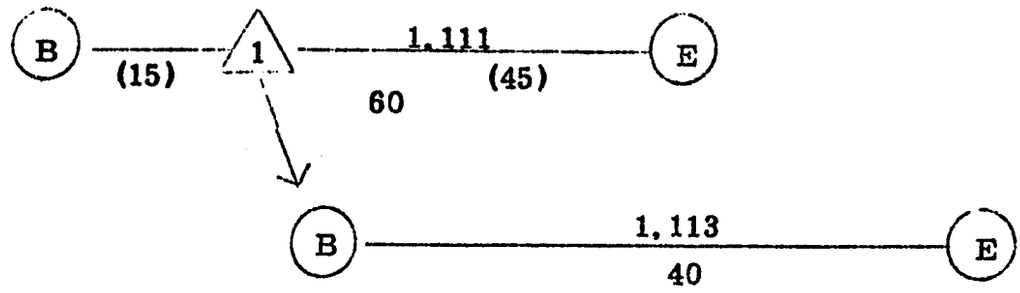
The arrow means that Activity 1.113 can be begun only if Activity 1.111 has been ended.[1]

It may happen that an activity can start when another is only partially accomplished. For example, 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. 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

---

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

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 "1," the new graphic configuration will be as follows:



An integrated project network, containing all three activity classes, is shown in Figure S-1. It indicates the strategic interfaces within the project at their highest aggregate level. Similar diagrams for lower summary levels will show the interdependencies in greater detail. 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.

FIGURE S-1

INTEGRATED NETWORK OF THE IRRIGATION PROJECT
TWO-DIGIT LEVEL

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

EXPLANATIONS

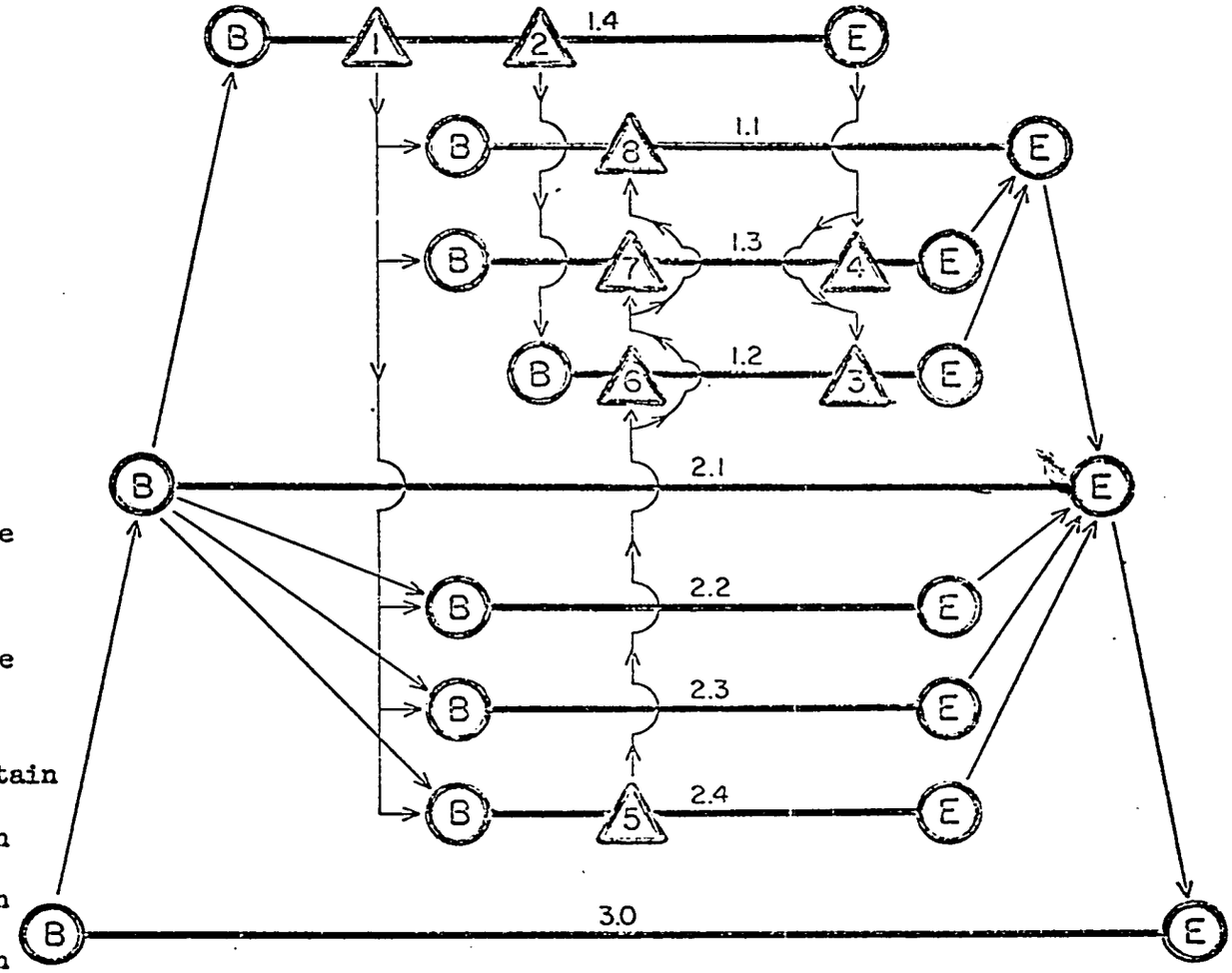
1.0 DIRECT ACTIVITIES
- 1.1 Reservoir system
- 1.2 Water transmission system
- 1.3 Electric system
- 1.4 Access roads

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



CHAPTER III

CLASSIFICATION OF INPUTS

3.1 MACRO-ECONOMIC FRAMEWORK OF EXPENDITURE CLASSIFICATION . . . . . III - 2

3.2 OBJECT-OF-EXPENDITURE AND INPUT CLASSIFICATION FOR USE IN A PROJECT DOCUMENT . . . . . III - 6

3.3 USEFULNESS OF CLASSIFICATIONS AND THE NEED FOR DISCRETION . . . . . III - 26

3.1 MACRO ECONOMIC FRAMEWORK OF EXPENDITURE CLASSIFICATION

In a previous chapter, considerable emphasis was placed on the need to develop a project-document with the highest possible degree of commonality of information: it should be possible to arrange and rearrange the expenditure figures for a project in various configurations to suit the different needs and viewpoints of the agencies concerned with the project. Each agency will view monies spent on the project in terms of its own classifications of the stream of expenditures within the governmental household or, in a broader perspective, within the national household as represented by national accounts.

Although budgetary, administrative, and national-accounting practices often substantially differ from country to country, there seems to be developing a significant body of internationally recognized (even if not legally accepted) theory of public and national accounting. It is concentrated around official publications of the executive subdivisions of the United Nations Economic and Social Council, especially its Fiscal and Financial Branch. This theory essentially coincides, both in substance and in application, with that of budgeting and social accounting in the United States and several other leading countries. It is also furthered by a current U. S. Planning-Programming-Budgeting crusade which attempts to put it into practice.

Without going into the details and subtleties of the subject which might distract from our main concern, we can say that the presently accepted theory uses three principal dimensions in which public, current,

and capital expenditures are classified:

Functional classification

Program-Project classification

Economic classification

Functional classification arranges public expenditure according to the incidence of benefits expected from this expenditure. The main divisions of this classification are usually fairly general, such as: agricultural development, industrial development, health, education, etc. It is often very difficult, or even impossible, to descend to much more detailed levels without getting involved in various inconsistencies and/or overlappings. Although this classification is extremely important from many points of view, it is not crucial for our interests: a single project usually falls into one of the categories and, consequently, so do all its inputs. There is, thus, no classification problem within the project. However, multipurpose projects such as those for community social welfare, river basin development, watershed and resources protection comprise a mixture of functions that may sometimes make imputing expenditures among them very difficult. These problems plague the cost-benefit calculus of multipurpose projects. Our variant of the PERT method can be helpful in cases where various functions of a project correspond to physically distinct components of this project. In such cases, the high-summary-level activities resulting in these components can be imputed to specific functions of the project. As explained before, in the great majority of projects, these activities can

be drawn from a limited catalog of standard "building blocks," which facilitates the task of sorting them (and consequently their inputs) according to the ultimate function of their products. However, in cases where the two or more functions of a project are not reflected by discrete physical components, the inputs of the project can only be imparted to these functions in terms of their single remaining common denominator--their money value. Fortunately, as stated above, the whole aspect of functional classification is not crucial for our considerations.

Program-Project Classification is of utmost importance for practical application of the theory of program budgeting developed by the U. S. Bureau of the Budget, the United Nations, and other pioneering organizations in this field. It represents an operational extension of functional classification: goals in various functional fields are expressed in measurable terms of the objectives or programs and of their component projects. Since our work is concerned with elaboration and presentation of project-documents, this classification, in which a unit is a program, is, so to speak, one level above our heads. However, throughout this study the attention has been constantly given not to introduce any elements which could be even remotely inconsistent with the principles of program-project classification.

Economic classification. The purpose of this classification is to distinguish among various expenditures on the basis of their immediate influence on a country's national accounts.

In the context of GROSS NATIONAL EXPENDITURE, project spending may contribute to capital formation, when a project results in permanent assets, or to current consumption of goods and services, when the project is of a campaign type. (Current accounting practices are not yet sophisticated enough to reflect the investment in invisible human capital.) Spending may also not have an immediate influence on GNP if it takes the form of purchases of property rights to existing capital assets, capital grants to governments, organizations, or persons, or transfer payments. Finally, the expenditure may go--directly or indirectly--abroad, causing a corresponding effect on the net balance-of-payments component of the Gross National Expenditure.

With reference to the GROSS NATIONAL PRODUCT, the expenditure on a project will be differentiated according to goods and services of various sectors for which a demand will be created by the implementation of the project. Here, not only the aggregate impact of the project--its contribution to the money-income flow--is studied but also the specific technological relationships between the inputs demanded and the extant and potential supplies of these inputs within the economy. It is in this context that it can be seen how a project may compound the problem of existing or latent bottlenecks. But it can also be seen how it stimulates new progress-oriented subsectors of production and/or services by creating new demand where formerly none existed that was strong enough to entice the local factors of production to enter the field.

3.2 OBJECT-OF-EXPENDITURE AND INPUT CLASSIFICATION FOR USE IN A PROJECT DOCUMENT

The previously outlined classifications reflect the macro-economic point of view: the relationships between great aggregate streams of expenditures within the total process of a national economy. A project document is micro-economic in its sphere of concern; what is statistics to a national economy is accounting to a specific project. Events taking place within the project can be translated into the statistical picture of the national economy through an appropriate classification of objects of expenditure in the project accounting.

Accounting is a discipline several centuries, if not millenia, old, and most of its concepts had been developed before the national accounts statistics were originated. The result is that almost every attempt to relate the quantitative records of development projects with those of the national economy has been made more difficult by conventional accounting procedures established in former times when records were kept primarily to assure the honesty of administrators and managers, and there was little, if any, analytical interest in the figures of expenditures.

This state of affairs is still reflected in public accounts of all countries, even the most advanced. Fortunately, during the last decade or two many countries, as well as the United Nations, have been working to elaborate an international standard of budgetary expenditure classification which would provide the necessary link needed to translate

specific accounting records into national accounting statistics. Perhaps the most advanced document in this field is the result of a combined effort on the part of the Fiscal and Financial Branch of the United Nations Department of Economic and Social Affairs, the Bureau of Technical Assistance Operations, the Economic Commission for Latin America, and the Latin American Institute for Economic and Social Planning.[1] The present writer believes an appropriate object-of-expenditure classification can be obtained by combining the "provisional Model Classification by Object of Expenditures" presented in this document, the principles of the United Nations national accounting classification,[2] the U.S. Department of Commerce commodity classifications,[3] and the International Labor Office classification.[4] When this

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[1] United Nations, 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, 1964, pp. 79ff.

[2] United Nations, A System of National Accounts and Supporting Tables, New York 1964 (Department of Economic and Social Affairs, Statistical Office of the United Nations, Studies in Methods, Series F, No. 2, Rev. 2).

[3] Bureau of the Census. Census of Manufactures: 1963, MC 63-2, Numerical List of Manufactured Products, U. S. Government Printing Office, Washington, D. C., 1964.
Bureau of the Census, 1963 Census of Mineral Industries, Numerical List of Mineral Products.
Executive Office of the President, Bureau of the Budget (Commodity Classification for Transportation Statistics.)

[4] International Labor Office, International Standard Classification of Occupations, Geneva, 1958, 1962.

combined classification is applied in a project-document (and later, in actual accounting of the implementation of a project), it will be possible to retrieve with a minimum of effort all significant information relative to a project in all its different financial and physical aspects. This classification is stated as follows:

OBJECT-OF-EXPENDITURE CLASSIFICATION

ONE-DIGIT LEVEL

0	Personal Services
1	Contractual Services
2	Materials and Supplies
3	Machinery and Equipment
4	Purchase of Land, Structures, and Rights
5	Construction
6	Current Transfers
7	Capital Transfers
8	Public Debt
9	Other Financial Disbursements
X	Aggregate Appropriations

It can be seen that the one-digit level object-of-expenditure classification provides the link between the main categories of budget accounting (public accounting) and those of national accounting. On lower levels (more than one digit), each class of the objects of expenditure will be subdivided according to a classification which best

indicates the influence of the particular expenditure on national accounting statistics and/or other crucial facets of a national economy, such as the demand for scarce factors of production and for foreign exchange. These subdivisional classifications are outlined in what follows.

0. PERSONAL SERVICES

This classification, more than any other, must be used with caution because of institutional peculiarities and varying degrees of technological advancement encountered in different countries. The following considerations are of particular importance with respect to many developing countries.

a. The classification must be simple and easy to apply regardless of local conditions but, at the same time, be one that can be gradually refined.

b. It must provide means for differentiating clearly among the highly skilled, professional occupations (engineers, agronomists, doctors, nurses, etc.). There is generally a short supply of these groups in developing countries and, therefore, an efficient "accounting" system is needed for this precious national resource.

c. It must allow for the large proportion of unskilled laborers in developing countries.

d. It must also recognize the peculiar position of the foreman in these countries. With a shortage of higher professional personnel,

on the one hand, and with widespread illiteracy and a largely unskilled labor force, on the other, the foreman's role is often greatly enhanced.

The above considerations have led us to adopt the International Labor Office's classification for our purposes.[5] It is worth noting that, while much shorter and less technologically detailed, this classification seems to agree in general principle with that of the U. S. Department of Labor. The latter is probably the most advanced in the field and reflects the enormous technological complexity of the American economy.[6]

The levels of classification, arranged in the increasing degree of detail (specialization), are:

Major Groups	(One digit or one letter)
Minor Groups	(Two digits)
Unit Groups	(Three digits)
Occupational Titles	(Four and more digits, according to the desired degree of detail)

In subdividing certain major groups, some levels may be omitted, in which case there may be a jump from, for example, the one-digit level directly to the three-digit level as in Major Group 4 (Farmers, Fishermen, Hunters, Loggers, and related workers).

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[5] International Labor Office, International Standard Classification of Occupations. Geneva, 1958, 1962.

[6] U. S. Department of Labor, Manpower Administration, Bureau of Employment Security, Dictionary of Occupational Titles, Third Ed. Washington, 1965.

To help the reader gain a working acquaintance with the classification and to facilitate the understanding of its use later in this study, the major groups are reproduced below, along with several examples of the detail on lower summary levels.

MAJOR GROUPS (ONE DIGIT)[7]

Major Group 0-0:	Professional, Technical and Related Workers (See below for details)
Major Group 0-1:	Administrative, Executive and Managerial Workers
Major Group 0-2:	Clerical Workers
Major Group 0-3:	Sales Workers
Major Group 0-4:	Farmers, Fishermen, Hunters, Loggers, and Related Workers
Major Group 0-5:	Miners, Quarrymen and Related Workers
Major Group 0-6:	Workers in Transport and Communication Occupations
Major Group 0-7/8:	Craftsmen, Production-Process Workers and Laborers Not Elsewhere Classified
Major Group 0-9:	Service, Sport and Recreation Workers
Major Group 0-X:	Workers Not Classifiable by Occupation
Armed Forces:	Members of the Armed Forces

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[7]Observe: We do not count here the first digit, 0, which precedes every code in the category of personal services. It is a code number that refers to the Object-of-Expenditure Classification of which Personal Services form only one part, coded 0.

MINOR GROUPS (TWO DIGITS)

Example 1: Minor Groups within the Major Group 0

(Professional, Technical and Related Workers)

0-0-0 Architects, Engineers and Surveyors

0-0-1 Chemists, Physicists, Geologists, and other Physical Scientists

0-0-2 Biologists, Veterinarians, Agronomists, and Related Scientists

0-0-3 Physicians, Surgeons, and Dentists

0-0-4 Nurses and Midwives

0-0-5 Professional Medical Workers Not Elsewhere Classified and Medical Technicians

0-0-6 Teachers

0-0-7 Clergy and Related Members of Religious Orders

0-0-8 Jurists

0-0-9 Artists, Writers, and Related Workers

0-0-X Draftsmen and Science and Engineering Technicians Not Elsewhere Classified

0-0-Y Other Professional, Technical, and Related Workers

Example 2: Minor Groups within the Major Group 0-4

(Farmers, Fishermen, Hunters, Loggers and Related Workers)

(Observe: These Minor Groups are at the same time Unit Groups, as explained above.)

0-4-0 Farmers and Farm Managers

0-4-1 Farm Workers Not Elsewhere Classified

0-4-2 Hunters and Related Workers

0-4-3 Fishermen and Related Workers

0-4-4 Loggers and Other Forestry Workers

Example 3: Minor Groups within the Major Group 0-7/8

(Craftsmen, Production-Process Workers and Laborers Not Elsewhere Classified)

0-7-0 Spinners, Weavers, Knitters, Dyers, and Related Workers

0-7-1 Tailors, Cotters, Furriers, and Related Workers

0-7-2 Leather Cutters, Lasters and Sewers (Except Gloves and Garments) and Related Workers

0-7-3 Furnace Workers, Rollers, Drawers, Moulders, and Related Metal Making and Treating Workers

0-7-4 Precision-Instrument Makers, Watchmakers, Jewellers, and Related Workers

0-7-5 Toolmakers, Machinists, Plumbers, Welders, Platers, and Related Workers

0-7-6 Electricians and Related Electric and Electronics Workers

0-7-7 Carpenters, Joiners, Cabinetmakers, Coopers, and Related Workers

0-7-8 Painters and Paperhangers

0-7-9 Bricklayers, Plasterers and Construction Workers Not Elsewhere Specified

0-8-0 Compositors, Pressmen, Engravers, Bookbinders, and Related Workers

0-8-1 Potters, Kilnmen, Glass and Clay Formers, and Related Workers

0-8-2 Millers, Bakers, Brewers, and Related Food and Beverage Workers

0-8-3 Chemical and Related Process Workers

0-8-4 Tobacco Preparers and Tobacco-Product Makers

0-8-5 Craftsmen and Production-Process Workers Not Elsewhere Classified

0-8-6 Packagers, Labelers, and Related Workers

0-8-7 Stationary-Engine, Excavating, and Lifting Equipment Operators and Related Workers

0-8-8 Longshoremen and Related Freight Handlers

0-8-9 Laborers Not Elsewhere Classified

UNIT GROUPS (THREE DIGITS)

Example: Unit Groups within the Minor Group 0-7-9

(Bricklayers, Plasterers, and Construction Workers Not Elsewhere Classified)

0-7-91 Bricklayers, Stonemasons, and Tile Setters

0-7-92 Plasterers

0-7-93 Cement Finishers and Terrazzo Workers

0-7-94 Insulation Appliers

0-7-95 Glaziers

0-7-99 Construction Workers Not Elsewhere Classified

N. B. Unit Groups within Major Groups 0-0 and 0-4 are essentially identical with the respective Minor Groups (see above).

OCCUPATIONAL TITLES (FOUR AND MORE DIGITS)

Example: Occupational Titles within the Unit Group 0-4-11

(Farm Workers Not Elsewhere Classified)

0-4-11.10 Farm Hand (General)

0-4-11.15 Farm Hand (Crops)

0-4-11.20 Farm Hand (Livestock)

0-4-11.25 Poultry Hatchery Worker

0-4-11.30 Farm Hand (Fur Bearing Animals)

0-4-11.35 Farm Hand (Bees)

0-4-11.40 Farm Hand (Silkworms)

0-4-11.45 Operator Farm Equipment (Motor Driven)

0-4-11.50 Operator Farm Equipment (Animal Drawn)

0-4-11.55 Nursery Worker

0-4-11.60 Propagator

0-4-11.65 Gardener

0-4-11.70 Grounds Keeper

0-4-11.75 Farm Laborer

0-4-11.90 Farm Workers Not Elsewhere Classified, Other

Example 2: Occupational Titles within the Unit Group 0-7-99 (Construction Workers Not Elsewhere Classified)

0-7-99.10 Housebuilder (General)

0-7-99.15 Floor-Layer (Mastic Composition)

0-7-99.20 Floor-Layer (Composition Tile)

0-7-99.25 Roofer (Slate, Tile, and Similar Materials)

0-7-99.30 Roofer (Composition)

0-7-99.35 Roofer (Asphalt and Similar Materials)

0-7-99.40 Roof Thatcher

0-7-99.45 Building Maintenance Man

0-7-99.50 Steeplejack

0-7-99.55 Sandblaster (Building Exteriors)

0-7-99.60 Steam Cleaner (Building Exteriors)

0-7-99.65 Paver

0-7-99.70 Diver

0-7-99.75 Well Digger

0-7-99.80 Pipe Layer

0-7-99.85 Scaffolding Erector (Metal or Wood)

0-7-99.90 Construction Workers Not Elsewhere Classified

Example 3: Occupational Titles within the Unit Group 0-8-99 (Laborers Not Elsewhere Classified)

0-8-99.20 Laborer (Light Physical Work)

0-8-99.30 Laborer (Heavy Physical Work)

The above examples should be sufficient to show how this classification system can be applied to projects of varying degrees of sophistication in developing countries.

a. It starts on very general levels and allows for progressive introduction of detail.

b. It clearly distinguishes highly skilled professions.

c. It clearly exhausts the class of unskilled labor prevalent in less developed countries with the three occupational titles below:

0-4-11.75 Farm Laborer

0-8-99.20 Laborer (Light Physical Work)

0-8-99.30 Laborer (Heavy Physical Work)

d. It provides the following easy rule for the identification of foremen.[8] The foremen who themselves carry out some of the duties, in addition to exercising supervision, should be classified in the craft or work concerned and distinguished from their co-workers by a final digit; for example, "Foreman paver: 0-7-99.66," as distinguished from "Paver: 0-7-99.65." (See Example 2 of Occupational Titles.) The

[8] Op. cit., p. 17.

foremen who are fully engaged in supervisory duties (often more than in one occupation) should be classified in a residual group and distinguished by a final digit; for example, "Foreman Construction General: 0-7-99.91," as distinguished from "Construction Workers Not Elsewhere Specified: 0-7-99.90." (See Example 2 of Occupational Titles.)

1. CONTRACTUAL SERVICES

1-1 Travel and transportation of persons

1-2 Transportation of things

1-3 Rent, communications, and utilities

1-4 Printing and reproduction

1-9 Other contractual services

This classification follows the current practice of the U. S. Bureau of the Budget (Circular A-12; July 22, 1960).

Unfortunately, in practice it is impossible to establish a one-to-one correspondence between divisions of this classification and the accepted divisions of national accounts. For example, expenditures on travel include such items as: train or airplane tickets, meals eaten during trips, hotel bills, cab fares, tips, and numerous other small items. These expenses go to establishments in different groups of national accounts. Although, in principle, it would be possible to establish a classification fine enough to differentiate between all these expenditures, in practice, no working operation could afford this kind of analytical luxury.

2. MATERIALS AND SUPPLIES

2-1.1 Products of Agriculture

2-1.2 Products of Forestry and Logging

2-1.3 Products of Hunting, Trapping, and Game Propagation

2-1.4 Products of Fishing

2-2.1 Products of Coal Mining

2-2.2 Products of Metal Mining

2-2.3 Crude Petroleum and Natural Gas

2-2.4 Products of Stone Quarrying, Clay, and Sand Pits

2-2.5 Products of Other Non-Metallic Mining and Quarrying

2-3.00 Products of Manufacturing

- 2-3.20 Food Manufacturing Industries, Except Beverage Industries
- 2-3.21 Beverage Industries
- 2-3.22 Tobacco Manufactures
- 2-3.23 Manufacture of Textiles
- 2-3.24 Manufacture of Footwear, Other Wearing Apparel and Made-Up Textile Goods
- 2-3.25 Manufactures of Wood and Cork, Except Manufacture of Furniture
- 2-3.26 Manufacture of Furniture and Fixtures
- 2-3.27 Manufacture of Paper and Paper Products
- 2-3.28 Printing, Publishing, and Allied Industries
- 2-3.29 Manufacture of Leather and Leather and Fur Products, Except Footwear and Other Wearing Apparel

2-3.30 Manufacture of Rubber Products

2-3.31 Manufacture of Chemicals and Chemical Products

2-3.32 Manufacture of Products of Petroleum and Coal

2-3.33 Manufacture of Non-Metallic Mineral Products, Except Products of Petroleum and Coal

2-3.34 Basic Metal Industries

2-3.35 Manufacture of Metal Products, Except Machinery and Transport Equipment

2-3.36 Manufacture of Machinery, Except Electrical Machinery

2-3.37 Manufacture of Electrical Machinery, Apparatus, Appliances and Supplies

2-3.38 Manufacture of Transport Equipment

2-3.39 Miscellaneous Manufacturing Industries

The preceding list corresponds exactly to the United Nations National Accounting classification[9] and to its International Standard Classification of All Economic Activities.[10] Thus, every expenditure on materials and supplies is related to an appropriate national-accounts grouping, i.e., the particular industry group in which the item was produced. However, the forementioned classifications do not have all the detailed subdivisions that may prove necessary for analyzing the qualitative demand for material inputs exerted by plans and projects.

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[9] United Nations, Studies in Methods Series F No. 2, Rev. 2, A System of National Accounts and Supporting Tables, New York 1964, p. 21.

[10] United Nations, Statistical Papers, Series M No. 4, Rev. 1, New York 1958.

For this reason, it is suggested that countries which have not yet worked out their own classifications use the three documents cited below:

Executive Office of the President, Bureau of the Budget, Commodity Classification for Transportation Statistics, Washington, 1963, for codes:

2-1.1 Products of Agriculture

2-1.2 Forestry and Logging

2-1.4 Fishing

(N.B. It was not possible to find a detailed classification for 2-1.3, Hunting, Trapping, and Game Propagation. Clearly, however, there is very little need for this particular detail.)

U. S. Department of Commerce, Bureau of the Census, Numerical List of Mineral Products, 1963 Census of Mineral Industries, Washington, for codes:

2-2.1 Coal Mining

2-2.2 Metal Mining

2-2.3 Crude Petroleum and Natural Gas

2-2.4 Stone Quarrying, Clay and Sand Pits

2-2.5 Other Non-Metallic Mining and Quarrying

U. S. Department of Commerce, Bureau of the Census, Numerical List of Manufactured Products, 1963 Census of Manufactures, U. S. Government Printing Office, Washington, 1964, for codes:

2-3.00 Products of Manufacturing

The simplest manner of arriving at a concordance between the numbering systems used in the United Nations publications, on the one hand, and in the United States publications, on the other, is, for the purposes of our work, as follows:

- use the above given code numbers for the level of generality which is covered by the above classification.

- attach the lower level (differentiating) code numbers from the United States classifications.

For example: What number should be given to "FARM WHEEL TRACTORS?" This item will be classed in our group, "2-3.36 Manufacture of Machinery, Except Electrical Machinery." We, therefore, establish the first four digits as

2-3.36

In the U. S. 1963 Census of Manufacturers, we find "35 Machinery Except Electrical"; within this group, "3522 Farm Machinery and Equipment" and, finally, "35222 Wheel Tractors."

We, therefore, suppress 35 and maintain 222. Our code for farm wheel tractors will thus be:

2-3.36.222

3. MACHINERY AND EQUIPMENT

Items forming this class will, by definition, belong to "Products of Manufacturing." The subdivisions are, therefore, identical with those of the group 23.00, Materials and Supplies; however, certain subdivisions, like food, beverages, and tobacco, will never be used, and others, like textiles, used only in very exceptional cases. For more detailed subdivisions, the same suggestion as for the preceding class of Materials and Supplies is made: U. S. Department of Commerce, Bureau of the Census, Numerical List of Manufactured Products, 1963 Census of Manufactures, U. S. Government Printing Office, Washington, 1964. The concordance of numbering codes should be assured in the same manner as that explained in the preceding paragraphs.

4. PURCHASE OF LAND, STRUCTURES, AND RIGHTS

4-1 Land

4-2 Structures

4-3 Land and Structures

4-4 Rights Pertaining to Land

4-5 Rights Pertaining to Structures

4-6 Rights Pertaining to Land and Structures

4-7 Other Rights (patents, copyrights, etc.)

5. CONSTRUCTION

Under this heading will fall project expenditures on construction activities performed by outside contractors. (Construction activities executed under the management of the project itself will not figure in this group but will appear as inputs in divisions: 1. Personal Services and 2. Materials and Supplies.)

If contracts are given out for specialized assignments, it is suggested that the classification system presented in the Standard Industrial Classification Manual (Executive Office of the President, Bureau of the Budget, Washington, 1957) be followed.

The main groups of the suggested classification are:

5-1 Plumbing, Heating, and Air Conditioning

5-2 Painting, Paper Hanging and Decorating

5-3 Electrical Work

5-4 Masonry, Stonework, Tile Setting, and Plastering

5-5 Carpentry and Wood Flooring

5-6 Roofing and Sheet Metal Work

5-7 Concrete Work

5-8 Water Well Drilling

5-9 Miscellaneous Special Trade Contractors:

- 5-91 Structural Steel Erection
- 5-92 Ornamental Metal Work
- 5-93 Glass and Glazing Work
- 5-94 Excavating and Foundation Work

5-95 Wrecking and Demolition Work

5-96 Installation or Erection of Buildings Equipment Not Elsewhere Classified

5-99 Special Trade Contractors Not Elsewhere Classified

6. CURRENT TRANSFERS

6-1 To private persons and organizations

6-2 To government enterprises

6-3 To local government

6-4 To abroad

7. CAPITAL TRANSFERS

Subdivisions as in "Current Transfers"

8. PUBLIC DEBT

This division will be mainly used to register expenditures for capital investment projects under the heading "interest during construction" in those instances when it is decided to charge this interest to the cost of the project. Other uses also may be found, depending on the decisions with respect to the legal and public accounting status of the project in question.

9. OTHER FINANCIAL DISBURSEMENTS

9-1 Loans and Advances

9-2 Acquisition of Financial Assets

9-3 Other

For certain projects, expenditures under these headings may be of great volume and importance; for example, loans to peasants that enable them to buy cattle, implements, fertilizers, etc., under certain integrated agricultural projects.

X. AGGREGATE APPROPRIATIONS

This division should appear only in the project document (i.e., before the implementation) and not in the project accounts after it is completed. The main item here is reserves for unforeseen expenditures which, by the time the project is completed, should be counted as either unused or imputed under the appropriate headings in the preceding nine divisions.

3.3 USEFULNESS OF CLASSIFICATIONS AND THE NEED FOR DISCRETION

A proper classification of a project's material inputs in terms of national accounts classification is not in itself a guarantee that the immediate impact of the implementation of the project on the formation of the GROSS NATIONAL PRODUCT (through its contribution to the country's aggregate demand) can be accurately measured. The reason

for this is that, in many cases, the unit price which a project pays for material inputs contains various other components, over and above the amount which will go to the industrial group that produced the item in question: various costs of transport, wholesaler's margin, and/or retailer's margin, other intermediaries' margins, customs duties, and charges of different kinds.

Economists and administrators who estimate the increase in their country's aggregate demand due to the implementation of the national plan or a specific group of projects must themselves possess considerable experience and flair or use the services of those who do. They will be required to make many discretionary assumptions concerning various margins implicit in final prices of the inputs.

However, it is very important not to overestimate the difficulties of this task and to keep in mind that it is possible to arrive at workable solutions and thus reap the tremendous advantages of having such estimates, even in crude form. The reasons for this optimism are these:

First, as indicated earlier, the project document will show the physical volume of inputs, expressed in appropriate units. Therefore, the physical-volume demand of several crucial items can be ascertained and this, in many cases, is all that is needed to assess the demand.

Second, in case of a limited number of strategic inputs, such as cement, structural and piping steel, iron, fertilizers, pesticides, and heavy chemicals, it will be possible to arrive at estimates of the

components of their final price as paid by the projects.

Finally, with respect to the multitude of minor items--which together represent a large fraction of project expenditures--their classification under technologically meaningful generic code headings should make it much easier to find rough averages applicable to whole groups of them.

CHAPTER IV

INPUT-AND-COST SCHEDULE

4.1 FORMAT OF THE INPUT-AND-COST SCHEDULE . . . . IV - 3

4.2 AGGREGATION OF INPUT-AND-COST SCHEDULES . . . IV - 6

4.3 THE NEED FOR DETAIL . . . . . IV - 10

4.4 FLEXIBILITY IN AGGREGATION . . . . . IV - 14

4.5 AN OVERVIEW: INFORMATION DESIGN IN THE CONTEXT OF DEVELOPMENT STRATEGIES . . . . . IV - 16

TABLE IV

FIGURES AND TABLES

		Following Page
Figure 4-1	Structure of Aggregation of Input-and-Cost Schedules	IV-10
Table 4-1	Input-and-Cost Schedule, Activity 1.111.	IV- 3
Table 4-2	Input-and-Cost Schedule, Activity 1.112.	IV- 9
Table 4-3	Input-and-Cost Schedule, Activity 1.113.	IV- 9
Table 4-4	Input-and-Cost Schedule, Activity 1.11X	IV- 9
Table 4-5	Input-and-Cost Schedule, Activity 1.110 (two pages) .	IV- 9
Table 4-6	Input-and-Cost Summaries of Activity 1.110 on Various Levels of Detail (three pages)	IV-15

4.1 FORMAT OF INPUT-AND-COST SCHEDULE

Once it has been decided how to structure projects in terms of functionally defined component activities and how to classify inputs in a meaningful way, it is not difficult to work out the appropriate quantitative presentation for a project. Nearly all governmental administrations and business enterprises of consequence have a number of formats and procedures, often carefully prepared and tested over the years, which can be used for our purposes, frequently without requiring more than minor modifications. It is likely, therefore, that the generalized format of documentation suggested on the following pages can meet nearly every situation that is likely to arise.

The single basic document in our scheme of presentation is what we shall call an ACTIVITY INPUT-AND-COST SCHEDULE. This schedule is nothing more than a listing of all inputs to be applied in a given activity, ordered according to the classification already described and supplemented by their respective costs and figures indicating timing. Table 4-1 shows such a schedule for an activity of the lowest summary level--i.e., the level which, in the information structure of the project, will not be split into any component work parcels. This example is drawn from the irrigation project discussed extensively in the preceding chapters. The activity under consideration is very simple: Profiling the Slopes of

TABLE 4-1

ACTIVITY INPUTS-AND-COSTS SCHEDULE

PROFILING SLOPES OF THE RESERVOIR
(Title of the Activity)

1.111
(Code Number)

Expected duration of implementation: 130 *Working days/from day no.* 51 *to day no.* 180 *after start of Project*

This Activity belongs to: LAND IMPROVEMENT: RESERVOIR
(Title of the next-higher-summary-level activity)

1.110
(Code Number)

This Activity comprises following next-lower-summary level activities. (Titles):

(Code Numbers):

NONE

CODE NO. (1)		DESCRIPTION OF INPUT (2)	UNIT (3)	PRICE PER UNIT (4)	NO. OF UNITS (5)	COST: (4)X(5) (6)	INPUT TO BE USED In Activity-No. (7)	INPUT TO BE USED On Day(s)-No. (8)	MINIMUM STOCK: No. of Days (9)
0	8-74.451	Bulldozer Operator-Foreman (1)	Man week	100.00	26	2,600.00		51-180	-
0	8-74.452	Bulldozer Operators (3)	Man week	75.00	78	5,850.00		51-180	-
0	8-99.30	Laborers, Heavy Physical Work (10)	Man Day	5.00	1,300	6,500.00		51-180	
2	3.32.111	Gasoline	Gallon	0.40	26,000	10,400.00		51-180	10
3	3.36.318.11	Bulldozers: Rental (4)	Machine Day	50.00	520	26,000.00		51-180	-
					TOTAL	51,350.00			

N. B. Hand tools are not listed among inputs because, as is often practices in this kind of work, workers are required to bring their own.

the Reservoir (Activity 1.111). It is hoped that the reader will show an indulgence for technological inaccuracies in this and other examples of schedules, which clearly should not impair the argument concerned with the use of the schedule as an information carrier. Most of the entry headings of the form are self-explanatory, and only a few remarks need be added:

- Code numbers corresponding to titles of activities are, of course, identical with those used in network diagrams.

- Time is measured in working days, in order to make time intervals comparable, in one-to-one equivalence, with the use of inputs in implementation of the activity.

- Code numbers of inputs are those of the classification system described earlier, modified to meet specific situations. The purpose of the thin line in Column (1), cutting off the first digit of code numbers, is to bring out the object-of-expenditure part of each code number and thus facilitate compilations for budgetary purposes; this will also make it easier to use the remaining digits of the code number for other compilations connected with procurement and with analyzing impact on national product.

- Column (8)--' Input is to be Used on Day(s) No. "--can be answered only approximately, which is all the precision required. The entries in our example indicate that the use of all inputs will be spread fairly evenly over the whole interval of implementation of Activity 1.111.

Were the case different--for example, were the need for labor concentrated in one or more shorter periods within this interval--the entries might usefully indicate it. To what extent such accuracy is needed, and with respect to which inputs, must be left to the judgment of the project management in preparing activity schedules; this judgment will have to reconcile the difficulties of projecting exactly the progress of works, on the one hand, with the need of precise projection figures for efficient procurement of materials and recruitment of labor, on the other.

- Column (9)--"Minimum Stock: No. of Days"--shows the recommended size of the stock of a given material expressed as a multiple of average daily use. As in Column (8), only approximate figures are required. Certainly, the same minimum stock will not be mandatory up to the last day of the period during which the input in question is used. The specific formula for handling this column ought to be left to the discretion of the management at appropriate levels. What is important is not what formula is used but that there is a nonambiguous formula consistently applied. Otherwise, procurement activities may get "out of phase" with other activities, and materials may be lacking or may pile up at wrong times.

4.2 AGGREGATION OF INPUT-AND-COST SCHEDULES

Direct Activities 1.111 (profiling slopes of reservoir), 1.112 (stabilizing rocks on slopes of reservoir), and 1.113 (stabilizing slopes of reservoir by planting trees, etc.), together form a direct activity of the next higher summary level--1.110 (land improvement: reservoir). An input-and-cost schedule for the latter is obtained by simple input-by-input summation of the schedules of its component activities.

One refinement is, however, necessary. As far as the physical work is concerned, Activity 1.110 is clearly composed of three separate activities on the next lower summary level:

Activity 1.111 Profiling Slopes of the Reservoir.

Activity 1.112 Stabilizing Rocks on Slopes of Reservoir.

Activity 1.113 Stabilizing Slopes of Reservoir by Planting Trees, etc.

These three activities may exhaust the entire work of land improvement without overlapping one another. It may be that they can be executed in a coordinated way by simple collaboration among the three foremen who head them, without anyone being specifically assigned the function of coordination and without any ancillary work required to the performance of that function. In such a case, these three lower

summary-level activity input-and-cost schedules will comprise the whole input demand of the next higher summary-level activity of which they are parts.

It is also possible, however, that coordination and supervision, especially the supervision of points of overlapping, will be entrusted to a staff member (presumably superior to those heading each of the activities), perhaps assisted by his own staff. For example, suppose Activity 1.110 is headed by a general foreman (probably a semi-engineer), assisted by an office clerk and a laborer. He also has, for a short period of time, a surveyor who will make measurements for definitive specifications of the tasks involved in the three component activities, 1.111, 1.112, and 1.113. We shall call this group of workers the COMMAND STAFF.

Of course, some office supplies, gasoline, etc., will be used incidental to the work of the Command Staff.

From the point of view of conventional accounting, the simplest way of treating these inputs (human and material) would be to keep them as parts of the management activities. At the end of the project, their cost would be allocated to various direct and service activities by some procedure of direct imputation combined with pro-rating of residuals. From the purely monetary point of view, such a procedure might well suffice for a tolerably truthful cost-accounting picture.

The shortcoming of the conventional procedure is that it confuses the nonmonetary side of project implementation exactly where the greatest clarity is needed: in precise scheduling of managerial effort and of ancillary staff, with respect to line activities. In our particular case, the problem is to schedule the work of a general construction foreman and a surveyor, both of whom are in short supply in developing countries. Thus, the bottleneck-detecting capacity of project programming becomes impaired.

To obviate this shortcoming, we shall use a simple device--an input-cost schedule for a fictitious activity:

Activity 1.11X Command Staff-Land Improvement:

Reservoir is added on the same four-digit level as the three component activities 1.111, 1.112, and 1.113 to account for the managerial inputs in question.

These inputs will not, therefore, be counted in managerial activities.

Which inputs ought to be shown in the X input-and-expenditure schedule is largely a matter of judgment. In our illustration, it was decided to indicate all personnel services (foreman, surveyor, office clerk, and laborer) and to ignore such inputs as office supplies and gasoline which, in this case, will be of only minor importance. These latter inputs will, of course, be charged to input-and-cost schedules of

management activities that involve administrative support for the direct activities (together with the cost of such items as payroll keeping, telephone charges, etc.). In other cases, the supplies and/or equipment used by the Command Staff level might be important enough to warrant inclusion in the X schedule.

Tables 4-2, 4-3, 4-4, and 4-5 show, respectively, input-and-cost schedules for activities 1.112, 1.113, the newly described activity 1.11X, and activity 1.110 (land improvement: reservoir). The latter comprises, as we know, the four lower-level activities: 1.111, 1.112, 1.113, and 1.11X.

Observe that the figures of inputs in the higher-order schedule are subdivided according to time intervals during which their application is expected to occur. This refinement may not be necessary for all inputs and in all cases. It is certainly essential for efficient procurement of sensitive inputs like manpower or scarce or perishable materials, especially in cases when input-and-cost schedules cover relatively long periods of time.

The simple logic of aggregating input-and-cost schedules has become clear by now: starting from the lowest summary level in each branch of activities--direct, service, and managerial--a pyramid of summation mounts all the time to higher and higher summary levels. The

TABLE 4-2

ACTIVITY INPUTS-AND-COSTS SCHEDULE

STABILIZING ROCKS ON SLOPES OF THE RESERVOIR — 1.112
(Title of the Activity) — (Code Number)

Expected duration of implementation: 20 *Working days/from day no.* 181 *to day no.* 200 *after start of Project*

This Activity belongs to: LAND IMPROVEMENT: RESERVOIR — 1.110
(Title of the next-higher-summary-level activity) — (Code Number)

This Activity comprises following next-lower-summary level activities. (Titles): *(Code Numbers):*

NONE

CODE NO. (1)		DESCRIPTION OF INPUT (2)	UNIT (3)	PRICE PER UNIT (4)	NO. OF UNITS (5)	COST: (4)X(5) (6)	INPUT TO BE USED In Activity-No. (7)	INPUT TO BE USED On Day(s)-No. (8)	MINIMUM STOCK: No. of Days (9)
0	7-91.41	Stonemason Construction-Foreman	Man week	100.00	4	400.00		181-200	-
0	7-91.42	Stonemasons, Construction (4)	Man week	75.00	16	1,200.00		181-200	-
0	8-99.30	Laborers, Heavy Physical Work (10)	Man day	5.00	200	1,000.00		181-200	
2	2.4.421	Construction Sand (detailed spec.)	Short ton	5.00	100	500.00		186-200	5
2	3.32.111	Gasoline	Gallon	0.40	450	180.00		186-200	10
2	3.33.410.11	Cement (detailed specification)	Bag 100 lb.	1.20	500	600.00		186-200	5
2	3.35.413.51	Structural Iron (detailed spec.)	Lb.	0.10	450	45.00		181-195	10
3	3.36.316.22	Mixer for Concrete: Rental (1)	Machine day	20.00	15	300.00		186-200	-
					TOTAL	4,225.00			

N. B. Hand tools are not listed among inputs because, as is often practiced in this kind of work, workers are required to bring their own.

TABLE 4-3

ACTIVITY INPUTS-AND-COSTS SCHEDULE

STABILIZING SLOPES OF THE RESERVOIR (PLANTING TREES, ETC.)
(Title of the Activity)

1.113
(Code Number)

Expected duration of implementation: 50 *Working days/from day no.* 151 *to day no.* 200 *after start of Project*

This Activity belongs to: LAND IMPROVEMENT: RESERVOIR
(Title of the next-higher-summary-level activity)

1.110
(Code Number)

This Activity comprises following next-lower-summary level activities. (Titles): *(Code Numbers):*

NONE

CODE NO. (1)		DESCRIPTION OF INPUT (2)	UNIT (3)	PRICE PER UNIT (4)	NO. OF UNITS (5)	COST: (4)X(5) (6)	INPUT TO BE USED In Activity-No. (7)	INPUT TO BE USED On Day(s)-No. (8)	MINIMUM STOCK: No. of Days (9)
0	4-01.841	Landscape Gardener--Foreman	Man week	100.00	10	1,000.00		151-200	-
0	4-01.842	Landscape Gardeners (2)	Man day	8.00	100	800.00		151-200	-
0	8-99.30	Laborers, Heavy Physical Work (2)	Man day	5.00	100	500.00		151-200	-
2	1.1919	Nursery Stock (detailed spec.)	Dozen	20.00	100	2,000.00		151-200	5
					TOTAL	4,300.00			

N. B. Hand tools are not listed among inputs because, as is often practiced in this kind of work, workers are required to bring their own.

TABLE 4-4

ACTIVITY INPUTS-AND-COSTS SCHEDULE

COMMAND STAFF - LINE IMPROVEMENT: RESERVOIR
(Title of the Activity)

1.11X
(Code Number)

Expected duration of implementation: 150 *Working days/from day no.* 51 *to day no.* 200 *after start of Project*

This Activity belongs to: LAND IMPROVEMENT: RESERVOIR
(Title of the next-higher-summary-level activity)

1.110
(Code Number)

This Activity comprises following next-lower-summary level activities. (Titles):

(Code Numbers):

NONE

CODE NO. (1)		DESCRIPTION OF INPUT (2)	UNIT (3)	PRICE PER UNIT (4)	NO. OF UNITS (5)	COST: (4)X(5) (6)	INPUT TO BE USED In Activity-No. (7)	INPUT TO BE USED On Day(s)-No. (8)	MINIMUM STOCK: No. of Days (9)
0	7-99.91	Construction, General-Foreman (1)	Man month	600.00	10	6,000.00		51-200	-
0	0-03.20	Surveyor, Land (1)	Man month	300.00	2	600.00		51-90	-
0	2-99.10	Office Clerk, General (1)	Man Month	250.00	10	2,500.00		51-200	-
0	8-99.20	Laborer, Light Physical Work (1)	Man day	5.00	150	750.00		51-200	-
					TOTAL	9,850.00			

N. B. The surveyor uses his own instruments.

TABLE 4-5 (First Page)

ACTIVITY INPUTS-AND-COSTS SCHEDULE

LAND IMPROVEMENT: RESERVOIR — 1,110

(Title of the Activity) — (Code Number)

Expected duration of implementation: 150 *Working days/from day no.* 51 *to day no.* 200 *after start of Project*

This Activity belongs to: RESERVOIR SYSTEM — 1,100

(Title of the next-higher-summary-level activity) — (Code Number)

This Activity comprises following next-lower-summary level activities. (Titles): *(Code Numbers):*

Command Staff.....1.11X
Profiling Slopes of the Reservoir.....1.111
Stabilizing Rocks on Slopes of the Reservoir.....1.112
Stabilizing Slopes of the Reservoir (Planting Trees, etc.).....1.113

CODE NO. (1)		DESCRIPTION OF INPUT (2)	UNIT (3)	PRICE PER UNIT (4)	NO. OF UNITS (5)	COST: (4)X(5) (6)	INPUT TO BE USED In Activity-No. (7)	INPUT TO BE USED On Day(s)-No. (8)	MINIMUM STOCK: No. of Days (9)
0	0-03.20	Surveyor, Land	Man month	300.00	2	600.00	1.11X	51-90	-
0	2-99.10	Office Clerk, General	Man month	250.00	10	2,500.00	1.11X	51-200	-
0	4-01.841	Landscape Gardener--Foreman	Man week	100.00	10	1,000.00	1.113	151-200	-
0	4-01.842	Landscape Gardeners	Man day	8.00	100	800.00	1.113	151-200	-
0	7-91.41	Stonemason Construction--Foreman	Man week	100.00	4	400.00	1.112	181-200	-
0	7-91.42	Stonemasons, Construction	Man week	75.00	16	1,200.00	1.112	181-200	-
0	7-99.91	Construction General--Foreman	Man month	600.00	10	6,000.00	1.11X	51-200	-
0	8-74.451	Bulldozer Operator--Foreman	Man week	100.00	26	2,600.00	1.111	51-180	-
0	8-74.452	Bulldozer Operators	Man week	75.00	78	5,850.00	1.111	51-180	-
0	8-99.20	Laborer, Light Physical Work	Man day	5.00	150	750.00	1.11X	51-200	-
0	8-99.30	Laborers, Heavy Physical Work	Man day	5.00	1,600	8,000.00	See below:	51-200	-
	The above item	(10)			1,300	6,500.00	1.111	51-180	
	is thus	(2)			100	500.00	1.113	151-180	
	distributed	(10)			200	1,000.00	1.112	181-200	
0	SUBTOTAL - PERSONNEL SERVICES:					(29,700.00)			

Continued on following page.

TABLE 4-5 (Second Page)

ACTIVITY INPUT-AND-COST SCHEDULE

LAND IMPROVEMENT: RESERVOIR
(Title of the Activity)

1.110
(Code Number)

Expected duration of implementation: 150 *Working days/from day no.* 51 *to day no.* 200 *after start of Project*

CODE NO. (1)		DESCRIPTION OF INPUT (2)	UNIT (3)	PRICE PER UNIT (4)	NO. OF UNITS (5)	COST: (4) X (5) (6)	INPUT TO BE USED In Activity-No. (7)	INPUT TO BE USED On Day(s)-No. (8)	MINIMUM STOCK: No. of Days (9)
2	1.1919	Nursery Stock (detailed specification)	Dozen	20.00	100	2,000.00	1.113	151-200	5
2	2.4.421	Construction Sand (detailed spec.)	Short ton	5.00	100	500.00	1.112	186-200	5
2	3.32.111	Gasoline	Gallon	0.40	26,450	10,580.00	See below:	51-200	10
		The above item			26,000	10,400.00	1.111	51-180	
		is thus distributed			450	180.00	1.112	186-200	
2	3.33.410.11	Cement (detailed specification)	Bag 100 lb.	1.20	500	600.00	1.112	186-200	5
2	3.35.413.51	Structural Iron (detailed spec.)	Lb.	0.10	450	45.00	1.112	181-195	10
2		SUBTOTAL - MATERIALS AND SUPPLIES				13,725.00			
3	3.36.316.22	Mixer for Concrete: Rental	Machine day	20.00	15	300.00	1.112	186-200	
3	3.36.318.11	Bulldozers: Rental	Machine day	50.00	520	26,000.00	1.111	51-180	
3		SUBTOTAL - MACHINERY AND EQUIPMENT				26,300.00			
		TOTAL ALL INPUTS				69,725.00			

last remaining schedule, at the apex of the pyramid, is nothing else than a complete input-and-cost schedule for the whole project. It also is the most comprehensive and detailed configuration in which a project document can be presented, if needed. Figure 4-1 shows this simple, pyramid-like structure of aggregation.

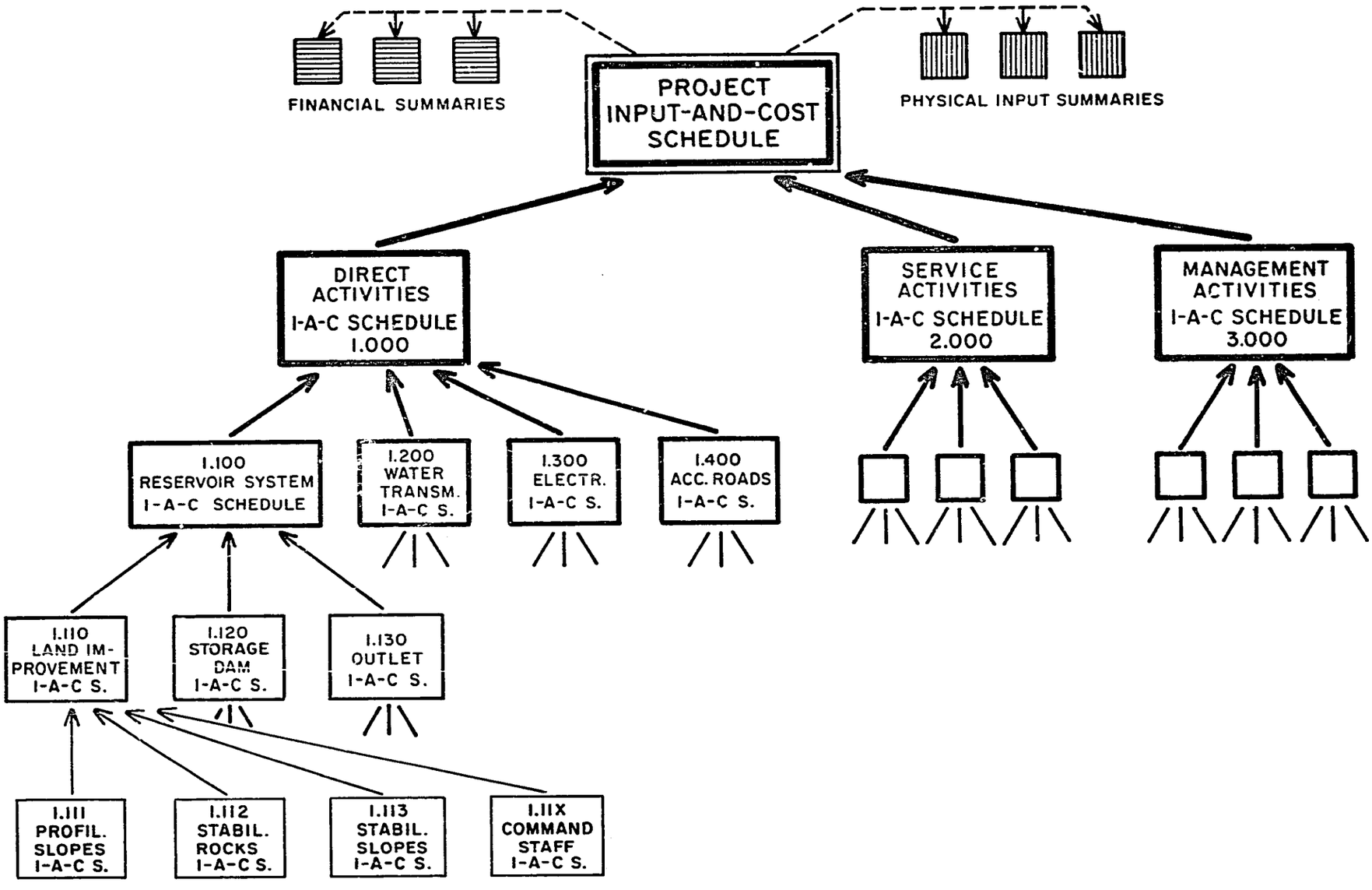
It should be emphasized that this structure of input-and-cost schedules is identical with that of the activities network, with respect both to articulation into member activities and to their occurrence at different times. This isomorphism is the foundation on which a penetrating system of cost accounting can be built to measure the efficiency of performance in terms of technologically meaningful work parcels.

4.3 THE NEED FOR DETAIL

The work of compiling precise input-and-cost schedules for each lowest-level activity is laborious; aggregating them up to the total project level, especially in the absence of automatic data processing, is equally tedious and time consuming. A question may be raised: Is all that effort, all that filling and processing of forms and calculating innumerable totals, really necessary? Can we not get away from the paperwork and concentrate on the real work of moving earth, cutting canals, pouring concrete? Is not the real work to be done out in the field with a pick and a shovel rather than in the office with an adding machine?

FIGURE 4-1

STRUCTURE OF AGGREGATION OF INPUT-AND-COST SCHEDULES



These questions have been asked again and again with respect to every system of programming that attempted to achieve a precision of information which would help to make a project's success more certain than winning at roulette. In many cases, the impatience with paperwork prevailed and exact programming was neglected. Occasionally, luck served and projects were successfully completed. More often, the game was lost, and many rusting pieces of equipment, unfinished roads, and silted, overgrown, useless canals across the world witness the fact that more fortunes are lost than gained at roulette.

It is undoubtedly true that many crucial managerial decisions, on all levels of responsibility, can be correctly made on the basis of only a very general picture of the inputs needed and their timing; for these types of decisions, such factors as human relations, general financial considerations, and sophisticated points of technological design predominate. In solving problems of these sorts, the manager will concentrate his attention on their operative factors; while the composition of the great mass of inputs is seen as background, the details do not greatly influence the looked-for solution.

There are, however, many situations where effective performance of managerial functions requires a completely elaborated, easily accessible listing of input requirements showing the most minute detail of quality,

quantity, and timing. The need for this kind of documentation arises constantly, and in an extremely pressing manner, in two crucial branches of management activities: (1) middle- and low-level "line" management and (2) procurement of inputs.

In contrast to "high headquarter staff" management, which implies, ideally at least, a good deal of analytical thinking and of comparing of alternatives, line management is involved mainly in supervising and expediting the physical movement of material and human inputs according to designs and specifications emanating from the headquarters programming branch. The task of the line is to translate the design into reality.

Consider again one of the activities forming the smallest work parcels in our irrigation project, for example, Activity 1.112 (input-and-cost schedule, Table 4-2). The task of stabilizing rocks on the slopes of the reservoir is left in charge of a "Stonemason Construction-Foreman," a member of the project's lowest tier of line management. He is the man under whose eye inputs will actually be applied in the literal, physical sense of the word. To perform his task effectively, he must have truly detailed specifications in order not to depart unwittingly from the concept the project's designer had in mind. Here we must distinguish between a 6/8-inch structural iron rod and a 7/8-inch rod, between fine-grain sand and coarse-grain sand, and so on. In speaking of "truly detailed

specifications," the word "truly" is meant in a relative sense; i.e., in the sense of the extent to which the designer of the project wishes to specify its detailed quantitative and qualitative characteristics. For whatever is not specified on the lowest summary level of the project document is implicitly left to the judgment and improvisation of the management of this level. It is good to leave some room for a foreman's judgment in applying his human inputs (unskilled labor, above all), especially if the work extends over a considerable area of varying scenery, under variable weather, as is the case in irrigation works, road building, etc. However, when it comes to material inputs, the technological complexity of most projects and exigencies of their future operation and maintenance make it necessary to specify almost all quantitative and qualitative details and to expect from line managers a strict adherence to these specifications.

The viewpoint of procurement is quite simple. Acquiring inputs for the project, making them available at the right time and in desired quantity and quality, can be done efficiently only if the branch of management in charge of this task has complete information on the "what," "how much," and "when" of the problem. This information can be obtained only by aggregating all detailed schedules of activities comprised in a project.[1]

4.4 FLEXIBILITY IN AGGREGATION

Detail and precision in a project document will not become an obstacle on those frequent occasions when it is necessary for the management or the government economic agencies to consider the project in more general perspectives such as the total impact of wages and

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[1]Consider only this simple illustration of how much detailed information is needed for efficient procurement. How many beds, mattresses, pillows, sheets, and blankets are needed for a workers' camp if, during the year's duration of a project (250 working days), there will be a total input of 250,000 man days of common labor? Clearly, the answer depends on whether 1,000 workers will be engaged for 250 days or 2,000 workers for 125 days. The required data can be obtained only by compiling all detailed input-and-cost schedules.

salaries, the total demand for a general group of material inputs, or the proportion of products manufactured locally to those imported. For these and similar considerations, input-and-cost schedules can be aggregated on any desired digit level of input classification. A brief illustration of how such aggregation can be generalized at will is shown in Table 4-6 which represents the input-and-cost schedule of Reservoir System (Activity 1.110), already given in full detail in Table 4-5. Moreover, thanks to the complete structural equivalence between the schedules and the network of activities to which they correspond, schedules can be combined to reflect every technologically significant partial combination of activities within the project. For example, in a large project that includes many low summary level earthmoving activities spread among several loosely related higher-level activities, it will be possible to obtain an aggregate picture of the earthmoving function for the total project. This may prove very helpful when alternatives of substituting machinery for manpower or different manners of pooling equipment are considered.

Because it is possible to vary the digit level of input aggregation and the digit level of activity aggregation and/or to combine activities into various subsets within the whole of the project, the manner of presentation is completely flexible. Information may be found to aid in the solution of

TABLE 4-6 (First Page)

ACTIVITY INPUTS-AND-COSTS SCHEDULE

LAND IMPROVEMENT: RESERVOIR — 1.110
(Title of the Activity) (Code Number)

Expected duration of implementation: 150 *Working days/from day no.* 51 *to day no.* 200 *after start of Project*

This Activity belongs to: RESERVOIR SYSTEM — 1.110
(Title of the next-higher-summary-level activity) (Code Number)

This Activity comprises following next-lower-summary level activities. (Titles): *(Code Numbers):*

Command Staff	1.11X
Profiling Slopes of the Reservoir	1.111
Stabilizing Rocks on Slopes of the Reservoir	1.112
Stabilizing Slopes of the Reservoir (Planting Trees, etc.)	1.113

CODE NO. (1)		DESCRIPTION OF INPUT (2)	UNIT (3)	PRICE PER UNIT (4)	NO. OF UNITS (5)	COST: (4)X(5) (6)	INPUT TO BE USED In Activity-No. (7)	INPUT TO BE USED On Day(s)-No. (8)	MINIMUM STOCK: No. of Days (9)
		INPUT SUMMARY: FOUR DIGIT LEVEL							
0	0-03	Surveyors				600.00		51-90	
0	2-99	Clerical Workers Not Elsewhere Classified				2,500.00		51-200	
0	4-01	Farmers and Farm Managers				1,800.00		151-200	
0	7-91	Bricklayers, Stonemasons & Tilesetters				1,600.00		181-200	
0	7-99	Construction Workers Not Elsewhere Classified				6,000.00		51-200	
0	8-74	Operators of Earth-Moving & Other Constr. Machinery Not Elsewhere Classified				8,450.00		51-180	
0	8-99	Laborers Not Elsewhere Classified				8,750.00		51-200	
2	1.19	Miscellaneous Farm Products				2,000.00		151-200	
2	2.44	Sand and Gravel				500.00		186-200	
2	3.32	Products of Petroleum Refining				10,580.00		51-200	
2	3.33	Non-metallic Mineral Products, Except Products of Petroleum and Coal				600.00		186-200	

Continued on following page

TABLE 4.6 (Second Page

ACTIVITY INPUT-AND-COST SCHEDULE

LAND IMPROVEMENT: RESERVOIR
(Title of the Activity)

1,110
(Code Number)

Expected duration of implementation: 150 *Working days/from day no.* 51 *to day no.* 200 *after start of Project*

CODE NO. (1)		DESCRIPTION OF INPUT (2)	UNIT (3)	PRICE PER UNIT (4)	NO. OF UNITS (5)	COST: (4) X (5) (6)	INPUT TO BE USED In Activity-No. (7)	INPUT TO BE USED On Day(s)-No. (8)	MINIMUM STOCK: No. of Days (9)
2	3.35	Metal Products, Except Machinery & Transport Equipment				45.00		181-195	
3	3.36	Machinery, Except Electrical				26,300.00		51-200	
		INPUT SUMMARY:: TWO DIGIT LEVEL							
0	0	Architects, Engineers and surveyors				600.00		51-90	
0	2	Clerical Workers				2,500.00		51-200	
0	4	Farmers, Fishermen, Hunters, Loggers and Related Workers				1,800.00		151-200	
0	7/8	Craftsmen, Production-Process Workers Not Elsewhere Classified				24,800.00		51-200	
2	1	Products of Agriculture				2,000.00		151-200	
2	2	Mineral Products				500.00		186-200	
2	3	Products of Manufacturing				11,225.00		51-200	
3	3	Products of Manufacturing				26,300.00			
				TOTAL ALL INPUTS		69,725.00			

Continued on following page

TABLE 4-6 (Third Page)

ACTIVITY INPUT-AND-COST SCHEDULE

LAND IMPROVEMENT: RESERVOIR
(Title of the Activity)

1,110
(Code Number)

Expected duration of implementation: 150 *Working days/from day no.* 51 *to day no.* 200 *after start of Project*

CODE NO. (1)		DESCRIPTION OF INPUT (2)	UNIT (3)	PRICE PER UNIT (4)	NO. OF UNITS (5)	COST: (4) X (5) (6)	INPUT TO BE USED In Activity-No. (7)	INPUT TO BE USED On Day(s)-No. (8)	MINIMUM STOCK: No. of Days (9)
		INPUT SUMMARY: ONE DIGIT LEVEL							
0		Personnel Services				29,700.00		51-200	
2		Materials and Supplies				13,725.00		51-20	
3		Machinery and Equipment				26,300.00		51-200	
				TOTAL ALL INPUTS		69,725.00			

almost any management problem through an appropriate marshalling of data, provided that the project breakdown into activities is technologically and organizationally meaningful and that input data are correctly estimated.

Aggregations on high levels of generality, with respect to both inputs and activities, can be expected to make up a significant part of the complete project document used by the planning agency and other outside groups.

4.5 AN OVERVIEW: INFORMATION DESIGN IN THE CONTEXT OF DEVELOPMENT STRATEGIES

At this point, we may profitably stop to review the general pattern of thought which has already been sketched on the preceding pages and which will be developed further in subsequent chapters.

Goals of social and economic strategies are rooted in powerful human feelings, but they are achieved by skillful use of emotionally neutral information. What begins as a passionate and prophetic struggle succeeds to the extent that its objective becomes more generally taken for granted as one implicit in the routine operations of the society and to the extent that information is available to manage these operations. Consider the road from the medieval peasants' revolts against misery and feudal oppression to the present-day social security systems of advanced

countries. With each forward step, the social consensus with respect to new value judgments is extended and, correspondingly, the emotional tension lessened, necessitating increased information on more facets of the social process. Goals are realized by constantly increasing the volume of information put into a progressively more complex existential algorithm, which is generally based on this formula: "If you want to achieve y (old age without poverty, care for the sick, etc.), obtain information on x, $x_2 \ldots\ldots x_n$ (number of population, age distribution, incidence of diseases, etc.), perform analytical operations k, l, m (averaging, obtaining percentages, etc.) and existential operations p, r, s (withdrawals, transfer payments, etc.).'

The sons of successful revolutionaries are managers. Actuarial tables of social security are monuments to yesteryear's fighters for justice.

Why allow such remarks in what purports to be a technical study? Because far from being obiter dicta, they concern the very essence of effective development techniques which the world today is trying to discover.

Let us restate this viewpoint in a more formal manner by borrowing some of the system-theoric imagery. In attempting to foment economic development we are dealing with an immense system, cut out

from reality as a whole, which is so complex that it is now and perhaps forever intractable by one single comprehensive theory. This system is instinctively felt to contain so many involved functional relations among various combinations of its main classes of objects--man, artifact (machine, manufactured compound, etc.), animate nature, inanimate nature--that only fragments of subsystems can be incorporated into the often unrelated theories and resulting analytical, predictive, and existential (i.e., goal-oriented) models. We have a theory of growing irrigated crops, of hydraulics, of various technologies involved in building an irrigation system, of national income, of budget management, of accounting, and of labor relations. We know that all these, and many others, will be operative when we implement our irrigation project because its impact in each of the areas involved will be significant enough to affect noticeably the society's interest. Also, we expect to encounter trouble of one kind or another because it is very likely that some cross relationships will work to the disadvantage of society.

Yet, we cannot wait decades for more study. Emotions run high. Increasing numbers of people are demanding an end to the suffering and

degradation that still defaces the planet.[2] In many a country, the planner works to the accompaniment of gun chatter. Impatient, driven by and committed to the temper of our time, we are trying to make headway at once on two fronts: that of analytical understanding and that of empirical action. Economic strategy straddles the gap between analysis and existence using what little is known about systems and their inter-relations to realize the existential goals. It amounts to the one-eyed leading the blind, but it is the best that mankind can do now.

Is there something that could be done to strengthen the chances of our undertaking? Yes. We can and should structure the flow of information within every partial system at each level so as to maximize the possibility of tracing all these interdependencies which seem to be crucial to the success of our strategy. This is what we have tried to achieve through the project design advocated in this study. Tasks required to implement a project are structured in terms of goal-oriented systems (activities) of differing levels which ultimately combine to form the project. The latter, in turn, is a part of a larger system of the national economy.

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[2]Even as these words are being edited, the press brings the text of the latest encyclical, "Progressio Populorum" (On the Development of Peoples). "We must make haste: Too many are suffering..." urges Pope Paul VI. (New York Times, March 29, 1967)

Inputs are related to activities and classified in a manner which is meaningful both within the limited system of the project and the larger system of the national economy which the former affects by its input demand.

Now, through the use of a few illustrations, we show how the way of approaching projects advocated in this study can help managers of public and private agencies engaged in economic development.

Comparison Between Alternative Means of Attaining a Goal

Efficient use of inputs in executing a given activity is not the same thing as efficient attainment of the goal at which the activity in question aims. There is always the possibility that some other activity, based on another technology, could have reached the goal at a smaller cost.

Providing electricity for dam and outlet gates in an irrigation system could be achieved by two alternative solutions:

a. A power plant on the site and a short circuit of on-site conduits from the plants to gates.

b. A long line tapping a distant high-voltage transmission line, stepdown equipment, and on-site circuits.

Each of the above alternatives can be presented as a partial network of direct activities (a subsystem), supported by service and management activities. The expected costs of direct activities can be

calculated from their input-and-cost schedules and by pro-rating the cost of service and management activities. Thus, the total investment necessary for each of the competing alternatives will be known as precisely as possible. This, combined with estimates of operating costs and expected depreciation, enable the planner to make a choice.

The principle of structuring the whole project in terms of activities is of special value when comparing technological alternatives. Not only does it enable the planner to detect the obvious differences directly attributable to given technologies--e.g., a transmission line versus a generator--but also those hidden and easily forgotten differences in service activities which will follow respective choices of technology. For example, an on-site power plant requires service activities in support of construction and installation to be concentrated in the central area of the project. On the other hand, the alternative of tapping a distant high-voltage transmission line not only extends service activities along the distance in question but it also demands a different mix of service activities. Activities networks will show differences in timing and sequence, while input-and-cost schedules will show differences in the input mix and resulting cost.

In a campaign type project, such as a literacy campaign, alternatives also appear as sets of direct and service activities. For example, depending on which set of activities is chosen, the necessary

printed teaching materials may be produced within the project or outside contractors may be hired for this purpose.

Procurement

Through the process of procurement, resources are put at the disposal of a project and, thus, become unavailable to other parts of the larger economic system within which the project is implemented. This makes for a problem of a dual nature: on the one hand, inputs should be procured in a manner that enhances the efficiency of the project in question; on the other hand, this should be done so as to minimize the disturbance to the rest of the economy. Consequently, the questions: What input? How much? When? are of crucial importance. Activities networks and input-and-cost schedules are designed specifically to answer these questions.

Measuring the Efficiency of Implementation

Cost accounting is built into the design. It relates inputs to specific activity goals providing the plan of accounts reflects the division of a project into activities. When a project is completed, the expenditure ledgers will reflect the distribution of the total cost among its component activities, thereby making it possible to determine immediately the direct

unit-cost of each activity. Computation of indirect costs which arise from service and management activities imputable to respective direct activities is greatly simplified because activities networks reflect the functional structure of the project.

Benchmark figures obtained from cost accounting provide a means of comparing the efficiency of executing basic types of work within a project, between different projects, and from year to year. Their economic significance is self-explanatory.

Technological Judgment in Administrative Procedure

One of the central problems of management, public as well as private, is that nontechnologically oriented administrators in the higher ranks of the accounting, audit, or treasury departments are often responsible for evaluating the proposals and actions of technological specialists. Disbursing officers must continually approve or reject requests for expenditures on inputs while the project is being executed. Auditors have to judge whether the progress of work and absorption of inputs by activities corresponds to the original plan, because the earlier a deficiency is discovered, the greater the chance to remedy the ill. For these and other similar functionaries, a project document clearly identifying inputs in relation to the activities by which they are to be

absorbed and specifying respective amounts and timing offers important information. Without this kind of document, their decisions would have to be based largely on guessing and intuition.

Modular Programming

Enormous economies of scarce skills would result if statistically tested input-and-timing modules of such typical "building blocks" as a mile of road and a building of a standard type were available and appeared repeatedly in the great mass of projects. Such "building blocks," however, can be used only when the project documents are structured in terms compatible to those of the modules. This is the case of the design described in this study.

Impact of a Project on Outside Economy

There is a detailed discussion of this subject later. For now it suffices to state that whether the impact is measured in terms of quality of inputs or their quantity, timing, or monetary value, the flexible aggregation of input-and-cost schedules will provide enough information to answer almost any relevant question.

Meaningful Progress Reporting

It was stated above that the cost-accounting control of efficiency is greatly facilitated if projects' plans of accounts reflect the division of projects into activities. The same point can be made more generally with respect to all forms of progress reporting. In a plan of accounts which is structured as an image of the network of activities each entry becomes a directly meaningful unit of information on the progress of implementation of respective activity. In fact, if the ledgers are kept up to date, their periodic balances directly constitute progress reports of a most useful kind.

Upon completion of project, the closed books offer not only an evidence of a faithful handling of funds (as they would do in many old-time accounting systems) but they provide above all a most valuable store of properly arranged data for technological and economic analysis.

Psychology of Planning and Implementation

The design under discussion imposes a degree of quantitative thinking and precision on planners which the current method of elaborating project documents lacks. The complexity of interdependencies among various functional components of a project and the resulting risk of costly failures is impressed on both planners and managers. Inconsistencies and errors of judgment are more easily identified. Finally, the design clarifies for each member of management team his function in the cooperative effort and, thus, his particular opportunity to contribute and to excel.

CHAPTER V

PROCUREMENT

5.1 CRITERIA OF PROCUREMENT POLICIES . . . . . V - 3

5.2 USES OF INFORMATION DERIVED FROM INPUT-AND-COST SCHEDULES . . . . . V - 7

5.3 ITERATIVE CHARACTER OF PROCUREMENT PLANNING . . . . . V - 10

5.4 ADVANTAGES OF "SLACK" FOR ITERATIVE PLANNING . . . . . V - 13

5.5 RELATIONS ACROSS INTERFACES AND THE PROJECT BOUNDARY . . . . . V - 14

CHAPTER V

FIGURES AND TABLES

		Following Page
Figure 5-1	Cement Procurement Plan: First Alternative	V- 8
Figure 5-2	Cement Procurement Plan: Second Alternative . . .	V-11
Figure 5-3	Aggregate Demand for Laborers	V-12
Figure 5-4	Illustrative Fragment of Management and Service Network (two pages).	V-15
Table 5-1	Illustrative Fragments of Input-and-Cost Schedule at the Project Level	V- 7

5.1 CRITERIA OF PROCUREMENT POLICIES

Procurement means marshalling resources--material and human--for implementation. Involved in project procurement are a number of internal and external problems whose solution will depend on the efficiency of implementation and the benefits offered society by a particular project. Information relating to these problems should be included in the project programming documents, and the input-and-cost schedule is designed with this purpose in mind. The points to be considered are the following:

- Lead time for ordering physical inputs and contracting personnel.

This process is notoriously long and difficult, especially in certain cases when it may be necessary, for example, to recruit highly skilled specialists or procure electrical machinery from an industrial country that is experiencing an economic upswing. The lead time may be variously defined and details of the definition should be left for the project programmers to work out. However, it is imperative to avoid ambiguities which may mislead persons not intimately familiar with the project. For example, lead time for heavy equipment may be counted from the date bids are invited or from the date they are adjudicated or from the date a binding agreement is signed. It is vital that the definition makes clear which date is to be used. The lead time is calculated with respect to dates indicated in Column (7) of the input-and-cost schedule.

- Secondary lead time, between the delivery of the ordered goods to the indicated site and their actual use as inputs in activities of implementation. While this lead time does not apply to the case of the human factor, it may be of great importance in the case of certain materials which are so essential for efficient implementation that it is necessary to maintain a minimum stock of them. We may note here that a secondary lead time of, say, 10 days for cement means that during periods when cement is being used, the stock will still be maintained at the approximate 10-day level. Here, then, is the link with the data of Column (8) of the input-and-cost schedule.

- Optimum size of orders from the viewpoint of efficient project implementation. To be considered under this heading are: the costs of various means of transportation and their respective capabilities measured in physical volume; passability of roads during rainy seasons; differences in unit costs of packaging and shipping varying volumes of a given material; physical capacity of storage facilities and cost of storage; and, finally, the degree of perishability of materials (e.g., cement, chemicals, or seeds in hot and humid regions).

- Smoothing-out the impact of the project's demand for inputs on the regional and/or national economy.

Supervising authorities of large scale public-sector projects should always be concerned lest the impact of implementation causes harmful dislocations elsewhere in the economy which might outweigh, at least in part, the advantages expected from the project. If there is a large demand for some vital construction material scheduled within a short period, it could greatly upset the normal working of the region's or even the country's building industry, lead to unhealthy market practices, and contribute to inflationary pressures. An excessively fluctuating demand for unskilled workers by a large public works project, with peaks of high employment alternating with drastic lay-offs of hundreds or thousands of laborers, could result in grave social difficulties in the neighboring areas, especially if some workers, as frequently happens, were migrants from distant localities.

Obviously, there are certain contradictions between the viewpoint presently under discussion and the one immediately preceding which dealt with the optimum ordering for the project's internal efficiency. This is an important juncture where the project's internal criteria may be found to be in discord with those of the larger system of which it is a part. A higher level mediation or arbitration may be necessary, perhaps by a

cabinet member or even the head of state. Here again is a case where a network chart, such as the one advocated above (Chapter II, Figure 6), would be most helpful in presenting the project framework and the logic of the proper sequence of implementation to the high authority responsible for striking a suitable compromise.

It would be most encouraging if the potential dislocating impact of a project were studied and appropriately tempered not only with concern for the surrounding regions and the national economy but also with concern for other countries' economies. In this respect, of course, most projects are too small to count. It is not at all certain, however, that the question would always be considered in the case of an exceptionally large undertaking which could generate disturbances transcending national borders.

Sound solutions to the problems of material and human procurement, just discussed, naturally require a great and diversified knowledge, experience, and capacity for imaginative analysis, both within the management of the project and outside it, on the high supervisory managerial levels of public and private economic administration. However, the available knowledge, experience, and imagination will be only very ineffectively used unless the project document supplies the respective managers with the data needed to quantify both the questions and their

solutions. Our suggested format tends to ensure that all the required significant data can be obtained from network diagrams of activities and input-and-cost schedules of various summary levels. The latter are structured to correspond with the network diagrams of activities. Some of the information appears explicitly in various columns of the schedule. The remainder can be obtained by simple arithmetic operations on primary data.

Let us see now how this numerical material is handled to yield the information in a form which can best serve as a basis for decisions relating to the definitive scheduling of procurement activities.

5.2 USES OF INFORMATION DERIVED FROM INPUT-AND-COST SCHEDULES

Table 5.1 presents illustrative fragments of the input-and-cost schedule on its highest level; i.e., on the level comprising the whole of inputs required for the project. Cement was chosen here as an example of a material input, and we observe that various amounts of this material are expected to be applied at various times and in different activities. This information, complemented by the specialized knowledge of the procurement officer, will now be used as a basis for programming the ordering, transportation, and storage of cement and resulting financial settlements.

TABLE 5-1

ACTIVITY INPUT-AND-COST SCHEDULE

IRRIGATION PROJECT
(Title of the Activity)

XYZ
(Code Number)

Expected duration of implementation: 870 *Working days/from day no.* 1 *to day no.* 870 *after start of Project*

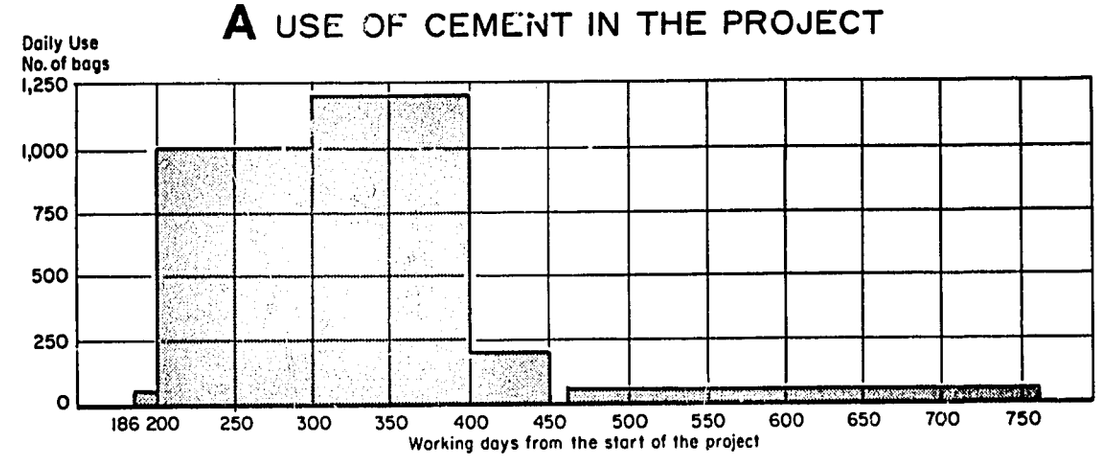
CODE NO. (1)		DESCRIPTION OF INPUT (2)	UNIT (3)	PRICE PER UNIT (4)	NO. OF UNITS (5)	COST: (4) X (5) (6)	INPUT TO BE USED In Activity-No. (7)	INPUT TO BE USED On Day(s)-No. (8)	MINIMUM STOCK: No. of Days (9)
		ILLUSTRATIVE ITEMS FROM INPUT-AND-COST SCHEDULE: PROJECT LEVEL							
0	8-99.30	Laborers, Heavy Physical Work (600)	Man day	5.00	30,000	150,000.00	1.120	101-150	-
	"	" " " " (800)	"	"	72,000	360,000.00	1.120½	151-240	-
	"	" " " " (300)	"	"	48,000	240,000.00	1.120	241-400	-
	"	" " " " (200)	"	"	26,000	130,000.00	1.210	101-230	-
	"	" " " " (700)	"	"	259,000	1,295,000.00	1.210	231-600	
			TOTAL - THIS INPUT:		435,000	2,175,000.00			
2	3.33.410.11	Cement (detailed specification)	Bag 100 lb	1.20	500	600.00	1.112	186-200	5
	"	"	"	"	200,000	240,000.00	1.122/3	201-400	10
	"	"	"	"	30,000	36,000.00	1.132	301-450	10
	"	"	"	"	15,500	18,600.00	1.211	461-760	10
			TOTAL - THIS INPUT:		246,000	295,200.00			

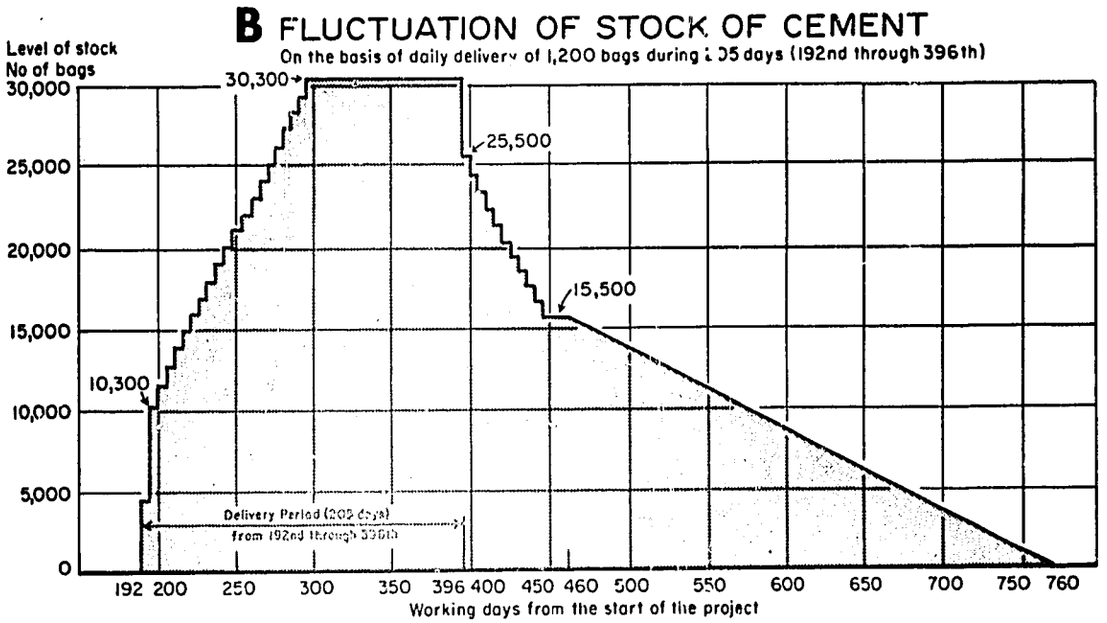
The first step is to ascertain the time pattern of the use of the input in question. This pattern is, of course, shown already in a tabular form in our illustrative schedule. It can be made more explicit and easier to comprehend by a simple diagrammatical presentation, as in Figure 5-1, A. Here, time is measured horizontally in units of 10 days, while the approximate consumption of cement is measured vertically in units of 1,000 bags. Thus, one square symbolizes the consumption of 1,000 bags over 10 days. The diagram shows that cement will be used according to a rather irregular time pattern, with heavy amounts consumed during the 200 days between the 201st and the 400th day, especially in the second half of that period; afterwards consumption will drop rapidly, stop for a short time (10 days), and then be resumed for a long period (230 days) at a very low level.

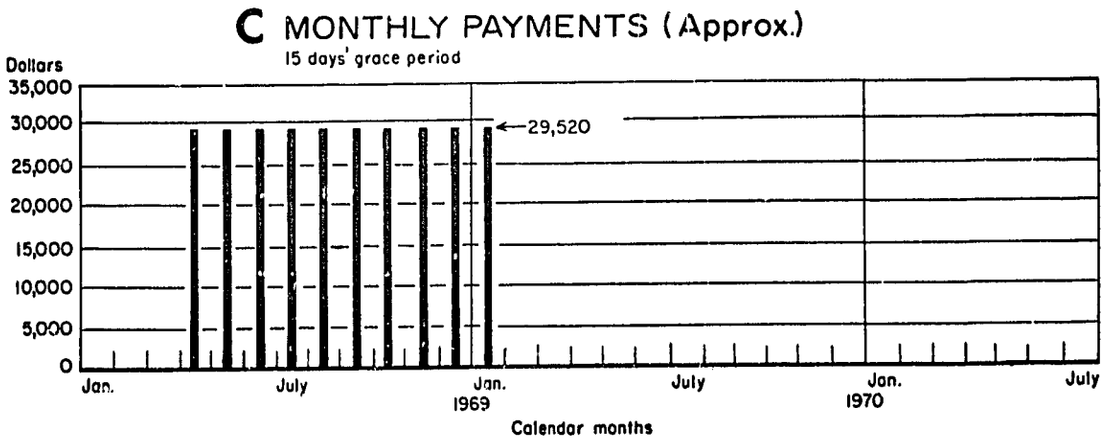
For a heavy and bulky commodity like cement, costs of transportation and storage are important determinants in the emerging plan of procurement. Suppose, for simplicity, that there are no constraints on the storage space and the length of time it can be used. (Say there are large, dry, easily protected, abandoned hangars in the close proximity of the site.) Suppose also that calculations show that cement can be transported most economically by intensive and uninterrupted use of a given number of trucks having a maximum total

FIGURE 5-1

CEMENT PROCUREMENT PLAN: First Alternative







(Calendar year = 250 working days)

daily capacity of 1,200 bags. In such circumstances, the advisable plan will be to build up a stock of cement sufficient for all uses throughout the duration of the entire project in the shortest possible time.

Accordingly, the tentative procurement plan will be to start the delivery of cement on the 192nd working day of the project (i.e., 9 days before its first use) and continue it without interruption for 205 working days (i.e., through the 396th day of the project) at a rate of 1,200 bags a day. Figure 5-1, B shows diagrammatically the fluctuation of the stock of cement throughout the whole period. Observe, that under this plan the requirement that the minimum stock of cement must cover 10 days' use in each activity is more than satisfied. Otherwise, an adjustment would be necessary. Also, had not the storage space been abundant and cheap to maintain and protect, modifications of the plan would have been indicated.

The plan of physical procurement provides a base for calculations of payments schedule. Assuming that it is customary for public agencies in the country in question to settle their accounts with the cement trade on a monthly basis (i.e., for deliveries during the past month) with a 15 days' grace period, the procurement in question would result in a series of payments depicted on Figure 5-1, C.

5.3 ITERATIVE CHARACTER OF PROCUREMENT PLANNING

We must now emphasize the tentative character of this first procurement plan and refer to those aforementioned considerations regarding the impact of a project on the rest of the economy and the availability of finance for the project. As previously stated, one of the purposes of the project, our document, as we conceive it, is to aggregate the input demands of numerous projects into larger groupings at the sectoral, regional, and national levels. This aggregation is especially advantageous because it permits the planner to forecast the resulting total demands for specific inputs and to identify in advance potential bottlenecks in supply. For example, in the case under consideration, a review of projects may indicate that an excessive pressure will be placed on the existing cement supply by other projects in the region where our irrigation project is located, resulting in possible work stoppages or harm to other kinds of construction denied this essential material. Then it may become necessary for a superior planning authority to order a revision of the procurement plans of some, or all, of projects involved, and our tentative plan, as sketched above, may be among the victims of such a decision.

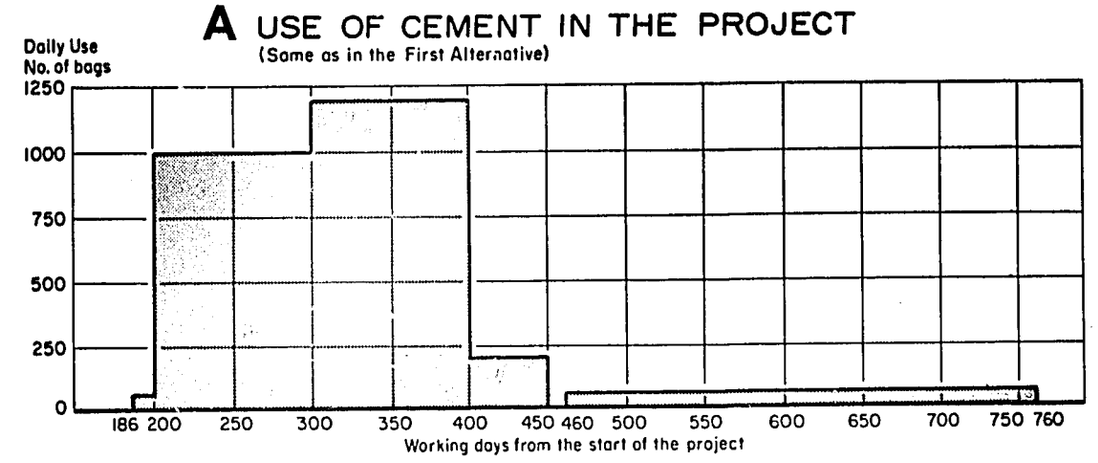
Financial considerations may also necessitate a revision of the first tentative plan of procurement of cement. If, after completing a summation of all payment series which would result from such procurement plans for all inputs, it should appear that the resulting schedule of expenditures cannot be reconciled with the expected flow of funds becoming available to the project from outside, some procurement plans would have to be changed.

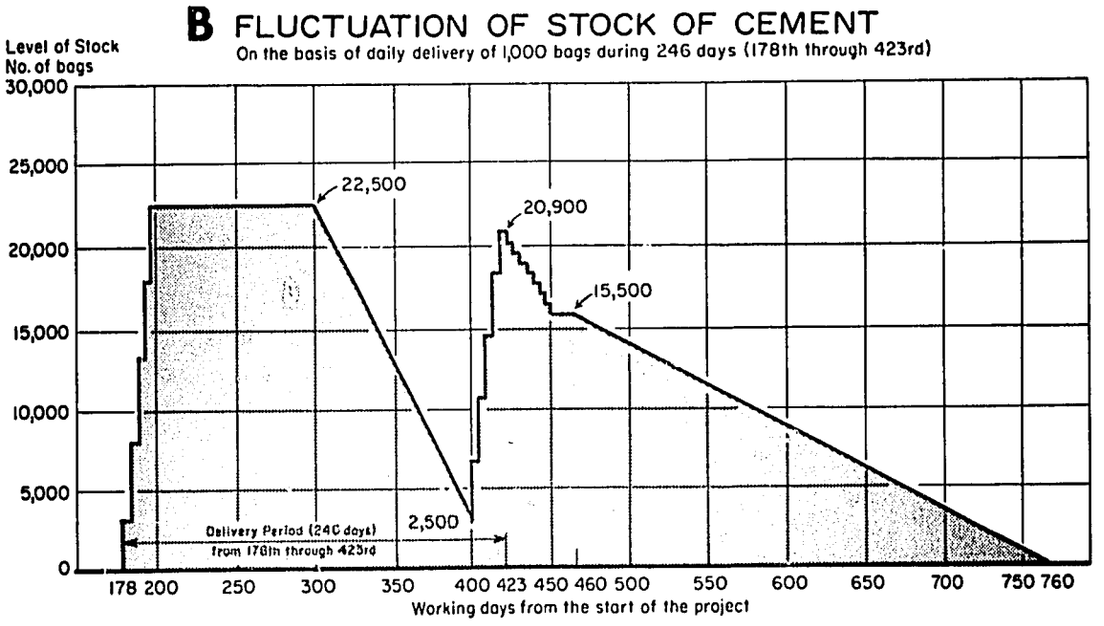
In a case where these external or internal considerations become operative, the procurement officer may have to settle for a non-optimum plan even though it does not fit his restricted set of criteria. For example, he will have to reschedule for the delivery of 1,000 bags a day, during 246 days, from the 178th through the 423rd day, instead of the previously planned delivery of 1,200 bags a day, during 205 days, from the 192nd through the 396th day. Figures 5-2, B and 5-2, C show, respectively, the resulting fluctuations of inventory and the payments series. What happened here is that an optimization of procurements and payments within a limited system of a project was shown to be incompatible with the optimization of input allocation or financial flows within a larger sectoral, regional, or national system to which our project belongs.

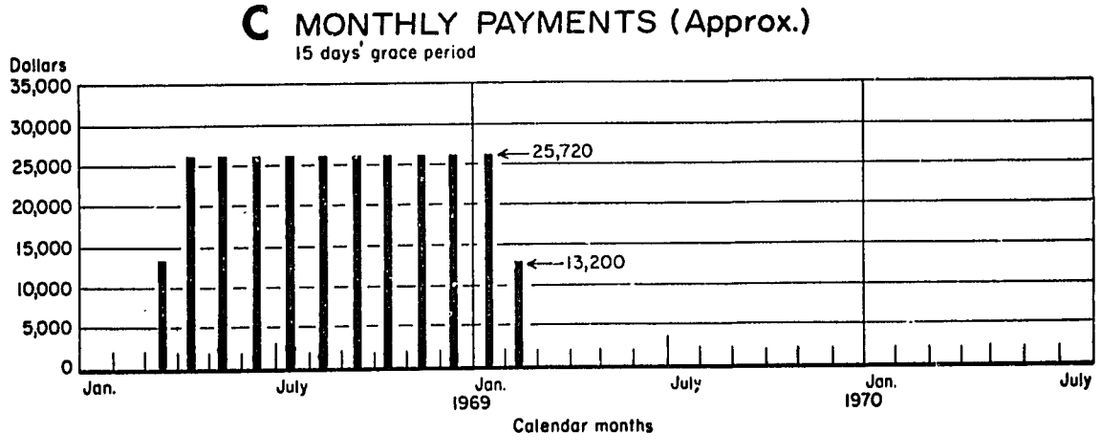
It is clear, thus, that if the aggregative reviews of project groupings by superior economic activities are meant seriously--and the

FIGURE 5-2

CEMENT PROCUREMENT PLAN: Second Alternative







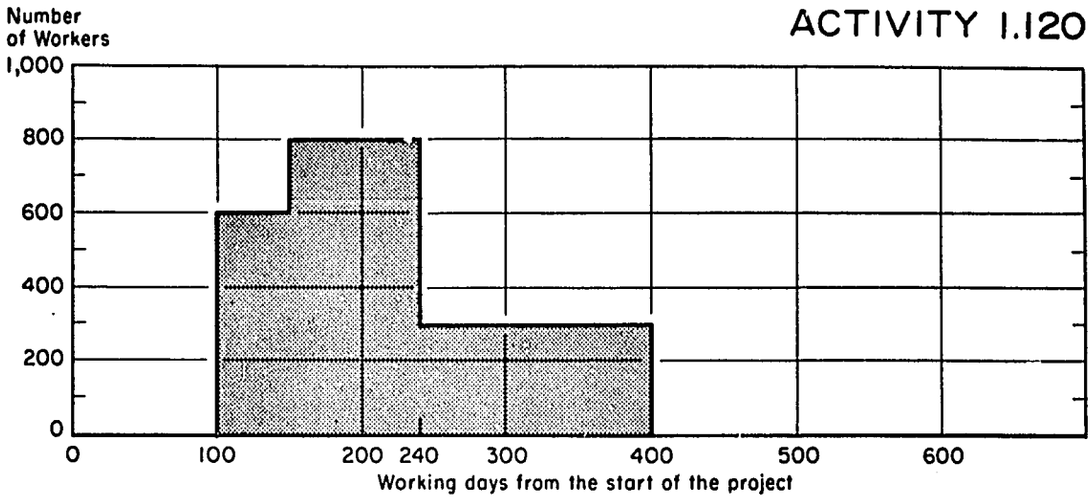
(Calendar year = 250 working days)

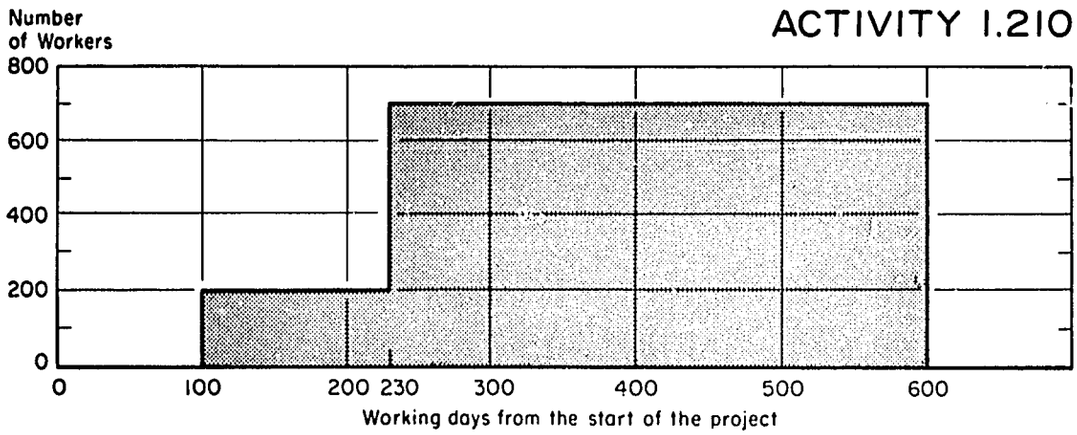
penalties for indifference are bottlenecks and stoppages--the emerging procurement plans must initially be regarded as tentative and subject to modification dictated by internal, as well as external, factors. The process of arriving at final procurement plans is highly iterative. Therefore, the greater the striving at optimization, the more difficult it becomes to work out correct plans. It is left to those at the middle and upper levels of management to decide at which point the increasing cost, in terms of skilled labor, of aiming at perfection begins to outweigh the advantages that could be gained. This calls for insight and intuition rather than complicated calculations.

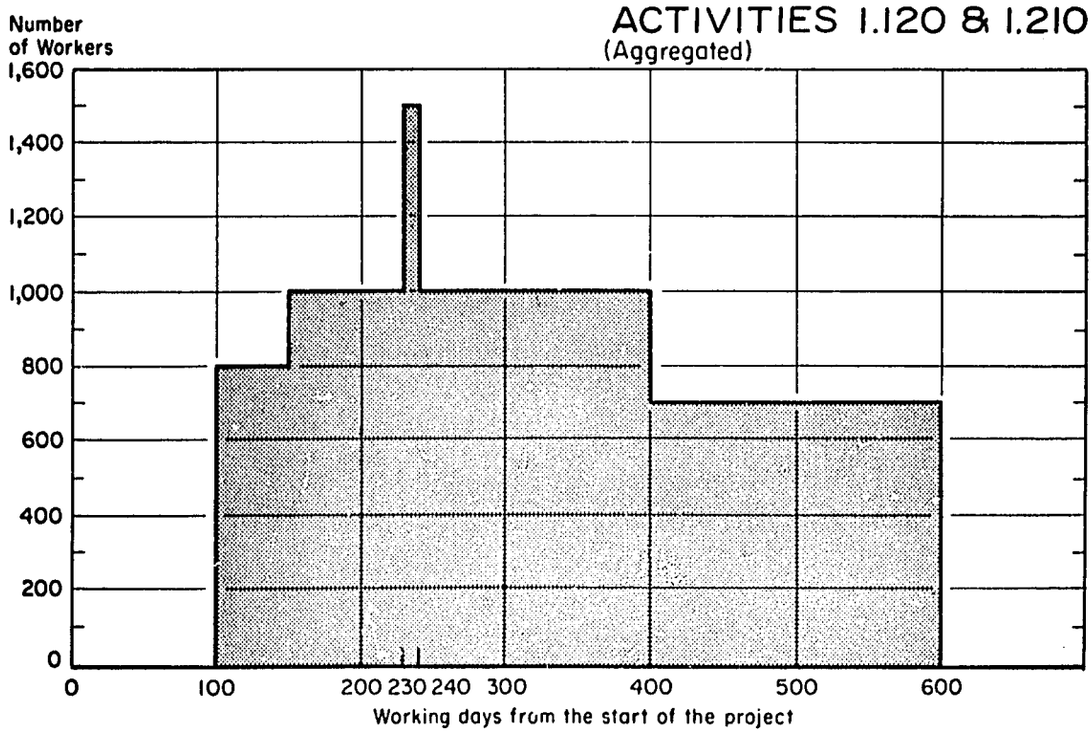
The other fragment of the input-and-cost schedule shown in Table 5-1, labor inputs, is especially instructive in that it shows how important procurement considerations may override the technical optimization criteria of the original activities network and even enforce a retroactive modification of this network. Figure 5-3 shows diagrammatically the time pattern of the demand for laborers which results from the input-and-cost schedule shown in Table 5-1. The short-lasting high peak in demand, 500 additional workers for barely 10 days, arises because of the brief overlapping of Activity 1.120 with Activity 1.210. It has a disruptive effect on the project's personnel division. It also jostles unnecessarily the rural community immediately surrounding the project,

FIGURE 5-3

AGGREGATE DEMAND FOR LABORERS







because the momentary gain in incomes for additional hands employed is too small to compensate for the disturbance it provokes. If these disadvantages are significant, it may be necessary to modify the network so as to eliminate the overlapping of activities and the resulting peak of demand. The above represents another example of the iterative character of the process of project planning.

5.4 ADVANTAGES OF "SLACK" FOR ITERATIVE PLANNING

It should become apparent now that the "slack" attached to many activities on various levels (i.e., the interval of time within which the implementation of a given activity can be delayed or advanced without impeding the implementation of other activities which are technically or organizationally dependent upon completion of the former) is not to be necessarily considered as a waste of time which, ideally, would be absent in a correctly programmed operation. On the contrary, a correctly programmed operation must be built on, among others, two principles: (1) Nothing is entirely correct in real life, and (2) What appears correct when considering a system separately may not be correct at all when seen in the context of a larger system of which the former is only one part. The great usefulness of slack lies in the fact that many activities can be, within limits, delayed or moved ahead, without disturbing

inordinately the original set of implementation-time values assigned to the project's constituent activities. A considerable amount of slack, distributed fairly evenly throughout the network, endows the system with an equivalent amount of internal flexibility. Many secondary adjustments can, thus, be made without forcing the modification of primary projections and data. This represents a profitable trade-off of the "waste" time involved in slack against the cost in highly skilled manpower which would otherwise be required throughout the implementation period to reprogram constantly a rigid, slackless network in an attempt to keep pace with an ever changing reality.

5.5 RELATIONS ACROSS INTERFACES AND THE PROJECT BOUNDARY

In the procurement planning, it is necessary to arrive at certain final figures and dates before being able to reach and pass successfully numerous important milestones in other management and service activities. For example, a service activity that involves the construction and furnishing of lodging and dining facilities can be started even before the final labor figures are established; however, it cannot proceed beyond its preliminary stage until the peak figure of workers to be lodged and fed is known. The same applies to the placing of contracts for supplying the camp kitchen with perishable foods. Here we can see how intricate are

some of the connections and interdependencies that determine the final efficiency of implementation of the project: little earth will be moved, even by the world's most advanced and powerful bulldozers, if the operators feel that they are being "shortchanged" by the camp kitchen with respect to fresh vegetables or any other food which they consider essential.

The interplay between these "quantitative" and the "qualitative" aspects of project management and planning is always present and always posing new problems. A thorough and imaginative use of the two basic tools presented in this study--the activities networks and the input-and-cost schedules--will suggest ways to identify some of the most important nexuses in this interplay, to anticipate the worst problems connected with project implementation, and to avoid them, or at least alleviate them with remedial solutions.

From Figure 5-4, which shows a partial networking of certain management and service activities, it is possible to get a rough idea of how the mutual interdependencies are strongly affected by the data to be derived from the final input-and-cost schedules and procurement plans for recruiting unskilled labor. It is worthy to note the abundance and variety of activities cutting across the boundary between the project and different outside agencies; i.e., across interfaces within a larger system, that of the nation. We feel strongly that an omission of these

FIGURE 5-4

ILLUSTRATIVE FRAGMENT OF A MANAGEMENT AND SERVICE NETWORK

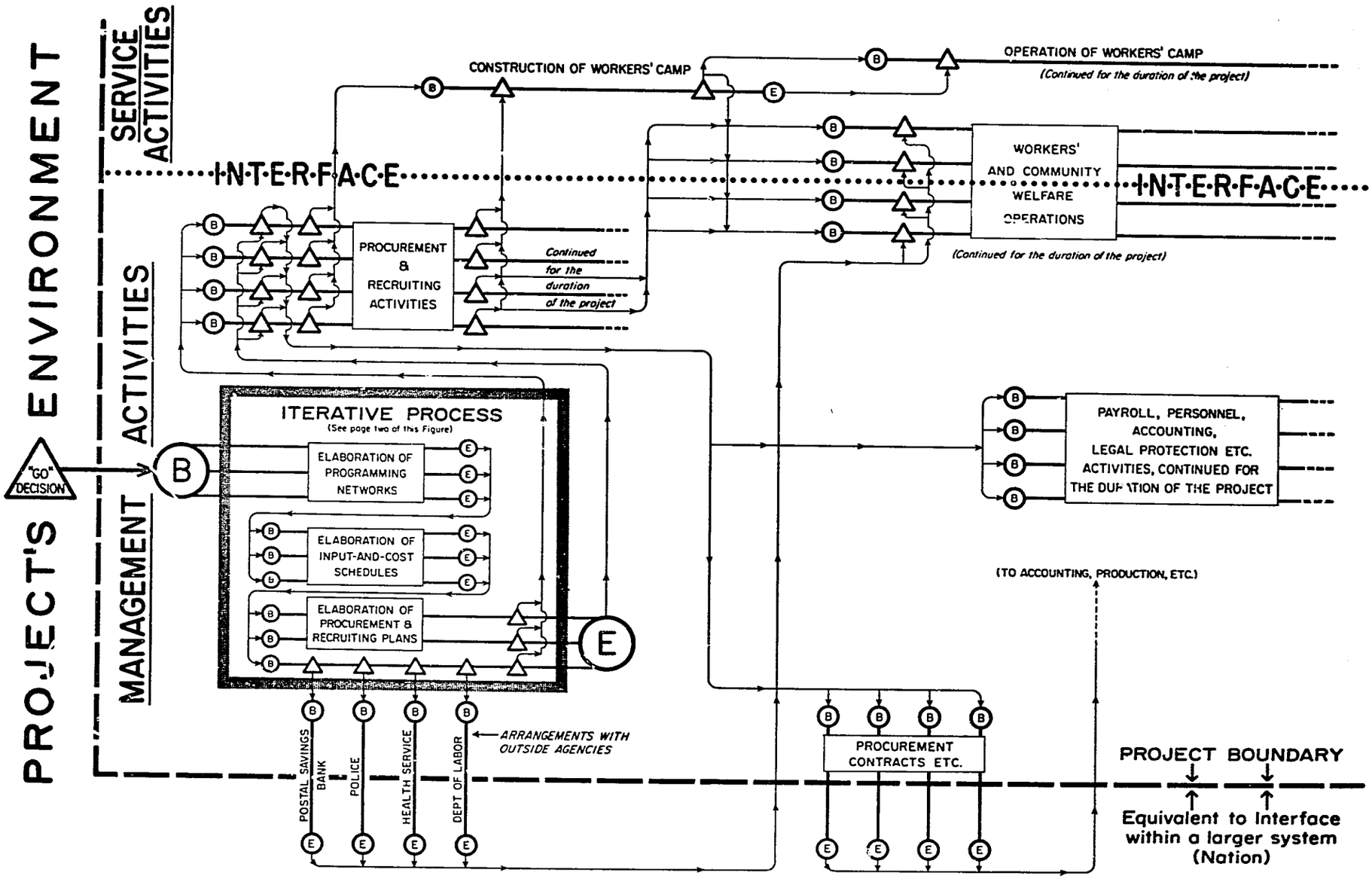
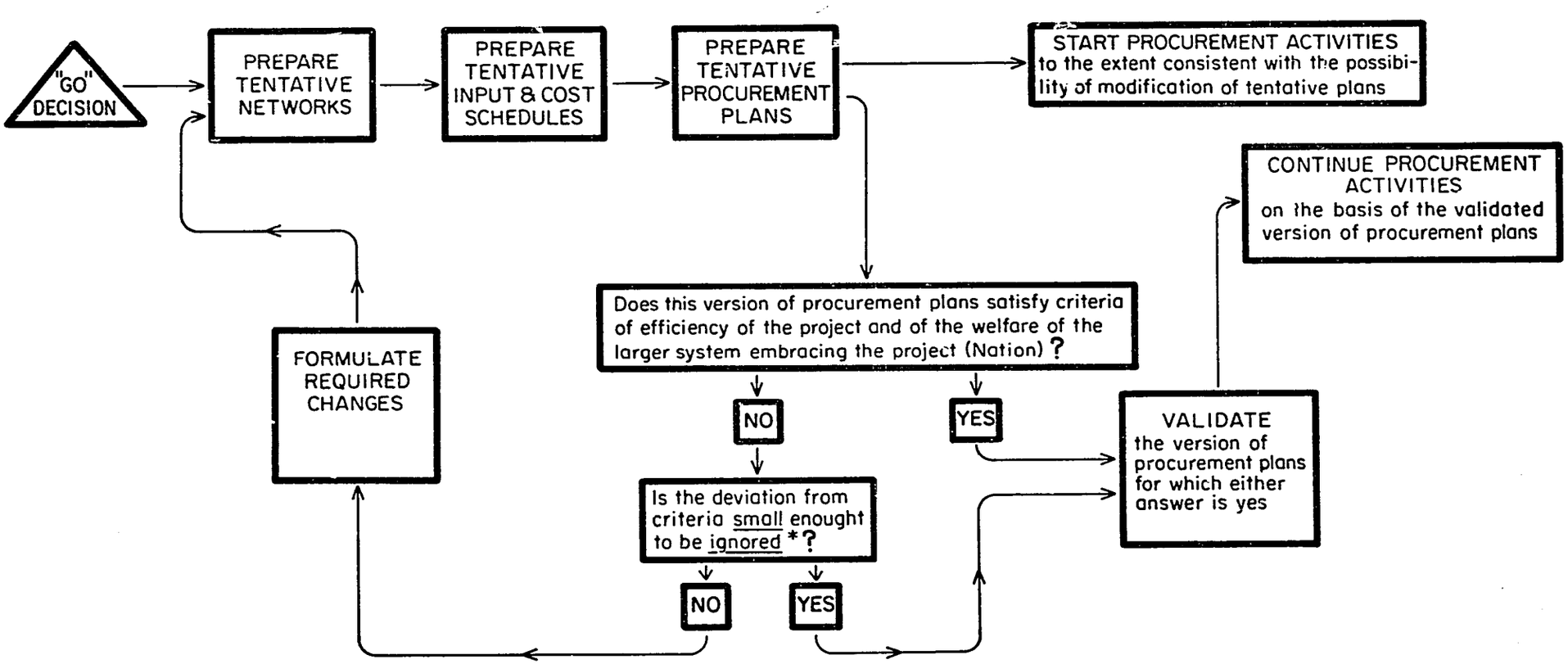


FIGURE 5-4 (cont.)

NETWORKS, INPUT-AND-COST SCHEDULES AND PROCUREMENT PLANS: ITERATIVE PROCESS (Loop)

An Iterative process consisting of an undetermined number of repetitions of a cycle of activities tending to a limit, i.e., a loop, defies direct presentation as a network. The difficulty is that the number of repetitions needed to approximate sufficiently the limit is not known in advance. It may be wise to present the whole process as a single activity with dates given only to its beginning and its end.

The logic flow of the iterative process under consideration can be seen in the following diagram.



A deviation is judged small enough to be ignored when the cost of scarce skilled planners and the delay in implementation, needed to make modifications, become equal or larger in value than the expected results of these modifications. This is a built-in "switching criterion" of the feedback loop under consideration.

activities in project planning--for "simplicity's sake" or any other reason--can result only in a far less efficient implementation process and, consequently, in a gross deterioration of the cost/benefit target postulated for a project. Banned from an activity network, the relationships between the project and the outside world will not cease to exist: they will reappear, in new and unwelcome forms, to plague the implementation by absorbing the strained energies of the management and diverting its attention from the important technical problems. Thus, through a proper advance arrangement with the local police, it is possible to avoid an intervention by national police riot squads at the height of the construction effort. Arranging in advance to have a postal savings bank clerk in the project's payroll office on Friday afternoons may be valuable for the relations between the project and the local community: it will help reduce the number of cases of broken heads and syphilis acquired in the neighboring villages over the weekend.

It is at this juncture where seemingly unrelated factors come together. Many opportunities exist for reconciling the cost/benefit calculus of the small system (the project) with that of the larger system (the community) in which the former is embedded.

It is not necessary here to elaborate further on the network shown in Figure 5-4. The technique to be applied is essentially the same as that explained in Chapter II.

CHAPTER VI

FINANCIAL PROFILE

6.1 VARIOUS ASPECTS OF PROJECT FINANCING . . . . . VI - 3

6.2 LOAN FINANCING ON THE ACCRUAL BASIS . . . . . VI - 5

6.3 PAYMENT SCHEDULES AND PRESENTATION IN NATIONAL BUDGET . . . . . VI - 7

6.4 RHYTHM OF EXPENDITURES VS. RHYTHM OF FINANCING . . . . . VI - 10

6.5 AGGREGATION: FINANCIAL PROFILE OF A PLAN . . . . . VI - 14

CHAPTER VI

FIGURES AND TABLES

		Following Page
Figure 6-1	Financial Profile of a Project	VI-10
Figure 6-2	Cumulative Accrual Diagram of Payments Due and Funds Available	VI-11
Table 6-1	Payment Schedule (Fragment)	VI- 8

6.1 VARIOUS ASPECTS OF PROJECT FINANCING

We have seen how, by combining information contained in activities networks with the data found in input-and-cost schedules and the practical experience of procurement planners, procurement plans for essential project inputs can be obtained. We have also glimpsed how financial considerations may necessitate the introduction of additional changes in this process of combining information from different planning phases. Now, special attention will be devoted to these financial aspects.

Procurement plans are directly concerned with the physical presence of inputs which must appear in the right amounts at the right place and on the right date throughout the implementation period. The resulting obligations and flows of money or credit bear, in their final or intermediate settlement, a close, but not one-to-one, relation to the physical stages of the delivery of goods. Discrepancies between them stem from the different means used to effect payments, such as the customary contractual form, the more refined bulk discount formula, and the penalties on payments delayed beyond the grace period. These discrepancies are quite negligible for some inputs, such as personal services, when the delay between the money and the input flows is usually only a few days. They become very large when important items, like electric generators, are bought against long-run credit. In such cases, payments will be made by government or private agencies managing the completed project long after the project (which is defined as a decision making and accounting unit) has realized its objective and

disappeared as an organizationally functional and legal entity.

Again, there are projects using more than one pattern of financing. Several projects are financed jointly by governments and international lending institutions and, consequently, a great variety of arrangements can be found. To give just one example: The government agrees to contribute a set sum of local currency in periodic payments and these funds will then be principally used for wages and salaries. Suppliers' invoices for most material inputs (paid in foreign currency) are sent to the lending institution's office and settled by it after a brief delay, with the resulting debit entries on the project's account establishing the indebtedness of the government to the lending institution. Thus, the loan consummates itself by successive accruals up to its previously agreed limit. An additional complication, however, occurs: a "carrying charge" is periodically debited on the unspent amount of the loan. A variant of this arrangement has the lending institution also making advance payments on such inputs as heavy machinery, etc., which are ordered ahead and delivered to the project later at an appropriate stage of implementation.[1]

Clearly, then, many approaches are needed to measure the financial aspects of projects, depending on the viewpoint of concern at any

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[1]A description of some of these techniques, as used by the International Bank for Reconstruction and Development, can be found in Norman G. Jones, "Disbursing World Bank Loans," Finance and Development, Vol. IV, No. 1, March 1967, pp. 51-55.

given moment and on the peculiarities of the project in question. It would be pointless to try to categorize and discuss even the major approaches here as the specifics of the problem go beyond our interests. Instead, we shall demonstrate with a few examples how the project format suggested throughout this study can be used to yield the practical information needed to answer many different questions of finance.

6.2 LOAN FINANCING ON THE ACCRUAL BASIS

In loan financing on the accrual basis, a lending institution pays the incoming invoices for delivery of certain kinds of inputs or makes advance payments for these inputs and simultaneously debits the project's account for equivalent amounts. The consecutive disbursements are charged interest for the time elapsing before the next settlement date (which may be fixed at the beginning and at the middle of the lending institution's fiscal year), when the accrued sum will be funded and become part of the long-term debt of the government or the specific agency designated to operate the completed project. Under this form of financing, it is obviously very important to know in advance the following: (1) what part of the project's total cost will be attributable to inputs financed by the lending institution, and (2) what the time pattern will be for accrual of the principal of the debt and the interest incident to it? Approximate answers to these two questions must often be known long before calculations are made for subsequent procurement plans.

The answer to the first question in the preceding paragraph may be found in the input-and-cost schedules. These can be aggregated to show the use of any particular input or generic group of inputs, at any desired level of generalization or detail, for any combination of activities (this applies to the case where only certain activities are covered by the loan agreement.) The activities networks, which attach time tags to the input information in the schedules, can provide the answer to the second question.

Thus, by combining networks with schedules, it is possible to gain the information needed to answer the two basic questions of this, and any other, inquiry: WHAT? and WHEN?

Information derived by the method suggested above is of value not only to the project and country concerned but also to the whole international field of economic development. The great international lending institutions, like all financial institutions, work under a double constraint. First, their lending capacity is limited by the amount of their resources. Second, it is limited by their uncertainty with respect to the exact time at which the future disbursements of committed funds will have to be made. Thus, international lending institutions find it necessary to keep reserves at a certain minimum level.[2] The greater the predictability of future payments required under hundreds of existing loan agreements, the less need there will

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[2]The already mentioned "carrying charge" debited to beneficiaries of loans granted but not yet consummated is one means of discouraging protracted underutilization of a "credit line."

be for idle reserves and, consequently, the more funds available for additional development loans.

6.3 PAYMENT SCHEDULES AND PRESENTATION IN NATIONAL BUDGET

Let us now approach the financing problem from a more conventional viewpoint. Assume that the project is financed by institutions within the country which deposit funds more or less regularly to its account and that payments are handled by the project management. It is then crucial to harmonize the inflow and the outflow so as to avoid the appearance of embarrassing negative balances that would tarnish the project's reputation. A need for additional information arises when a country has a development budget and the project financing is planned within this framework. Budgetary procedures in most countries require, first of all, that expenditures be presented under main object-of-expenditure headings. Second, and more important, it is necessary to allocate funds from the annual budgetary appropriation at more frequent intervals--either quarterly or monthly. Third, in countries where efforts are being made to apply the principle of program budgeting in practice, additional breakdowns of the project's total expected expenditure may have to be made. These calculations become very simple in principle when using the previously discussed uniformation system as a basis, but this does not imply that the actual computation work itself is easy, for, on the contrary, it may be quite laborious in the absence of automatic data processing.

How useful the standard classification code of inputs can be for financial calculations may be seen from the following elementary illustration. Suppose that a year or two after a national plan is approved and put into execution, largely through development budget, a considerable change takes place in some important and widely used input--a type of labor, a crucial raw material or carburant. A successful budgetary readjustment depends then on a rapid and accurate calculation of effect of this change on the many diverse projects under various headings of the development budget. If inputs are grouped under standard code classes, it is quite easy even for a limited number of relatively unsophisticated clerks to perform the necessary survey and calculations by following received instructions. In the absence of proper classification, each project would have to be separately analyzed by highly trained personnel. Such work would be very lengthy, wasteful of skilled human resources, and its results not always reliable; above all, experience shows that in the usual rush of budget estimates decisions on readjustments usually cannot wait for long and, consequently, would have to be made on the basis of guesses rather than of sound calculations.

The essential operations of arriving at a Payment Schedule are easy to infer from Table 6.1. The Payment Schedule diagrammed in Table 6-1 uses a 10-day interval but can, of course, be elaborated on any other desired scale, such as daily or monthly. However, it is important to remember that, while the previously discussed documents dealt with "working days" (a usage proper in the technological context of activities networks and their respective inputs), the payments schedule must be converted into intervals of actual calendar time; i.e., must include non-working days so that it corresponds to the conventional calendar. For budgetary presentations, the schedule must also be dated in terms of the calendar time.

A look at the payment schedule will justify our decision to use the object-of-expenditure code number as the first digit of the input classification code. In this manner, the whole procedure of sorting expenditures among different budgetary classes is painlessly done at an early stage where the original low level input-and-cost schedules are prepared. Once assigned, these classification tags are transferred automatically through all stages of activities schedules and, then, through procurement plans. Consequently, in payment schedules, the payments will appear grouped under appropriate budgetary object-of-expenditure headings. The tedious work of compiling budgetary documents can be done largely by relatively low skilled clerical workers and will not require too much scarce managerial and high-level accounting talent.

TABLE 6-1

PAYMENT SCHEDULE (Fragment)

IRRIGATION SYSTEM A.B.C.
(TITLE OF THE PROJECT)

X. Y. Z.
(PROJECT'S CODE NUMBER)

...FO	RTNIGHTS		QUARTERLY SUMMARY	FORTNIGHTS...	
OBJECT OF EXPENDITURE	Mar. 1 thru Mar. 15 162nd thru 172nd i.e. 11 working days	Mar. 16 thru Mar. 31 173rd thru 182nd i.e. 10 working days	Jan. 1 thru Mar. 31 120th thru 182nd i.e. 63 working days	Apr. 1 thru Apr. 15 183rd thru 193rd i.e. 11 working days	--- --- i.e.
0 Personnel Services	15,000.00	13,000.00	90,000.00	14,000.00	
1 Contractual Services	-	2,000.00	200,000.00	-	
2 Materials and Supplies	12,000.00	10,000.00	100,000.00	12,000.00	
3 Machinery and Equipment	-	-	-	150,000.00	
4 Purchases of Land, Structures and Rights	-	100,000.00	100,000.00	-	
5 Construction	10,000.00	-	10,000.00	-	
6 Current Transfers	-	-	-	10,000.00	
7 Capital Transfers	-	1,000,000.00	1,000,000.00	-	
8 Public Debt	-	-	-	-	
9 Other Financial Disbursements	1,000.00	-	2,000.00	-	
X Aggregate Appropriations (Reserve) 5,000.00 per fortnight	5,000.00	5,000.00	30,000.00	5,000.00	
TOTAL	43,000.00	1,130,000.00	1,532,000.00	191,000.00	

With respect to program-budgeting classification, it was already explained in a previous chapter that, while most projects will fall within a single program category, there is an important exception--the multipurpose project like river valley development or resource conservation. As long as the specific purpose of activities within a multipurpose project complex can be identified, the problem is partly manageable. If, for example, there are two dams on the same river, one used solely for hydropower and another used exclusively for irrigation, then a proper handling of the input-and-cost schedules of direct activities should permit us to divide expenditures under two appropriate budget program headings of, say, energy and irrigation. Even then, it will probably be difficult to classify some service activities under only one of the two headings and, likewise, management activities will prove problematical in this respect because at the upper levels they are by definition related to the creation of a whole and not imputable to any fragment of this whole being created. The cost of these activities will have to be pro-rated among direct activities. However, in the process of pro-rating, the object-of-expenditure classification will be lost, together with the rest of input classification, insofar as the object being pro-rated is, of course, not material inputs but their money cost.

6.4 RHYTHM OF EXPENDITURES VS. RHYTHM OF FINANCING

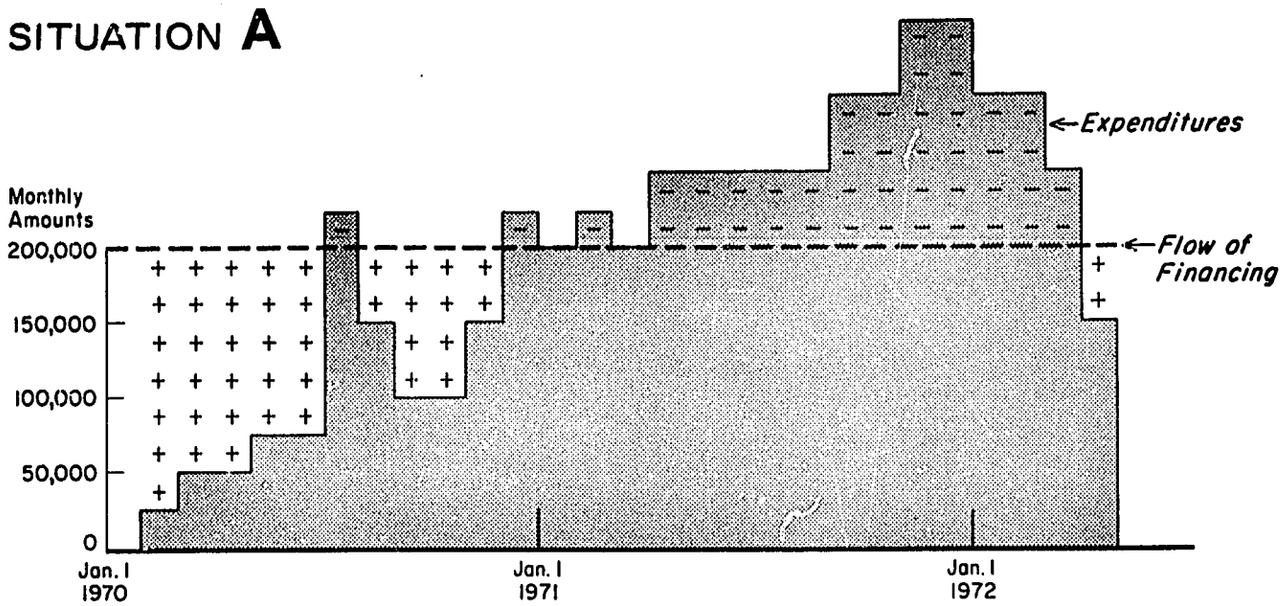
If the inflow of funds to the project can be regulated to accommodate the uneven outflow of project expenditures through budgetary procedures or other devices, the financial side of the project will pose no problems. Even in those cases where money is not lacking, however, the inflow of funds may often have its own rhythm which not necessarily always coincide with the project's demands.

A rough, but comprehensive, idea of a project's financial situation can be obtained by diagramming the payment schedule on the background of the expected flow of financing. This has been done in Figure 6-1 which shows two different situations. The first, presented in diagram A, is not problematical. The small payments bulges that appear above the financing line during the first half of the implementation period can easily be accommodated with funds accumulating at other times. Generally, the resources collected during the first half will be sufficient to cover any need for extra funds in the second half. On the balance, there would be considerable reserves formed in the first half, for use in the second half. The second situation, presented in diagram B, is more difficult. Here, the original project cannot be reasonably begun until short-term financing is found which will defray the great bulk of payments demanded in the early stages of the project and can be repaid by funds accumulating in the latter stages.

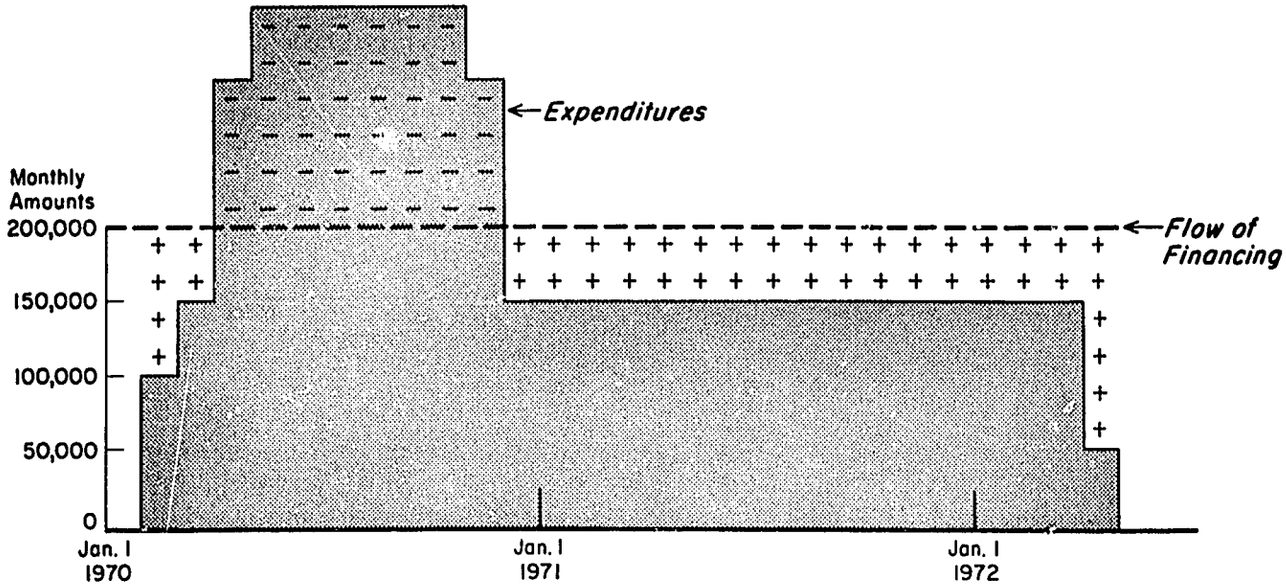
FIGURE 6-1

FINANCIAL PROFILE OF A PROJECT

SITUATION A



SITUATION B

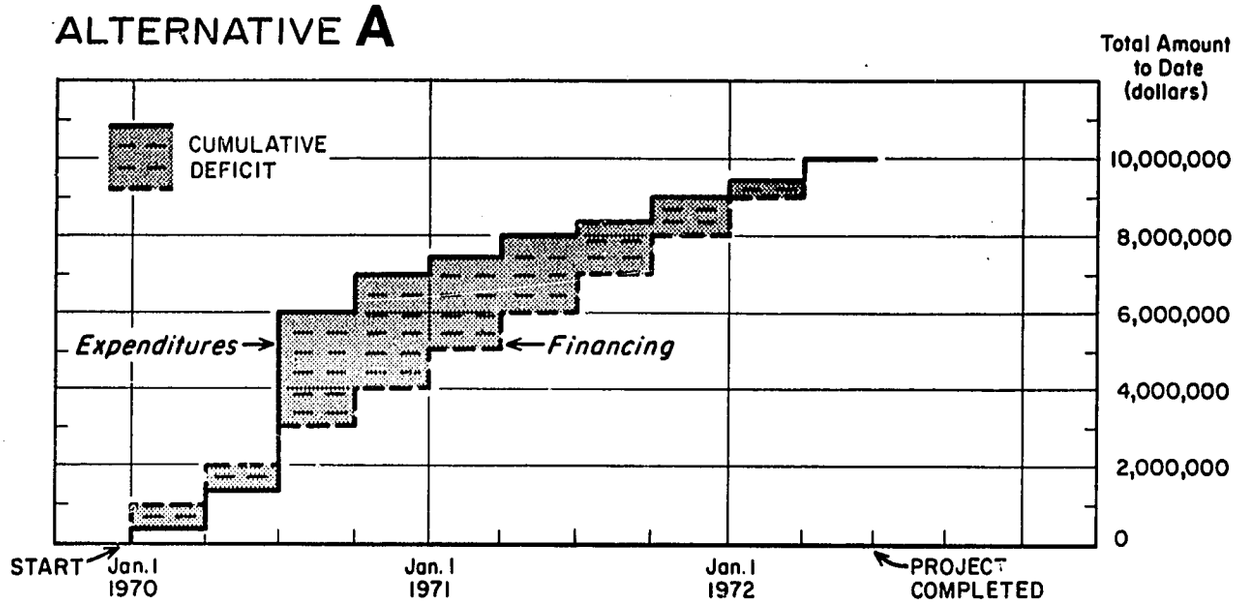


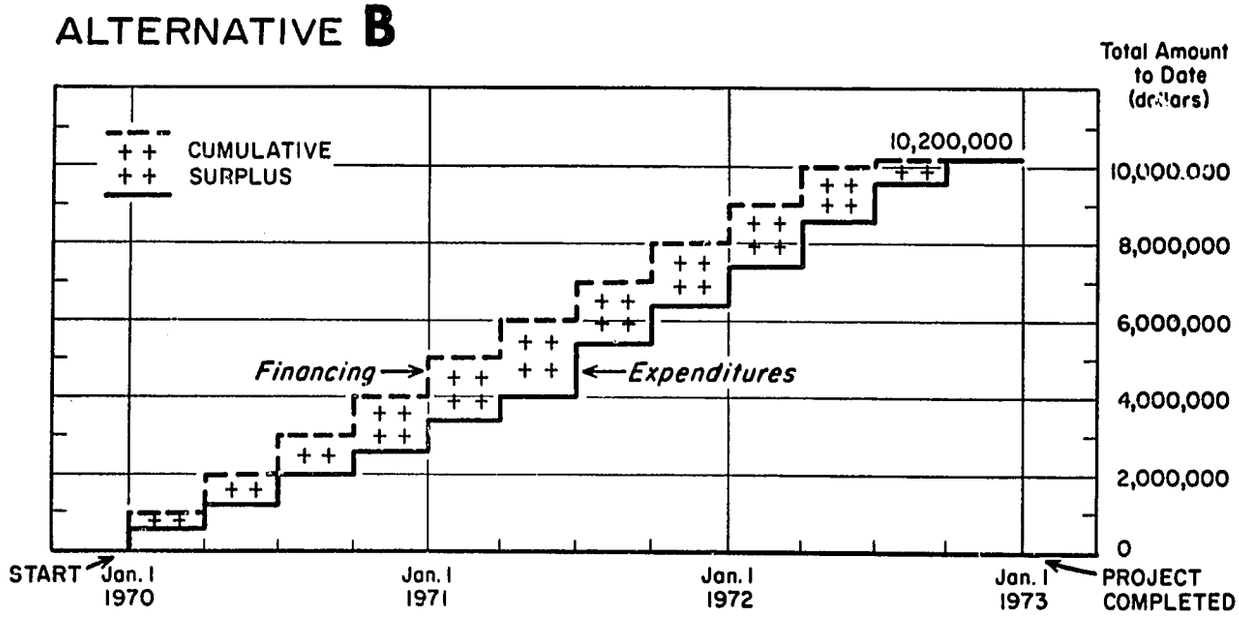
What if such short-term financing is unavailable? If the expected benefits of the project are judged to be so great as to justify the increased cost which would result from a less than optimal sequence of activities, another solution may be found. Instead, activities may be carried out at a slower rate so as not to outrun the funds available at any date. Here, again, we see the advantage of activities network diagrams and their equivalent input-and-cost schedules for testing the technical feasibility of alternative activities' sequences and for studying their corresponding costs and time-patterns of expenditures.

Such a study can be facilitated by another diagrammatical device which recommends itself for cases requiring more precision and insight than the preceding diagrams in Figure 6-1 can offer. Figure 6-2 presents the cumulative accrual of payments and available financing for the entire implementation period. The vertically measured distance shows, for each date, the total payments that have become due so far and the total financing that has become available up to that time. The ogive diagram, "Alternative A," shows a technologically optimal configuration of activities which, however, would cause a financial gap in the middle of implementation of such magnitude that work would have to be suspended due to the lack of funds. If "Alternative B" were adopted instead, it would entail a switch to a technologically less advantageous sequence of activities, involving a longer interval of implementation (two years against 18 months) and a higher total cost (10,200,000 against 10,000,000). The second alternative

FIGURE 6-2

CUMULATIVE ACCRUAL DIAGRAM OF PAYMENTS DUE AND FUNDS AVAILABLE





promises, however, execution of the project without stoppages, because now the rhythm of expenditures is more consistent with the accretion of fiscal resources.

Translating the costs of an activities network into an ogive diagram can serve another very useful purpose insofar as it will show the costs both in statu mascendi at any given short period and in their cumulative total at that period. Even when the short-term financing needed to bridge a gap in funds is available, it is important to know how much it will cost; i.e., by how much it will increase the originally projected total cost of the project. A choice must be made between two alternatives: In the first instance, the project is carried out according to the original most efficient, cost-minimizing configuration of activities, but an additional cost is incurred from the interest on borrowed funds; in the second instance, a less efficient configuration is applied which does not require short-term borrowing and, thus, interest payments are avoided.

The diagram for "Alternative A" in Figure 6-2 shows the approximate amount of funds that will have to be borrowed to support the execution of the optimum activities network. For purposes of explanation, it is easiest to use consecutive 3-month intervals (corresponding to a short-term 3-month note). Thus, neglecting the details of the rhythm of accrual within each of the 3-month periods, we shall assume that at the beginning of each quarter a 3-month loan is contracted for an amount equal to the difference expected to exist at the end of the quarter between the cumulative sum of payments

and the cumulative financing received since the beginning of the project. This very rough procedure gives us a first, and highly useful, approximation of the interest cost involved.

The following table which illustrates the interest cost of short-term financing is based on the assumption that the project, or an agency representing it, can borrow at a rate of 6 per cent per year; i.e., at 1.5 per cent per quarter.

SHORT-TERM FINANCING OF THE "ALTERNATIVE A"

For Period	To Be Borrowed	Interest 6% p.a.; i.e., 1.5% per quarter
1970 - 3rd quarter	3,000,000	45,000
1970 - 4th quarter	3,000,000	45,000
1971 - 1st quarter	2,500,000	37,500
1971 - 2nd quarter	2,000,000	30,000
1971 - 3rd quarter	1,500,000	22,500
1971 - 4th quarter	1,000,000	15,000
1972 - 1st quarter	500,000	7,500
	TOTAL	202,500

The original cost of "Alternative A" (10,000,000) will, thus be raised to 10,202,500. If this figure is compared with the cost of the "Alternative B" (10,200,000), it is seen that the difference is negligible. At the same time, it is obvious that the faster the project is completed, the sooner its benefits will become available to the community, and this consideration may cause the planners to opt for "Alternative A."

6.5 AGGREGATION: FINANCIAL PROFILE OF A PLAN

The technique used in the foregoing exercises to aggregate project costs accruing during the implementation of various activities can also be applied to groupings of any number of projects. A simple tabulation and summation of the financial transactions occurring in the relevant projects at different dates in a given time period will give us a financial profile of the plan for the entire period. One such transaction, common to many projects, is the accrual of long-term debts with international lending institutions. When these debts are totaled, it is possible to see how much the country's long-term external debt has increased for that period due to execution of the plan. Similarly, a profile of the country's internal debt can also be obtained. Projected actual payments in cash are another possible type of transaction that can help us compose a financial profile. Their summation will amount to a calendar of cash payments or, more simply, the cash budget for the plan's public sector may be almost equivalent to the development budget. The main difficulty is that many projects are implemented by agencies with extra-budgetary accounting. Thus, both the technique used to obtain the financial profile of the plan and the corresponding diagrammatical presentation are the same as that described in the preceding sections.

Again, the main stumbling block encountered in composing a plan with a desirable financial profile is essentially the same as that met at the project level; namely, how can the flow of outgoes be harmonized with the

flow of funds becoming available? However, when this problem occurs at the plan, rather than the project, it is more complex.

One reason for the added complexity is that the clustering of several projects in the same time interval can cause highly explosive situations. In many types of projects, the normal pattern of expenditures follows roughly a bell-shaped curve. This is because expenditures tend to be low during the early months, or even years, of implementation, when most of the work is of an exploratory or preparatory nature directed at establishing a bridgehead for future activities. In the next period, there is a great expansion of the working force and an extensive utilization of building materials and equipment, causing expenditures to shoot upwards rapidly and continue at a maximum level for some time. In the third and last period, when the finishing touches are added and the required adjustments are made, expenditures fall again. Any small country, just embarking on its development effort that possesses only a few projects of the type described above, all clustered inadvertently within the same time period, may find itself confronted with one tremendous demand peak. This results when the peaks of all individual projects are superimposed on one another. The situation can be, financially, very embarrassing, for even if funds are found to satisfy the most pressing needs, the sudden increase in expenditures may have a highly inflationary effect on an economy lacking skills and flexibility. Usually, however, with a peak of this kind, there is simply a widespread work stoppage which throws the implementation process into confusion and dissolves employee morale.

Therefore, it is mandatory to survey the projected financial profile of a plan closely with a sharp eye for latent peaks of payments which cannot be covered by available funds. Of course, the obvious solution is to rephase the project sequence in the plan. This, however, presents additional problems. Even for a single project, the job of estimating the effect on total costs and implementation time caused by a change in the activity sequence, is extremely difficult for the project manager who is intimately acquainted with interdependencies between various activities of his project. So, estimating the effect of a change in the sequence of interrelated projects within a plan may be a task that is beyond the capabilities of most contemporary governments, even if they are familiar with such advanced techniques as PERT and input-output calculus. At the moment, no usable tool exists equal to the task in question. It seems, however, that an imaginative use of input-output tables, aimed at crude identification of principal production interrelationships and supplemented by an equally crude networking of main technical interdependencies between various complementary projects, could at least help limit the damage resulting from a financially dictated reshuffling of projects within a plan.

CHAPTER VII

INPUTS PROFILE: IMPACT ON NATIONAL ECONOMY

7.1 AGGREGATION . . . . . VII - 2

7.2 IMPACT VS. EFFECT . . . . . VII - 4

7.3 BENEFITS OF IMPACT: "PROGRESS ORIENTED" INDUSTRIES AND SKILLS . . . . . VII - 6

7.4 DIFFICULTIES OF IMPACT: ALLOCATION OF RESOURCES . . . . . VII - 8

7.5 "ACCOUNTING PRICES" AND OTHER MEANS OF ECONOMIZING SCARCE RESOURCES . . . . . VII - 9

7.6 FOREIGN EXCHANGE REQUIREMENTS OF A PLAN: IDENTIFICATION AND EVALUATION OF IMPORT CONTENTS IN INPUTS

7.61 Project-Document Format and a Country's Foreign Exchange Accounting . . . . . VII - 11

7.62 Statistical Questions . . . . . VII - 18

7.1 AGGREGATION

The aggregate demand for inputs required by projects contained in the national plan (or in any other grouping of projects) is obtained by simply adding together the items appearing at each level in the input-and-cost schedules of the projects involved. The fact that a common classification and coding system is applied to all projects makes the summation a very simple (although tedious) task which can be executed by low-grade clerical personnel. While great technical expertise may be required to evaluate the complex considerations that cause economic authorities to take a special interest in the exact figure of demand for, say, structural iron, once that interest is formulated by the scarce experts, the information sought can be obtained by the clerks. The latter need only be instructed as follows: First, take out of the file input-and-cost schedules of all projects; second, find in each schedule the amounts in Columns (5) and (6) for the item under Code Number 2-3.35.413; and, third, obtain respective totals of these two items.

Here again we note the flexibility of the input classification system and the input-and-cost schedules. Use of a digital code system enables us to ask questions and obtain answers on almost any desired level of detail or generalization. Thus, if interested generally in the demand for "stone, clay, and glass products," we might request a summation of all items under the first-four-digits code 2-3.33; if interested only in cement items, then we would specify the code number, 2-3.33.410, and so on.

In this manner, less sensitive inputs can be classed together under low-digit level general headings, while more strategic inputs can be singled out at a detailed level. Similarly, the time pattern of demand profiles can be traced in greater or less detail, depending on how frequently the aggregation is made--weekly, monthly, quarterly, etc.

It must be repeated here that this great precision can only be achieved with respect to three (fortunately, the most important ones) object-of-expenditure groups: 0-Personal Services, 2-Materials and Supplies, and 3-Machinery and Equipment. In group 1-Contractual Services, a certain amount of confusion may arise between more specific input subgroups (see Chapter III). Fortunately, this group, as defined in our classification, will not be of strategic importance in most projects. Major difficulties occur, however, in group 5-Construction if large construction contracts are awarded in entirety to outside parties. In principle, these contractors might be asked to provide the required information in the form of their own input-and-cost schedules. In practice, there is little hope that this could always be done according to format with the precision and promptness desired, except for the largest and most strategic input items. Consequently, there will be a good deal of guesswork in the aggregation phase. It is worth noting again at this juncture that if, through technical and statistical studies of modular construction units ("building blocks"), a standard average input table for typical construction works could be found, it would help to overcome the difficulties involved in estimating this object-of-expenditure group.

The remaining object-of-expenditure groups (6-Current Transfers, 7-Capital Transfers, 8-Public Debt, and 9-Other Financial Disbursements) do not reflect actual movements of physical inputs. Item X-Aggregate Appropriations will always disappear from the classification of ultimate expenditures because the money is spent on specific items and any unused portion returned to the agency financing the project. It is, in fact, a "reserve for uncertainties."

7.2 IMPACT VS. EFFECT

Now the case made previously for distinguishing between the "effect" of a project and its "impact" (see Chapter I) can be restated, hopefully more convincingly, in light of the concepts that have been subsequently evolved and illustrated in this study. Take, for instance, a country that proposes as part of its sanitary program to build water supply works in several towns not yet having these facilities. One "effect" that completion of these facilities may be expected to have is to improve the health of the population, which, in turn, will increase labor productivity and, thus, the national product originating in the areas benefiting from the sanitary program. Another effect will be the appearance of new national accounts components in these towns; i.e., labor and other inputs for the operation and maintenance of water works, future replacements for obsolete equipment, and so on, ad infinitum.

The "impact" of the implementation of the program will be determined by the program's input-and-cost schedule; that is, the sum of

the schedules of all projects involved in the program. With respect to the timing, this impact will be further delineated by the program's procurement plan, an aggregation of procurement plans of individual projects. It is immaterial at this point whether the program's input-and-cost schedule and procurement plan are prepared with as much detail as the individual project plans; for, even if only the strategic inputs were singled out and the remaining classed together in large generic groups, the impact would still be there and eventually materialize as a demand for certain goods and services. That demand was not previously present in the economy. Therefore, its appearance tends to move the economy away from its former equilibrium and, even more important, away from its former structure of production. Different input requirements, enumerated in the program's input-and-cost schedule, will show how much the demand for various labor skills and products will increase due to the implementation of projects. Thus, as a result of the water works projects, we find an increase in the demand for pipefitters, pipes, cast-iron manhole covers, forkings for pipejoints, etc.

An aggregation at the national plan level will show total demand for specific inputs--goods and skills--during the entire implementation period. Generally, a plan covers several years and, hopefully, is succeeded by new plans. The impact of these plans over time will be to change qualitatively the structure of the traditional economy. All this will be taking place independently of and prior to the attendant project effects which will begin to appear only after the implementation is completed.

7.3 BENEFITS OF IMPACT: "PROGRESS ORIENTED" INDUSTRIES AND SKILLS

There is one characteristic of the impact phenomenon that makes it something more than just one arithmetic item in the national economic calculus: the important modernization force within developing societies. Although there may be exceptions, the average less developed country can be expected to concentrate, in its input-and-cost schedule, on demanding inputs from those industries currently at the frontier of its particular growth rather than from the traditional industries that may be legacies of an earlier colonial or semicolonial period. Thus, the plan will demand inputs such as cement, pipes, iron wares, services of surveyors, rural agents, and engineers, instead of sugar cane products, distilled liquors, tobacco, ores, manservants for polo clubs, faithful attendants for safaris, etc.

Programs such as the aforementioned one for waterworks are likely to be assigned considerable size and importance in any national plan for a number of years. Thus, it is possible to recognize in advance a large and consistent demand for a well defined group of items, including iron pipes, cast-iron forkings, and other similar accessories. The demand for these items will be further strengthened by their frequent occurrence (under the same code numbers!) in the input-and-cost schedules of other projects of different kinds. While each of the projects may require only a small amount of any single item, their total demand for it may be considerable. Many less developed countries undoubtedly possess modest foundries and other fledgeling iron working industries which could be

expanded were there an assured continuous demand for their products. These backward and forward linkages that lead to an increasing sophistication of the product have been widely and hopefully discussed in the economic writings of recent years.

Observe, however, this important fact: the existence now of an "inchoate" demand, which will become effective in small installments over the years as a result of orders placed by individual projects and whose full extent, duration, and regularity is not known in advance by foundry and iron works owners due to their ignorance of plan details, will not by itself spur them to ambitious expansion of their enterprises. What will, in greater likelihood, happen is that some years from now they will be regretfully telling themselves: "If I had realized five years ago how large, regular, and continuous the demand for my product would become, I would have expanded my operations rather than allow importers to fill the project orders that I couldn't handle." Such timidity will be found among producers who fear that each order may be their last.

A plan's demand for "progress oriented" products and skills must be made widely known in advance to manufacturers, owners of resources, and the general populace if it is to have a definite positive impact on the country's production structure. This feedback of information is needed to stimulate the national economic system to move in the desired direction. We now recognize one of the important purposes behind the laborious filing and aggregating of input-and-cost schedules under their numerous code-number headings: this makes it possible to publicize widely a plan's demand for

specific inputs. A national plan, with auxiliary documents, can be therefore used as a means of mobilizing entrepreneurial resources and stimulating imagination. It can show local industry and labor how they may reap profits as well as contribute to national progress by supplying the products and skills required.

7.4 DIFFICULTIES OF IMPACT: ALLOCATION OF RESOURCES

The impact of a plan will also naturally have its share of negative aspects. Precisely because the input demand will be largely directed towards the skills and products of new, sometimes struggling, industries, any somewhat ambitious plan will face the grave problem of shortages in the supply available nationally. Indeed, some headings of a plan's input-and-cost schedule will often read like a list of potential bottlenecks, which could bring a number of important projects to a standstill at any moment and endanger the investment already made. The project format suggested in this study cannot, of course, do anything to make scarce resources more abundant. It can, however, greatly facilitate their rational allocation within existing constraints and prevent waste resulting from administrative confusion and poor communication of available information.

An aggregation of input-and-cost schedules on the plan level is the surest way to identify the latent bottlenecks of material or human inputs well in advance. The format based on activities networks and input-and-cost schedules can most appropriately be used for "rephasing" a plan through

shifts in the temporal sequence of projects. The latter will relieve pressures on strategic inputs in particularly short supply by spacing them more evenly over the time interval of the plan.

7.5 "ACCOUNTING PRICES" AND OTHER MEANS OF ECONOMIZING SCARCE RESOURCES

In the recent literature, much effort and space has been devoted to the possibility of using so-called "accounting prices" or "shadow prices" as a tool for allocating scarce resources. In calculating the estimated cost of projects by this method, fictitious prices, higher than those actually in force, would be assigned to inputs in scarce supply and/or artificially low prices to the abundant inputs in order to sway the users of inputs from the scarce ones to the abundant ones and, thus, to relieve the difficulties of allocation. It is highly doubtful whether any country in the world, even the most advanced, is today capable of facing and solving the formidable problems which such a system would pose. If, however, it or a simpler variant of it were ever attempted, the project format advocated here is ideally suited to provide the necessary information and accounting structure.

Not until public administration, statistics, econometrics, and computer sciences have achieved quasi-perfection, by using the "accounting prices" system, can we banish our worries about allocation of resources. Until then, some less sophisticated, but more practicable, methods may be thought of as a relief in certain, more tractable, cases of bottlenecks. Suppose, for example, that the input-and-cost schedule of a national plan

foresees the application of 100,000 tons of cement and 2,000,000 clay bricks in various projects during a specific time period. A study of available productive capacity reveals that the plan can absorb a maximum of 75,000 tons of cement during that period without disturbing the private construction market while the available supply of clay bricks far exceeds the postulated 2,000,000. If no shifts of activities beyond the period in question are practicable, and the planning authority is determined to carry the projects through, the only way out of the difficulty would be, of course, to issue a directive obliging project directors to substitute clay bricks for cement products wherever possible. The great advantage of each project's having a set of detailed activity input-and-cost schedules is that it becomes possible to pinpoint, within a relatively short time, the specific activities in each project where the substitution is possible and to obtain a fairly close estimate of the cement that could be saved in each one. Since the Planning Agency had this information, it could calculate the total expected savings and decide whether further adjustments in either direction were necessary. Furthermore, if the location of any project with respect to brick factories caused transportation difficulties (not to be neglected in the case of such a heavy product), additional adjustments between projects could be made to minimize the cost of transport.

In principle (i.e., if one consciously suppresses certain parameters of reality), all the above sketched adjustments could be made even in the absence of activities networks and input-and-cost schedules of various levels of activities. In practice, however, this is impossible:

latent information becomes useful in large social organizations only when it is moved through clearly structured channels and when the operators and users of these channels are sufficiently acquainted with procedures of moving the information through them. Otherwise, the "noise" of errors, of misunderstandings of definitions, of pretending not to understand in order to improve one's position, etc., will make it impossible to gain enough information in time to carry out the recommended action.

7.6 FOREIGN EXCHANGE REQUIREMENTS OF A PLAN: IDENTIFICATION AND EVALUATION OF IMPORT-CONTENTS IN INPUTS

7.61 Project-Document Format and A Country's Foreign Exchange Accounting

It is not necessary to argue here the importance of the relationships between the emerging countries' developmental efforts and their foreign-exchange position. This is widely acknowledged as a critical problem area of the contemporary international economy and it has, for several years, been the subject of a lively discussion among academicians and officials of governments, the International Monetary Fund, and other international economic organizations.

Without prejudicing the outcome of this discussion, it is safe to say that whatever measures are eventually agreed upon to protect the continuity of the developmental effort from untoward swings in foreign exchanges (due to the demand of development-projects for imported inputs as well as to foreign-trade fluctuations and trends), the efficacy of these

measures and the precision with which they can be adapted to fit a specific situation in any country will greatly depend on the availability of sufficient statistical and accounting documentation on that situation. This documentation will provide the numerical substance for the specific application of formulae agreed upon internationally, most likely in their general algebraic form.

It is, therefore, of great interest to us to see how the structuring and accounting of projects and their groupings in a national development plan relates to that need for documentation. What concepts and procedures are particularly useful in the programming of projects and in the accounting of their implementation for the problem in question? How does the project-document fit into the overall framework of accounting for a country's foreign-exchange position?

During and after the implementation of a stepped-up investment effort (i.e., a development plan), a country's foreign exchange position will be affected by various positive and negative items that appear with lead-times and time-lags peculiar to their function in the process of production.

Thus, the negative items appearing with lead-times will be:

- equipment, supplies, materials, and services for implementation of projects;

- raw materials, supplies, and services constituting recurring inputs of directly productive permanent projects (e.g., a factory, once construction is completed);

- materials, supplies, and services constituting recurring costs of operation of nondirectly productive permanent projects (e.g., a hospital, once construction is completed);

- equipment, supplies, materials, and services for replacement of the depreciated fixed capital of permanent projects.

The positive items appearing with various time-lags will be:

- goods and services produced for export, once permanent projects are completed;

- goods and services produced in substitution of imports, once permanent projects are completed.

The algebraic sum of these conflicting negative and positive influences will have a strong tendency, during the earlier years of the intensified development effort, towards the minus sign: investments in the economic and social infrastructure will show their increased capacity to earn or to save foreign exchange only over long periods; even directly productive investments of an export or import-substitution nature have often considerable gestation periods; in the meantime, they require foreign equipment, materials, supply, and services for their execution.

No matter how a country mobilizing its internal resources for development accommodates its increased foreign-exchange needs, it can work out an approximate forecast of them in advance. We shall call that forecast, PLAN, disregarding the question of how indicative or normative that PLAN will be in different countries. Negative and positive items of each particular project should be identified and their timing established. Then,

the mass of individual projects are aggregated (on the program's level and finally on the Plan level). The aggregation should show three crucial elements: (1) the Plan-total of negative items; (2) the Plan-total of positive items; and (3) their timing over the interval of the forecast. These elements will give the net foreign exchange requirements of the Plan and their timing. Together with the foreign-exchange aspect of the country's traditional (non-developmental) activities, they will yield the overall forecast of the foreign-exchange position and the extent of assistance needed to maintain a reasonable liquidity.

The project design outlined in this study was formulated to satisfy, among others, the needs of the above discussed procedure. Within each project-document, different inputs are arranged according to a fairly detailed standard object classification. Thus, the degree of local or foreign origin of each input can be shown in a manner that allows for easy aggregation within a project and of several projects on the Plan or sectoral levels. Under this system, the total demand of the Plan for any important input (such as gasoline, iron pipes, insecticides, etc.) can be calculated and known in advance of actual importing. Even the demand for certain minor items can be calculated easily at short notice, if necessary. It would be most desirable, and not unfeasible, if all countries followed the same standard classification. This would allow for the greatest possible international comparability and for aggregation on the global level.

Also, the timing of various inputs within each project can, by using the PERT structuring of networks, be presented in standard numerical and graphic schedules to permit easy aggregation of the total of financial streams of the Plan.

The advantages of the proposed system of presentation of projects go far beyond the ease and orderliness of primary calculations. The system, if consistently practiced and exploited, should allow one to trace gradually the whole network of interdependencies between the projects that combine through sectoral programs into the Plan. As a rule, a multi-year plan would be subject to annual reconsideration and revision so that earlier forecasts could be corrected to agree with the most recent actual figures. Thus, the system would facilitate a permanent process of rolling adjustment. But, above all, it would provide a rational framework for an objective and quantitative dialogue between a country in need of foreign exchange and authorities having the power to satisfy that need.

Let us review these advantages in more detail:

(a) Outputs of directly productive projects scheduled in the early part of the Plan may become available as inputs in later investment projects. For example, a foundry constructed in the first year of the Plan could supply pipes for a waterworks project in the third year, thus substituting for an import that would otherwise have been necessary and thereby reducing the total foreign-exchange requirements of the Plan. Such interdependencies are easy to think of analytically but in administrative practice, where individual projects are of necessity elaborated at various times in the

virtually closed vessels of separate agencies, they are difficult to identify and even more difficult to quantify. The standard classification of inputs and the manner of grouping and structuring them in terms of activities that we recommend permit the Central Planning Agency to assess input needs of projects on various levels of generalization or detail. Further, this approach makes it possible to aggregate the input needs of projects emanating from diverse functional agencies and to estimate their aggregate time-profile. Calculating the overall IMPACT is thus made easier. Finally, our system for classifying and structuring inputs facilitates identification of those outputs from recently completed projects which might satisfy the input-needs of future projects. In certain areas of the world, such as South America, Central America, the system could be, one dares to hope, extended to analyze the intracontinental interdependencies, thus contributing to regional cooperation and to development of the economic complementarity within the area.

(b) Publishing detailed lists of goods and services to be used in the implementing a multi-year plan in the public sector of the economy, as is done by the Small Business Administration in the United States, could do much to stimulate the initiative of local progress-oriented businessmen. Such lists would make them aware of sustained opportunities offered to certain lines of production, especially in the lines of simpler construction equipment, foundry products, institutional furniture, and the like. An important by-product of fostering private talent and initiative in this manner within the wide framework of public sector planning could be

considerable economy of foreign exchange: some goods classified as imported in the original projects could become available locally by the time the projects enter the implementation stage.

(c) It would be most unrealistic to expect that a multi-year Plan could be implemented throughout its entire period without major changes in price of at least some important inputs. In the case of imported inputs, this entails changes in total foreign-exchange requirements. Constant recalculating is necessary to estimate the impact of these fluctuations. Only a proper classification of inputs and ability to aggregate them on the Plan level can make it possible to calculate with ease and relative precision what the effects will be when the price for an input changes drastically from that originally forecast. In the absence of such an aggregating system, it is necessary to analyze repeatedly all individual projects each time a vital imported input undergoes a large price change--clearly an unrealistically complicated procedure. In practice, a lack of the ability to estimate the effects of significant price changes of major imports leads to sudden and unexpected foreign-exchange drains and payments crises.

(d) Whatever form any internationally accepted system for dealing with the foreign-exchange problems of the less developed countries might take, the actual mechanics of it will be strengthened and more likely to endure if specific claims are based on a quantitative accounting and statistical system which permits their validity to be tested with a high degree of precision and objectivity.

7.62 Statistical Questions

After it is decided how inputs should be classified and structured within a project document, the next important question from the foreign-exchange viewpoint is: What are the most practical methods for estimating approximate foreign content of various inputs? With regard to this problem we can recognize six basic cases of varying degree of difficulty:

(a) Local manpower

(b) Imported (or non-resident) manpower

There is no difficulty with these two cases.

(c) Visible imports (tangible goods).

In this case, it is easy to find out the c.i.f. price for most goods. The difference between the c.i.f. price and the price quoted to the project is the locally earned margin of importer and other agents involved in the distribution and transport of the good to the project site. In most countries it should not be too difficult to divide the imports likely to be required for development projects into a few broad categories and then calculate statistically the average percentages of margins between the c.i.f. price and the price "loco projecti." Thus, estimating the foreign content in the price of imported inputs should not be too difficult in most cases.

(d) Invisible imports (services obtained from abroad)

In principle, it may be difficult in this case to disentangle the purely foreign content from that added locally. In practice, such an instance would be rare and of minor importance. Generally, it would be easy

to identify and calculate; i.e., foreign fees, purchasing trips abroad, insurance, etc.

(e) Goods bought from local producers

This is a case of great difficulty. A locally produced article may be made entirely with local raw materials or entirely of imported raw materials. In the latter case, the foreign content of its price may be very large. In between is the whole spectrum of goods with varying proportions of local and foreign raw materials. Considerable work may be required here to arrive at useful generalizations and averages. Probably the most practical solution would be for the planning agency of a developing country to prepare a limited, but still comprehensive, list of those local project inputs which are most costly (such as cement and other construction materials, office, school, and hospital furniture, paints, structural iron and steel, and so on) and analyze the cost structure of these goods at intervals so as to obtain coefficients applicable for a limited period to these types of goods. The very success of a country's development effort would tend to make these coefficients obsolete after a while.

For less important inputs, making periodical sample surveys and establishing a single average proportion of foreign content to be applied to the numerous small items in that class would seem to be the only practical solution.

(f) Local services

Like invisible imports, this case could, in principle, be very difficult. In practice, considering the types of services most likely to be used, inputs in this class can be handled with relative ease. Often when the import content will seem significant, as in the case of imported gasoline which is a component of the cost of locally hired transport, it will be possible to establish average coefficients that can be automatically applied to such items.

The system which has been suggested for estimating the foreign-exchange needs of a development plan requires a great deal of work and an orderly analytical presentation of the projects involved. It may be asked whether the effort necessary to operate such a system will be justified by the results. To this question one can answer as follows:

In the first place, the suggested system commends itself because of its advantages in fields other than foreign-exchange requirements; above all, it enables planners to forecast bottlenecks with strategic inputs. Therefore, the effort actually imputable to the estimates of foreign-exchange requirements would be much less than it might appear.

Second, the foreign-exchange drain caused by development efforts is a serious problem that is bound to arise again and again. Sweeping difficult problems under the carpet does not help, because they always reappear and usually become more critical the longer they are ignored. A really effective long-run solution is to be sought by thorough examination of the problem, using all available means of accounting and statistics.

Only quantitative analysis of causes underlying the difficulties carried *ex ante* on projected operations as well as *ex post* on those already completed will give us reliable estimates of foreign-exchange pressures to be expected from the implementation of development plans. These estimates, constantly revised and pushed ahead in the measure as time passes, should become the quantitative basis of future international solutions.

CHAPTER VIII

AN INFORMATION-ORIENTED DESIGN FOR PROJECT ACCOUNTING SYSTEM

		Following Page
Figure 8-1	Information Flow in the Accounts Structure	VIII-15

CHAPTER VIII

AN INFORMATION-ORIENTED DESIGN FOR PROJECT ACCOUNTING SYSTEM

In the foregoing chapters of this study we have shown that a project has many aspects--quantitative, qualitative, functional, and temporal--which can be used to describe and measure it. We have indicated the great advantages to be gained by a proper use of these measures as well as the losses that can be incurred when they are ignored or neglected. Good programming, it has been emphasized, consists of extracting the utmost possible available information and of combining it with the common sense and experience of the managers.

A proper question to ask now is: how can we make certain that all the necessary information results organically from the normal operations of the administrative and clerical staff? Members of the latter are often not sufficiently familiar with the intricacies of programming and are upset by changes in their work routines. If the programmer were to make himself intrusive by constantly annoying and burdening the administrative, accounting, and record keeping personnel with new demands for time-consuming calculations and listings that had no relation to the classification categories currently in use for project accounting and record keeping, his chances of getting

cooperation would be extremely poor. Subterfuges would come to be used on both sides. The resulting frictions would prove detrimental to the work and good will would disappear.

The necessary information must be available to the programmer not because he requests it but because the structure of the accountings and record-keeping system, and the logic-flow equivalent to it, is such that the data are automatically collected in appropriate groupings. Thus, we need an accounting system which can produce all the items of information on project implementation which in the foregoing chapters were shown to be of vital interest for agencies engaged in improving a nation's economy.

What are the characteristics required of such a system?

First, it must safeguard the integrity of execution. This characteristic is, of course, shared with all other accounting systems. There is no need to elaborate on this aspect because conventional systems provide methods of validation of transactions which can be adopted, according to circumstances of time and place, in any specific application of our system.

Second, it must provide a means for the internal pre-transaction audit during project implementation so as to determine the validity of a proposed transaction submitted for approval. (For example: is this proposed purchase of cement for a given purpose within the limit programmed for this project?)

Third, it must automatically impute (directly or indirectly) the expenditures to activities within the project, so that in the end all resources are distributed among component activities and no residue is left. (This characteristic is shared with cost accounting systems and is necessary for measuring the actual efficiency of execution against standards proposed in the project document and against external benchmarks.)

Fourth, it must differentiate the inputs of the project according to national-accounts classification and labor classification explained in earlier chapters. (This facilitates the measurement of the project's actual impact on the national economy.)

Fifth, it must also classify the inputs according to the budgetary classification explained previously, so that the accounts of all implemented projects can be aggregated into the development budget accounting report and used to evaluate implementation.

A system which satisfies these requirements will now be presented.

In this system, all transactions occurring during a project's lifetime as a legal entity * can be assigned to one of three principal categories of accounts.

* When a project results in permanent physical assets, its "legal life" usually ends after these assets are taken over by an agency charged with operating them. An example of this might be the transfer of control of an irrigation system to an appropriate permanent agricultural agency. A campaign-type project may be terminated by transferring the staff to other operations and by surrendering the unused materials, supplies, equipment, etc. to a permanent agency.

1.000 PROPERTY-CONTROL ACCOUNTS

These show how many and what kind of inputs the project absorbs from the economy and, perhaps, produces for its own use. They also show the financial flows of monies, claims, and obligations as they correspond to the flow of inputs.

2.000 IMPLEMENTATION ACCOUNTS

These show how the various inputs are apportioned among the activities within the project and how the service and management activities contribute to the execution of direct activities.

3.000 COMPLETION ACCOUNTS

These show how all the costs are imputed after a project is completed. We shall now explain the more important details of the structure and functioning of these three principal groups.

1.000 PROPERTY CONTROL ACCOUNTS

This group is subdivided into two major divisions: 1.100 and 1.200.

1.100 EVOLUTION OF FUNDS, CLAIMS AND OBLIGATIONS

This division organizes all information pertaining to the use of the project's financial resources. It reveals a project's financial status vis-a-vis the outside world, at any given moment, and the project's ability to incur new obligations against goods, services, and rights needed for the implementation. These accounts provide the data both for assuring the integrity of execution and for the planning and programming of the project's financial

management. Below is a proposed list of main subheadings in the 1.100 division. While not exhaustive, as it is impossible to foresee all contingencies that might arise in different projects, the list is believed to cover all essential categories of transactions likely to be encountered.

1.100 EVOLUTION OF FUNDS, CLAIMS AND OBLIGATIONS

ASSETS AND OTHER DEBITS

1.101 Drawing Rights on Authorized Financing

1.102 Cash, Banks, Funds with Govt. Agencies, Funds in Transit, etc.

1.103 Prepayments, Advances, etc.

1.104-A Orders Placed

1.104-B Reserves for Orders Placed (Cr)

1.105 Accounts Receivable

1.106 Investments, Loans, Financial Claims, etc. due to be liquidated before the project's completion (Cf., Account 1.217 below)

1.107 Transfers, Grants, etc.

1.108 Indemnities

1.109 Interest Charges paid during implementation

1.110 Acquisition of Rights, Goods and Services from other Parties

1.111 Property for Disposal
1.111 Property Disposal
1.112 Gain (DT) or Loss (CR) on property disposal

1.119 Misc. Deferred Debits

LIABILITIES AND OTHER CREDITS

1.151 Authorized Financing
1.1511 Not yet Utilized
1.1512 Utilized

1.152 Interest Accrued during Implementation-Capitalized

1.153 Accounts Payable

1.159 Misc. Deferred Credits

Although many goods, services, and rights bought by the project from outside parties will be registered temporarily under Orders Placed (1.104-A), or Prepayments, Advances (1.103), ultimately all the inputs absorbed by the project must be debited to the summary account, Acquisition of Goods, Services and Rights from Other Parties (1.110). This account will, in turn, be credited for the distribution of acquired inputs among debit accounts in Division 1.200 discussed below. Thus, it is assured that the structure of the accounting system and that of the input-and-cost schedule will correspond at every level of generality from the lowest to the highest.

1.200 ACQUISITION, UTILIZATION, AND DISPOSAL OF GOODS SERVICES AND RIGHTS

This division shows an input breakdown. All inputs are assigned to different classes and subclasses according to the Budget/National Accounts classification recommended in this study.

Observe the important distinction between the two parts into which this division is split: 1.210 and 1.220. The sum of items in 1.210 equals the total of those in 1.110. Both 1.110 and 1.210 show the total of absorbtion of inputs from the outside of the project. On the other hand, accounts grouped under 1.220 represent the intermediate transformation of goods that takes place within the project. The project's mechanical workshops may buy simple products, such as iron, sand, and concrete, and turn them into relatively more sophisticated items like piping, fittings, etc., or, they may salvage and rehabilitate worn out equipment. In order to determine whether these operations

compete successfully with buying from the outside (cost accounting) and also gain an accurate picture of a project's actual technological needs, these operations have to be properly registered. This is precisely the role of the 1.220 group of accounts. Accounts debited in 1.210 and 1.220 will be credited when goods, services, and rights are debited to the project activities in Group 2.000.

1.200 ACQUISITION UTILIZATION AND DISPOSAL OF GOODS, SERVICES AND RIGHTS

1.210 ACQUISITION FROM OTHER PARTIES

1.220 PRODUCT-RECOVERY SALVAGE, ETC. WITHIN THE PROJECT

1.211.....Personal Services (Subheadings follow the classification recommended in the foregoing chapter on input classification. For example: Acc. 1.211/0-7-91, Salaries of Bricklayers, Stonemasons and Tile Setters)

1.212.....Contractual Services (Subheadings determined as above. For example: Acc. 1.212/1-4, Printing and Reproduction)

1.213.....Materials and Supplies (Subheadings determined as above. For example: Acc. 1.213/2-3.33.410.11, Cement) 1.223

1.214.....Machinery and Equipment (Subheadings, determined as above..... For example: Acc. 1.2.14/3-36.318.11, Bulldozers) 1.224

1.215.....Land Structures and Rights.....1.225

1.2151....Land and Rights.....1.2251 e.g. artificial island

1.21511 Land 1.22511

1.21512 Rights

(Continued on next page)

1.200 ACQUISITION, UTILIZATION AND DISPOSAL OF GOODS, SERVICES AND RIGHTS
(continued)

1.2152....Structures and Rights 1.2252

1.21521 Structures..... 1.22521
1.21522 Rights

1.2153....Land and Structures and Rights 1.2253

1.21531 Land and Structures.....1.22531
1.21532 Rights

1.2154....Rights other than pertaining to land and structures
(Patents, copyrights, etc.)

1.216.....Construction by outside contractors

1.217.....Financial claims extending beyond the date of project
completion (Cf. Account 1.106 above)

1.250.....DEPRECIATION

1.251.....Depreciation chargeable to implementation activities
1.252.....Depreciation non-chargeable to implementation activities

1.260.....EXTRAORDINARY LOSSES ON PROPERTY

1.270.....PROPERTY DISPOSAL (to be credited to Acc. 1.111)

2.000 IMPLEMENTATION ACCOUNTS

This group is divided into divisions which should correspond to the project's component activities. It must be left to the management to decide at which summary level differentiation into more and more detailed account subheadings should stop.

The logic behind the structuring of the divisions in Group 2.000 is shown below in a rather sketchy example based on the irrigation project discussed throughout this study.

2.000 IMPLEMENTATION ACCOUNTS
Example of Major Subheading

2.100 DIRECT ACTIVITIES

2.110 ACTIVITIES RESULTING IN PROPERTY

2.111 RESERVOIR SYSTEM	SUBHEADINGS:	
	2.1111	Land Improvements
	2.1112	Storage Dam
	2.1113	Outlet and Primary Gate
2.112 WATER TRANSMISSION SYSTEM	Subheadings defined as above according to the division into component activities	
2.113 ELECTRIC POWER SYSTEM	"	"
2.114 ACCESS ROADS	"	"

2.120 ACTIVITIES NOT RESULTING IN PROPERTY

2.121 EXTENSION COURSE FOR FUTURE IRRIGATION AGENTS
Subheadings defined as above

2.200 SERVICE ACTIVITIES

2.210 O. & M.* Stores

2.220 O. & M.* Equipment

2.230 O. & M.* Production Plant, Repair Shops, etc.

2.240 O. & M.* General Facilities (Offices, Worker's Camp, Heat, light, etc.)

2.250 M.* General Property (unused land, structures, etc.)

2.260 Construction, wreckage and salvage of structures serving service activities

2.270 Transportation and communications

2.280 Diversion Canal

2.300 MANAGEMENT ACTIVITIES

2.310 Programming, Finance, Accounting, Administration, Personnel, Procurements & Property, Information, Medical, Security, Legal...etc.

2.320 Engineering, Supervision, Laboratories, Quality Control, Design, Specifications...etc.

2.330 Investigations...etc.

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* O. & M. is an abbreviation for Operation and Maintenance; M. is for Maintenance

Implementation Accounts are debited for goods, services, and rights according to the use made of these inputs in the execution of the project. Obviously, when an input first begins its journey through the implementation process, it gives rise to a credit entry on an appropriate specified input account (e.g.,"cement") in Group 1.200 (Acquisition, Utilization and Disposal of Goods, Services and Rights) and to an equivalent debit entry on the account of the activity in which it was applied (e.g.,"storage dam"). Thereafter will follow much internal circulation: Many inputs will go first into service or management activities, from which they will gradually "seep" into direct activities in the form of support functions performed by service and management for the direct activities. Also, throughout the implementation process there will be a good deal of "cross servicing" among various service activities themselves: repair shops will serve transportation, stores will serve both of them, and so on. An internal play of debits and credits between various service and management activities will register this complex process of mutual support and interdependence.

Some debits on service activity accounts and, above all, on management accounts will still be unbalanced by credits when implementation is completed and, thus, cause these accounts to have debit balances. Debits of this kind are usually for inputs which cannot be imputed directly to direct activities. The residual is called distributive cost of the project. It is imputed to the direct activities in the next

account group, Completion Accounts (3.000), according to cost-accounting principles adopted for a given project.

Group 2.000, Implementation Accounts, will thus faithfully reflect the whole technology of a project, from the first to the last step of execution. Insofar as the structure of its divisions mirrors the structure of functional implementation activities, measurement of efficiency of execution will be possible on any level and for every cross section of the project.

3.000 COMPLETION ACCOUNTS

Accounts in this group show what the total cost of a project will be. This total cost will be allocated (directly or by imputation) among the components of the project. The total cost of realizing a project can now be compared with the cost assumed for the COST BENEFIT calculus which was the basis for the initial "go ahead" decision. This is the project's first "moment of truth". The second comes later when experience shows whether the expected benefits have really been achieved.

The following is a sketch of this account group for our irrigation project.

3.000 COMPLETION ACCOUNTS

3.100 PROPERTY

3.110 Reservoir System

3.111 Land improvements
3.112 Storage dam
3.113 Outlet and primary gate, etc.
(See Group 2.000)

3.120	Water Transmission System	Subheadings defined as above
3.130	Electric Power System	"
3.140	Access Roads	"
3.150	Capital Grants. Transfers, etc., made to other Parties as part of implementation of the Project	
3.160	Rights and Claims to be Transferred to the Agency which will Permanently Operate the Completed Project	
3.161	Rights	
3.162	Claims	

3.200 NON-PROPERTY

3.210 Accomplishment of an Extension Course for Future Irrigation Agents

The number of separate sub-accounts in Group 3.000 is, of course, dependent on the level of detail accepted previously in Group 2.000. Generally, this will be decided jointly by the engineers, accountants, and record keepers. The groups should be sufficiently detailed to meet the needs of cost-accounting and effectiveness control. In principle, excessive detailedness is not a drawback because our account-structure, which is parallel to the activity-structure, always permits us to aggregate low-level components at any higher level of generalization that might be indicated for purposes of cost-analysis. In practice, a lot of detail may not be worth the time and money required.

The debits in Group 3.000 are obtained from two sources:

First, all debits of Direct Activities in Group 2.000 aggregated at a desired level.

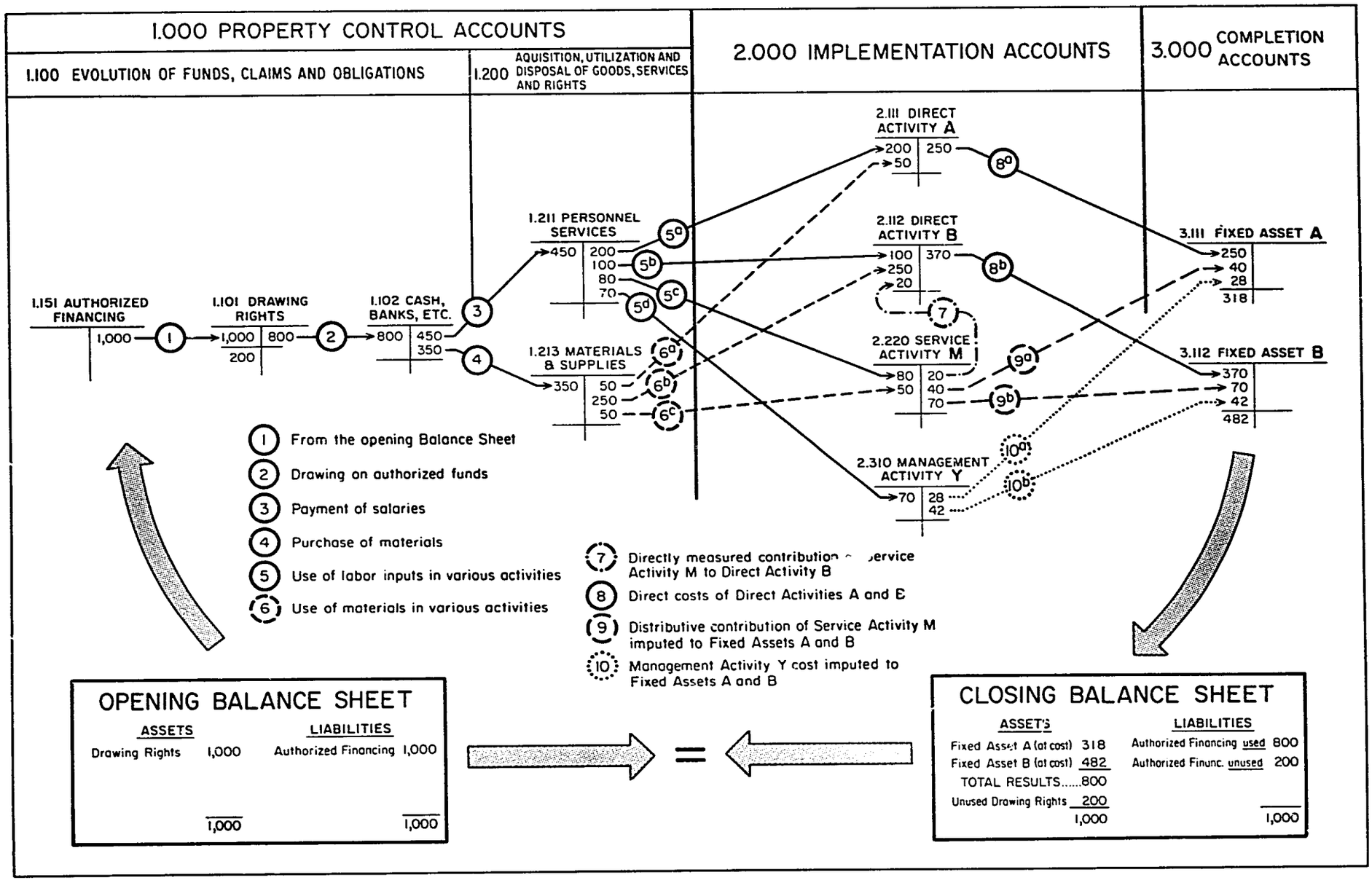
Second, all final debit balances of Service Activities and Management Activities in Group 2.000 remaining at the end of implementation. These debit balances are now imputed to various accounts of Group 3.000, Completion Accounts, according to cost-accounting formulas adopted by the project in question. This kind of cost distribution is treated in numerous works on the subject, and so there is no need here to discuss it in detail. For example, it is possible to ascertain the clerical cost of procurement for a completed fixed asset by prorating this cost in proportion to the cost of materials and supplies absorbed directly by direct activities which resulted in these fixed assets.

At the end of the project's accounting cycle, we will have the debit accounts in Group 3.000. The total of these debits, the total cost of the project, is identical with the total credit on Account 1.1511, Authorized Financing Utilized. The accounting cycle is now closed.

FIGURE 8 - 1 shows, in a highly simplified form, the flow of information through the accounting structure described in this chapter.

FIGURE 8-1

INFORMATION FLOW IN THE ACCOUNTS STRUCTURE



CHAPTER IX

THE ROAD AHEAD: MODULAR PROGRAMMING

Robert M. Waddell
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CHAPTER IX

THE ROAD AHEAD: MODULAR PROGRAMMING

9.1 Estimates of Inputs: Accounting Measures and Probabilistic Measures . . . . . IX- 3
9.20 Capacity Expansion Technique (Modular Technique) Explained . . . . . IX- 5
9.21 Input Quantities . . . . . IX- 5
9.22 Input Timing IX-15
9.23 Activity Network Presentation IX-21
9.300 How to Exploit the Modular Concept IX-22
9.31 National Plan IX-22
9.320 Modular Technique in Plan and Project Implementation IX-23
9.321 . . . . . IX-23
9.322 "Rolling Refinement of Programming" . IX-23
9.323 Estimates of Contractors' Inputs . . . IX-26
9.324 Advance Procurement IX-27
9.33 Heuristic Value of Modular Technique IX-28
9.400 Work to be Done in Application of Modular Technique . IX-29
9.41 Fundamental Classes of Projects IX-29
9.420 Projects Resulting in Permanent Physical Assets IX-30
9.421 Technical Approach IX-30
9.422 Functional Sectors IX-32
9.423 Candidate Input Modules IX-35
9.424 How to Modularize a Specific Industry . IX-41
9.425 Enlargement of Existing Facilities . . IX-44
9.43 Campaign Type Projects IX-50
9.5 The Road Ahead IX-55

CHAPTER IX

FIGURES, TABLES, CHARTS

		Page
Figure 9-1	Input Configuration . . . . . .following	IX-12
Figure 9-2	Activity Network--Power Plant Construction . . . . . .following	IX-21
Figure 9-3	"Rolling Refinement" of Project Programming . . . . . .following	IX-26
Figure 9-4	Railroad Transportation . . . . .following	IX-41
Table 9-1	Capacity Expansion Factors, Electrical Generation/Transformation Module . . .	IX- 8
Table 9-2	Equipment Installation Material Module . .	IX- 9
Table 9-3	Equipment Installation Labor Module . . .	IX-10
Table 9-4	Building Module	IX-11
Table 9-5	Construction Labor Module	IX-12
Table 9-6	Final Proportions of Demand for Inputs . .	IX-13
Table 9-7	Time-Phased Factor Distribution .following	IX-16
Table 9-8	Estimated Cash Requirements	IX-18
Table 9-9	Per Cent Input	IX-19
Table 9-10	Ratio Labor to Material and Equipment . . .	IX-20
Table 9-11	Candidate Capital Input Modules by Major Functional Economic Sectors . .following	IX-40
Table 9-12	Railroad Facility Expansion Table .following	IX-42
Table 9-13	Modular Building Block, Anti-Cholera Vaccination Campaign	IX-54
Chart 9-1	Per Cent Input	IX-19a

9.1 ESTIMATES OF INPUTS: ACCOUNTING MEASURES AND PROBABILISTIC MEASURES

If a planning organization is to succeed, it must have at its command two distinct techniques of work. First, there is a need for methods and document formats that will assure the most accurate figures practicable, the freedom to analyze at will various levels of detail, and the ability to compile breakdowns along all meaningful cross sections of totals.[1] Such a technique aims at maintaining consistency among various projects composing a plan. Laxity in this respect is likely to cause physical bottlenecks and financial shortages of funds in local or foreign currencies. Second, there is a need for other methods that will enable planners to make rapid, though necessarily approximate, comparisons among rival alternatives and to project the effects of contemplated courses of action. These approximations can serve as guides in the early stages when fundamental choices must be made, even though the precise numerical consequences of these decisions will not be known until detailed project documents are elaborated.

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[1] The foregoing pages are almost entirely devoted to methods appropriate for this domain.

The first of the above discussed techniques relies on development and refinement of accounting measurement. The second one must use probabilistic measures derived from the recent experience and must constantly be tested against an ever changing economy and technology.

Ever since the invention of input-output analysis by Wassily W. Leontief, it has been utilized frequently to estimate the quantitative characteristics of an economy's future course. Recently, an important special application in the domain of development planning was worked out.[2] It is a probabilistic technique which discovers quantitative relationships among the inputs composing various branches of capital investment and which uses these coefficients to make rapid broad estimates of input demands that might be exerted by contemplated alternative plans. Furthermore, this technique, which we shall henceforth call the capacity expansion technique, offers devices for approximate timing of major groups of inputs. Skillfully applied, it would become an efficient tool for making rational choices in the early, crucial decision-making stages of planning.

In conceptual structure, the capacity expansion technique is so close to the technique of networks and input schedules advocated in this

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[2]Robert M. Waddell, et. al., Capacity Expansion Planning Factors (Washington, D. C.: Economic Programming Center, National Planning Association, 1966).

study for project implementation that the two can be combined to offer a unified set of tools for all planning stages--from the initial choosing among competing alternatives, through implementation, to the reporting and analysis of completed plans and projects.

9.20 CAPACITY EXPANSION TECHNIQUE (MODULAR TECHNIQUE) EXPLAINED

9.21 INPUT QUANTITIES

The principal aspects of the capacity expansion technique can be easily seen when the latter is examined in relation to a small project fragment. This we shall do, and thereafter we will show the technique's major advantages and how it can be combined with those techniques suggested in earlier chapters.

Up to now, the capacity expansion planning factors have been calculated for that part of the economy defined as "Manufacturing." Using U. S. figures as a base, the class has been subdivided into 252 industries. This has made it possible, though not always easy, to establish a rough concordance between this classification and those of the U. N. national accounts and the U. S. Census of Manufacturing which are recommended in our study.

For each industry, there is a table that shows in percentage form the proportion of various inputs needed to create a unit (say, one dollar's worth or one million dollars' worth) of productive capacity. The inputs shown on an industry table are of two levels of complexity.

1. The lower level consists of input items produced by other industries; nonmanufacturing, such as agricultural products or sand, as well as manufacturing, such as cement, timber, iron and steel goods, equipment, machinery, etc. Except for certain differences of classification mentioned above, all these items can be found in what in our input-and-cost schedules is entered under the headings of (2) Materials and Supplies and (3) Machinery and Equipment (see Chapter III).

2. The higher level includes the modular inputs, which are themselves complexes of above-indicated input items combined in fixed proposition. These modules appear in 7 groups:

i. Equipment Installation Material Modules

ii. Auxiliary Facilities Modules

iii. Indirect (Distributive) Cost Module

iv. Construction Building Modules

v. Building Accessory Modules

vi. Construction Nonbuilding Modules

vii. Labor Cost Modules

a. Expressed in manhours
b. Expressed in dollars

How is this input estimating technique used in a particular project?

For an illustration, let us return to the Irrigation Project discussed earlier. Among the direct activities of the project, we find Direct Activity 1.31, "Power Plant." Suppose that we are in an early stage of project planning and what is needed at the moment is a rapid estimate of inputs required and a rough projection of their timing.

Electrical power plants, an item of understandable importance, are the subject of a separate module, ELECTRICAL GENERATION/ TRANSFORMATION MODULE, which belongs to Group ii, Auxiliary Facilities Module.[3] This module is as follows:

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[3] Ibid. This exposition has, for the sake of arithmetic ease, been greatly simplified and endowed with some arbitrary assumptions. However, the logic of the procedure has, we hope, been faithfully retained.

TABLE 9-1

CAPACITY EXPANSION FACTORS
ELECTRICAL GENERATION/TRANSFORMATION MODULE

Input Code Used in This Study (1)	Input (2)	Leadtime Months Mean (3)	Leadtime Months Range/2 (4)	Factor (5)
3-3.36.19210	Diesel Engine	7	2	0.17
3-3.37.12	Power Transmission/ Distribution Equipment	7	6	0.24
3-3.37.21	Generator and Allied Equipment	6	3	0.07
	Equipment Installation Material Module (of the appropriate type)	9	6	0.06
	Equipment Installation Labor Module (of the appropriate type)	7	7	0.11
	Building Module (of the appropriate type)	8	8	0.35
				1.00

From the above listing, we see that the first three items can be directly entered in the estimate of required inputs, under code numbers of the classification adopted in this study and with factors indicated in Column 5.

The fourth item in Table 9-1, Equipment Installation Material Module (of the appropriate type), has a factor 0.06 which, in turn, is composed of factors shown in Table 9-2.

TABLE 9-2

EQUIPMENT INSTALLATION MATERIAL MODULE

Input Code Used in This Study (1)	Input (2)	Leadtime Months Mean (3)	Leadtime Months Range/2 (4)	Factor (5)	As Factor of Table 9-1 (5) x 0.06 (6)
2-3.33.410	Cement	11	4	0.05	0.0030
2-3.35.578	Wire and Cable	10	5	0.11	0.0066
2-3.39	Insulation Materials	5	2	0.06	0.0036
3-3.36.197	Valve & Pipe Fittings	10	5	0.20	0.0120
3-3.37.131	Switchgear Apparatus	9	5	0.58	0.0348
				1.00	0.0600

All the items in Table 9-2 can enter directly in our input estimate, with factors indicated in Column 6.

Next, we find the composition of the Equipment Installation Labor Module from Table 9-1, where it appears with a factor of 0.11. It is shown in Table 9-3.

TABLE 9-3

EQUIPMENT INSTALLATION LABOR MODULE
(of the appropriate type)

Input Code Used in This Study (1)	Input (2)	Leadtime Months Mean (3)	Leadtime Months Range/2 (4)	Factor (5)	As Factor of Table 9-1 (5) x 0.11 (6)
0-7-52.50	Fitter Assemblers, internal combustion engineers	6	6	0.45	0.0495
0-7-62.15	Electrical Fitters, motors and dynamos	9	5	0.35	0.0385
0-8-99.30	Laborers, heavy physical work	7	7	0.20	0.0220
				1.00	0.1100

All items in Table 9-3 can be included in our estimate with their factors as indicated in Column 6.

The composition of the BUILDING MODULE, the last item in Table 9-1, is shown in Table 9-4.

TABLE 9-4

BUILDING MODULE
(of an appropriate type)

Input Code Used in This Study (1)	Input (2)	Leadtime Months Mean (3)	Leadtime Months Range/2 (4)	Factor (5)	As Factor of Table 9-1 (5) x 0.35 (6)
2-2.421	Sand and Gravel	9	6	0.05	0.0175
2-3.25.212	Lumber	9	7	0.10	0.0350
2-3.33.410	Cement	12	3	0.10	0.0350
2-3.35.294	Builders' Hardware	8	7	0.05	0.0175
2-3.35.411	Structural Iron and Steel	10	3	0.20	0.0700
	Construction Labor Module of the appropriate type	8	7	0.50	0.1750
				1.00	0.3500

It remains only to expand the only modular item in Table 9-4, the CONSTRUCTION LABOR MODULE (Factor 0.50). This is done in Table 9-5.

TABLE 9-5

CONSTRUCTION LABOR MODULE
(of the appropriate type)

Input Code Used in This Study (1)	Input (2)	Leadtime Months Mean (3)	Leadtime Months Range/2 (4)	Factor (5)	As Factor* of Table 9-1 (5) x 0.50 x 0.35 = (5) x 0.175 (6)
0-7-91.15	Bricklayers construction	12	3	0.50	0.0875
0-7-99.25	Roofers	8	4	0.30	0.0525
0-8-99.30	Laborers, heavy physical work	8	8	0.20	0.0350
				1.00	0.1750

*Note that this module has a factor of 0.50 in the Building Module (Table 9-4). The latter, in turn, has a factor 0.35 with respect to Table 9-1. 0.50 x 0.35 = 0.175.

The process of fitting the simple inputs and modules together is illustrated graphically in Figure 9-1. It shows how various component inputs converge, some directly and some through one or more modular stages, to yield the project's total final demand for inputs.

Table 9-6 shows the proportionate values of all inputs required by the project. It is obtained by totalling the proportionate values of inputs resulting from the stage-by-stage expansion of modular tables 9-1 to 9-5.

FIGURE 9-1

INPUT CONFIGURATION

Corresponding to Tables 9-1 to 9-5

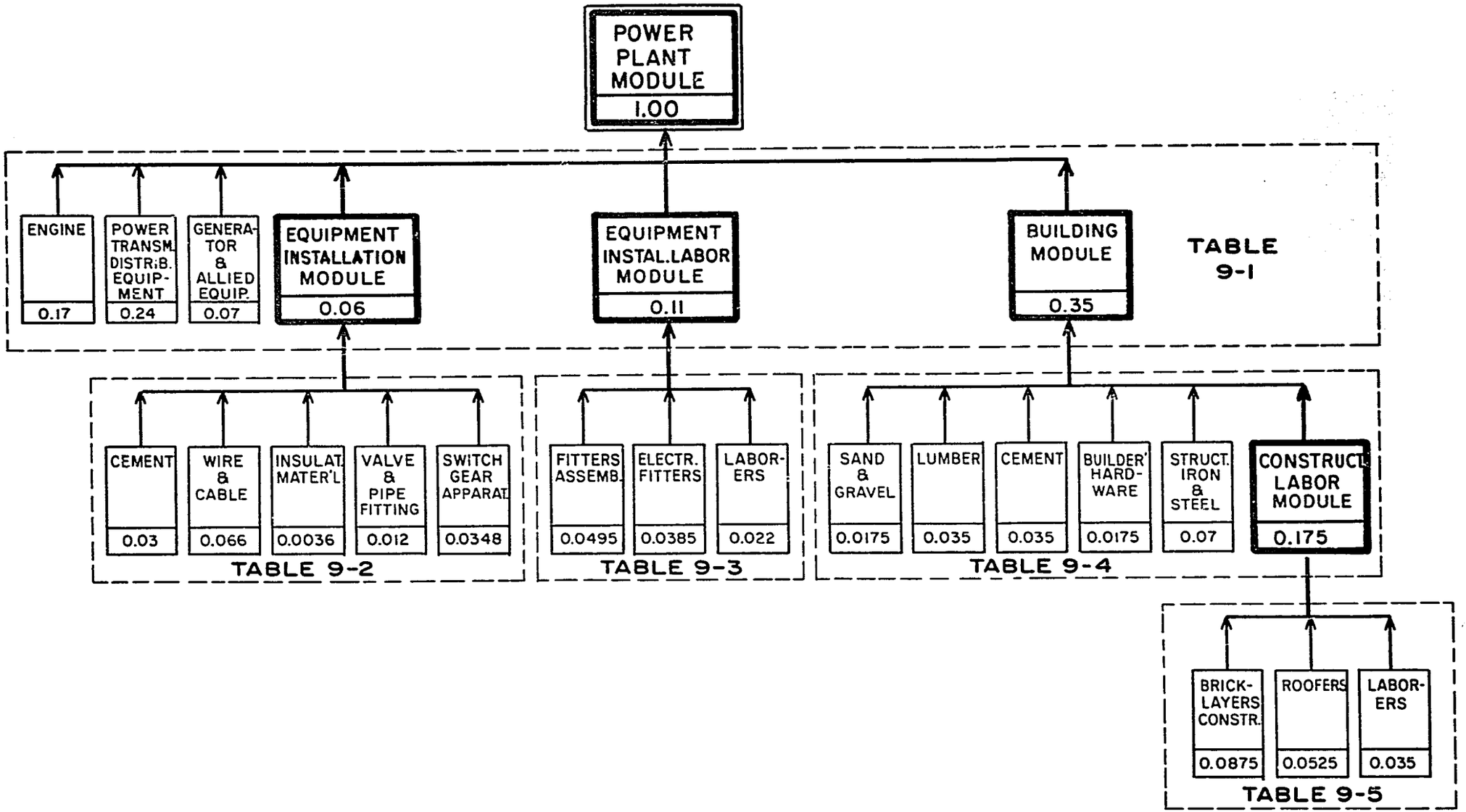

TABLE 9-6

FINAL PROPORTIONS OF DEMAND FOR INPUTS
(Resulting from expansion of modular Tables 9-1 to 9-5)

Input Code Used in This Study (1)	Input (2)	Leadtime Months Mean (3)	Leadtime Months Range/2 (4)	Factor (5)	Cost in Dollars (5) x 150,000 (6)
0-7-52.50	Fitter Assemblers, internal combustion engineers	6	6	0.0495	7,425
0-7-62.15	Electrical Fitters, motors and dynamos	9	5	0.0385	5,775
0-7-91.15	Bricklayers, construction	12	3	0.0875	13,125
0-7-99.25	Roofers	8	4	0.0525	7,875
0-8-99.30	Laborers, heavy physical work				
	0.0350	8	8	0.0350	5,250
	0.0220	7	7	0.0220	3,300
2-2.421	Sand and Gravel	9	6	0.0175	2,625
2-3.25.212	Lumber	9	7	0.0350	5,250
2-3.33.410	Cement 0.0350	12	3	0.0350	5,250
	0.0030	11	4	0.0030	450
2-3.35.294	Builders' Hardware	8	7	0.0175	2,625
2-3.35.411	Structural Iron and Steel	10	3	0.0700	10,500
2-3.35.578	Wire and Cable	10	5	0.0066	990
2-3.39	Insulation materials	5	2	0.0036	540
3-3.36.192.10	Diesel Engine	7	2	0.1700	25,500
3-3.36.197	Valve and Pipe Fittings	10	5	0.0120	1,800
3-3.37.12	Power Transmission/ Distribution eqpt.	7	6	0.2400	36,000
3-3.37.131	Switchgear Apparatus	9	5	0.0348	5,220
3-3.37.21	Generator and allied equipment	6	3	0.0700	10,500
		Total		1.0000	150,000

Previously we have dealt with proportions in which different inputs participate in the total project. The next step, to absolute figures, is a simple one. It relates an input (or a group of inputs) of major importance to the ultimate function of the project and to the measure, in absolute terms, in which this function will be performed. In our example of a power plant, the function is to furnish a given amount of electric power to be determined by the size and structure of the irrigation system to which the power plant belongs. Thus, simple engineering calculations will establish that the task requires a certain strength of diesel engine and electric generator ensemble. Let us suppose that the approximate cost of such an ensemble (machinery only, without accessories and installation) is $36,000, consisting of $25,500 for the engine and $10,500 for the generator. (This is consistent with the ratio of 0.17:0.07 of respective factors of these pieces of equipment.) Then, having established the expected cost of the two crucial components of the project, we obtain the estimated total cost of the project:

$$\frac{36,000}{0.17 + 0.07} = 150,000 \text{ dollars}$$

The factor values of the various inputs will determine their part in the above total. These amounts are shown in Table 9-6, Column 6.

9.22 INPUT TIMING

The capacity expansion technique also enables us to make an approximate measurement of the time period required to apply each of the project inputs during the implementation period. This measure is given by entries in Columns 3 and 4, Tables 9-1 through 9-6. These entries are explained on page I-3.13 of Capacity Expansion Planning Factors[4] as follows:

> The Mean Leadtime is the average time in months prior to the completion of a plant in operating condition, by which the material, equipment, or manpower defined by the input item is needed on the plant site. The Leadtime Semi-Range (shown in the table as Range/2) is the range in months before and after the mean leadtime during which the input item is needed on the plant site. It is implicitly assumed that the quantity defined by the input factor should arrive on the plant site at an approximately uniform rate, starting at the mean leadtime plus the semi-range and ending at the mean leadtime minus the semi-range, measured in months prior to the date at which the plant is to be ready for operation.
>
> For example, the mean leadtime for a specific input may be 4.50 months. This means that half of this input must be on the plant site 4.5 months before completion of plant construction. The semi-range may be 2.50 months. This means that the start of this input would be 4.50 + 2.50 months, or 7.00 months before completion of plant construction, and, that completion of this input would be 4.50 - 2.50 months, or 2.00 months before completion of plant construction.

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[4] Ibid.

Table 9-7, TIME-PHASED FACTOR DISTRIBUTION, has been prepared to show the method of distributing the input factors within the monthly project framework, which is estimated to take 16 months from start of construction to completion.

It will be observed that a listing of input item factors with their mean and semi-range leadtimes in months are transferred from Table 9-6 to Columns 1, 2, and 3 of Table 9-7, TIME-PHASED FACTOR DISTRIBUTION. Column 4, Range, of this table represents the total months in which the item is active and is derived by multiplying the months in Column 3 by two. Column 5 represents the months in which the item's first leadtime month occurs and is derived by subtracting the months, semi-range, Column 3, from its mean month, Column 2. Input item factors of Table 9-6, Column 5, are transferred to their respective positions in Column 6 of Table 9-7, TIME-PHASED FACTOR DISTRIBUTION. Next, the average monthly factor, Column 7, of the distribution table, is computed by dividing the total factor, Column 6, by the months in which the item is active, Column 4.

The average monthly factor, by item, is distributed within the project's monthly time frame. It is well to add the monthly factors for labor and for material and equipment separately before totalling them. Moreover, each of these monthly figures should be cumulated.

TABLE 9-7

TIME-PHASED FACTOR DISTRIBUTION

Item	Leadtime Mean	Leadtime Range/2	Leadtime Range	Leadtime Complete	Factor	Avg Mo. Factor	Construction Start	Leadtime Month 16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Construction Completion
(1)	(2)	(3)	(4)	(5)	(6)	(7)																		
	From Table 9-6		(3)×2	(2)−(3)	From Table 9-6	(6)·(4)																		
LABOR																								
Mechanics	6	6	12	0	.0495	.0041						.0044	.0041	.0041	.0041	.0041	.0041	.0041	.0041	.0041	.0041	.0041	.0041	
Electrician	9	5	10	4	.0385	.0039				.0034	.0039	.0039	.0039	.0039	.0039	.0039	.0039	.0039	.0039					
Bricklayer	12	3	6	9	.0875	.0146			.0145	.0146	.0145	.0146	.0146	.0146										
Roofer	8	4	8	4	.0525	.0066						.0063	.0066	.0066	.0066	.0066	.0066	.0066	.0066					
Laborer (1)	8	8	16	0	.0350	.0022		.0020	.0022	.0022	.0022	.0022	.0022	.0022	.0022	.0022	.0022	.0022	.0022	.0022	.0022	.0022	.0022	
(2)	7	7	14	0	.0220	.0016				.0012	.0016	.0016	.0016	.0016	.0016	.0016	.0016	.0016	.0016	.0016	.0016	.0016	.0016	
Percent-Month								.0020	.0167	.0214	.0223	.0330	.0330	.0330	.0184	.0184	.0184	.0184	.0184	.0079	.0079	.0079	.0079	
-Cumulated								.0020	.0187	.0401	.0624	.0954	.1284	.1614	.1798	.1982	.2166	.2350	.2534	.2613	.2692	.2771	.2850	
Dollars-Month								300	2505	3210	3345	4950	4950	4950	2760	2760	2760	2760	2760	1185	1185	1185	1185	
-Cumulated								300	2805	6015	9360	14310	19260	24210	26970	29730	32490	35250	38101	39195	40380	41565	42750	
MATERIAL & EQUIPMENT																								
Sand	9	6	12	3	.0175	.0015			.0010	.0015	.0015	.0015	.0015	.0015	.0015	.0015	.0015	.0015	.0015	.0015				
Lumber	9	7	14	2	.0350	.0025		.0025	.0025	.0025	.0025	.0025	.0025	.0025	.0025	.0025	.0025	.0025	.0025	.0025	.0025			
Cement (1)	12	3	6	9	.0350	.0058			.0058	.0058	.0058	.0058	.0058	.0060										
(2)	11	4	8	7	.0030	.0004			.0002	.0004	.0004	.0004	.0004	.0004	.0004	.0004								
Hardware	8	7	14	1	.0175	.0013			.0006	.0013	.0013	.0013	.0013	.0013	.0013	.0013	.0013	.0013	.0013	.0013	.0013	.0013		
Iron & Steel	10	3	6	7	.0700	.0117					.0115	.0117	.0117	.0117	.0117	.0117								
Wire & Cable	10	5	10	5	.0066	.0007			.0003	.0007	.0007	.0007	.0007	.0007	.0007	.0007	.0007	.0007						
Insulation	5	2	4	3	.0036	.0009											.0009	.0009	.0009	.0009				
Diesel Engine	7	2	4	5	.1700	.0425									.0425	.0425	.0425	.0425						
Pipe	10	5	10	5	.0120	.0012			.0012	.0012	.0012	.0012	.0012	.0012	.0012	.0012	.0012	.0012						
Transformer	7	6	12	1	.2400	.0200					.0200	.0200	.0200	.0200	.0200	.0200	.0200	.0200	.0200	.0200	.0200	.0200		
Switchgear	9	5	10	4	.0348	.0035				.0033	.0035	.0035	.0035	.0035	.0035	.0035	.0035	.0035	.0035					
Generator	6	3	6	3	.0700	.0117									.0115	.0117	.0117	.0117	.0117	.0117				
Percent-Month								.0025	.0116	.0167	.0484	.0486	.0486	.0488	.0968	.0970	.0858	.0858	.0414	.0379	.0238	.0213	-	
-Cumulated								.0025	.0141	.0308	.0792	.1278	.1764	.2252	.3220	.4190	.5048	.5906	.6320	.6699	.6937	.7150	.7150	
Dollars-Month								375	1740	2505	7260	7290	7290	7320	14520	14550	12870	12870	6210	5685	3570	3195		
-Cumulated								375	2115	4620	11880	19170	26460	33780	48300	62850	75720	88590	94800	100485	104055	107250	107250	
TOTAL																								
Percent-Month								.0045	.0283	.0381	.0707	.0816	.0816	.0818	.1152	.1154	.1042	.1042	.0598	.0458	.0317	.0292	.0079	
-Cumulated								.0045	.0328	.0709	.1416	.2232	.3048	.3866	.5018	.6172	.7214	.8256	.8854	.9312	.9629	.9921	1.0000	
Dollars-Month								675	4245	5715	10605	12240	12240	12270	17280	17310	15630	15630	8970	6870	4755	4380	1185	
-Cumulated								675	4920	10635	21240	33480	45720	57990	75270	92580	108210	123840	132810	139680	144435	148815	150000	

It may be noted that labor cost is 28.5 per cent of the total project cost, and material and equipment represents the balance 71.5 per cent.

Likewise, we see that at 50 per cent of time, or at the end of the eighth month, the following cumulated inputs have been planned:

	Cumulated Factor at 50% Time	Cumulated Factor at 100% Time	Per Cent Expenditure at 50% Time
Labor	18.0	28.5	63%
Material & Equipment	32.2	71.5	45%
Total	50.2	100.0	50%

When the monthly and cumulated distributed factors are all multiplied by the total project cost, $150,000, the monthly and cumulated expenditures are then entered in the appropriate position on the table.

These expenditures are then transferred to a schedule of cash requirements for the project. Thus, the important information concerning when cash is needed to construct the project is shown in Table 9-8, ESTIMATED CASH REQUIREMENTS. This table is constructed on the basis of accounting payrolls and material and equipment invoices.

TABLE 9-8

ESTIMATED CASH REQUIREMENTS

Month Following Start of Construction	Labor Payroll		Material and Equipment Invoices		Total Cash Requirements	
	Month	Cumulated	Month	Cumulated	Month	Cumulated
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	300	300	375	375	675	675
2	2505	2805	1740	2115	4245	4920
3	3210	6015	2505	4620	5715	10635
4	3345	9360	7260	11880	10605	21240
5	4950	14310	7290	19170	12240	33480
6	4950	19260	7290	26460	12240	45720
7	4950	24210	7320	33780	33780	57990
8	2760	26970	14520	48300	17280	75270
9	2760	29730	14550	62850	17310	92580
10	2760	32490	12870	75720	15630	108210
11	2760	35250	12870	88590	15630	123840
12	2760	38010	6210	94800	8970	132810
13	1185	39195	5685	100485	6870	139680
14	1185	40380	3570	104055	4755	144435
15	1185	41565	3195	107250	4380	148815
16*	1185	42750	-	107250	1185	150000

*Completion

It is advisable to consolidate the rate of expenditures for labor and for material and equipment over time in order to observe the logic of synchronizing both types of inputs. This can be done best by converting inputs and time percentages as illustrated in Table 9-9 and accompanying Chart 9-1.

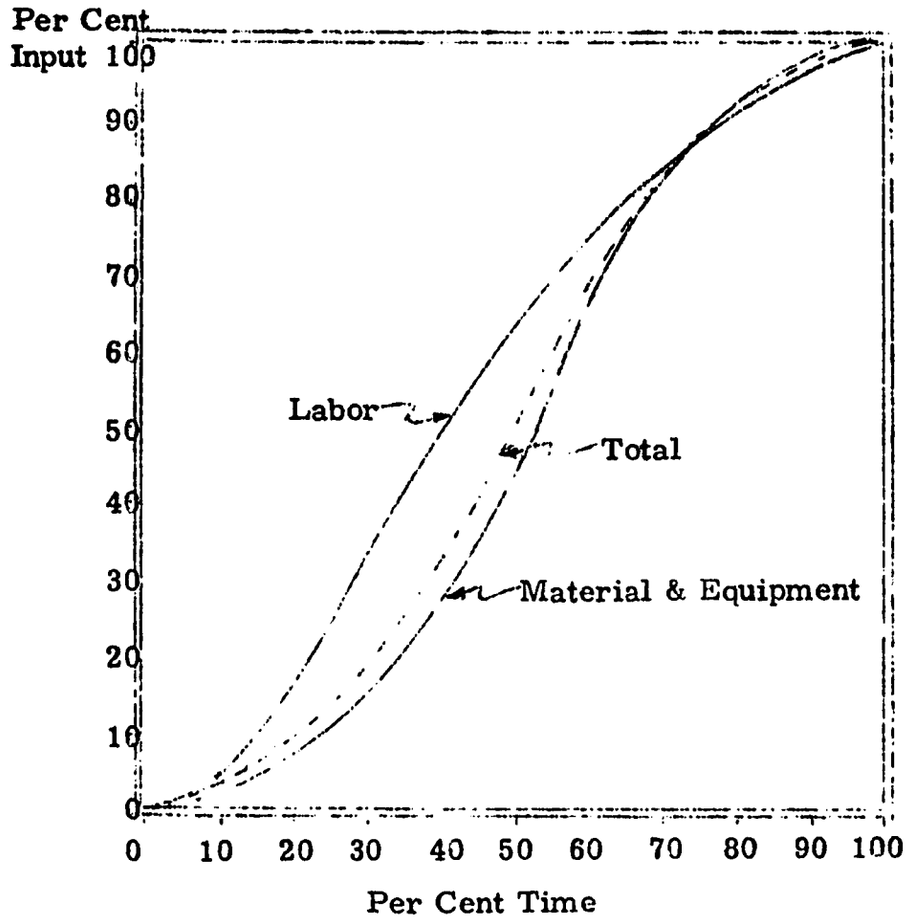
TABLE 9-9

PER CENT INPUT

% Time	Labor 28.5		Mat'l & Equip. 71.5		Total 100.0	
	Interval	Cum.	Interval	Cum.	Interval	Cum.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
10	3.5	3.5	1.8	1.8	2.3	2.3
20	12.1	15.6	4.2	6.0	6.4	8.7
30	16.1	31.7	10.2	16.2	11.9	20.6
40	18.1	49.8	11.8	28.0	13.6	34.2
50	13.3	63.1	15.0	43.0	14.5	48.7
60	10.3	73.4	23.8	66.8	20.0	68.7
70	9.8	83.2	17.1	83.9	15.0	83.7
80	8.0	91.2	8.9	92.8	8.6	92.3
90	4.5	95.7	5.0	97.8	4.9	97.2
100	4.3	100.0	2.2	100.0	2.8	100.0

CHART 9-1

PER CENT INPUT



From the chart, we can see that labor is demanded earlier than material and equipment for the reason that the major equipment items (engine, transformers, and generator) arrive fairly late in project construction, and these items represent major expenditures of the project cost. Labor cost to install these items is based on a relationship 17 cents of labor per dollar of equipment. This is contrasted to labor cost to building material cost ratio of $1.20 labor per dollar of building material.

Table 9-10 shows time-phased ratios of labor cost to material and equipment cost. The ratios were derived from input time-phasing.

TABLE 9-10

RATIO LABOR TO MATERIAL AND EQUIPMENT

(1)	(2)	(3)	(4)	(5)	(6)	(7)
%	Labor Expenditures		Material & Equipment Expenditures		Ratio Labor to Mat'l & Equip.	
Time	Interval	Cum.	Interval	Cum.	Interval	Cum.
					(2) : (4)	(3) : (5)
10	1500	1500	1930	1930	.78	.78
20	5170	6670	4500	6430	1.15	1.04
30	6880	13550	10940	17370	.63	.78
40	7740	21290	12650	30020	.61	.71
50	5680	26970	16090	46110	.35	.58
60	4400	31370	25530	71640	.17	.44
70	4190	35560	18340	89980	.23	.40
80	3420	38980	9550	99530	.36	.39
90	1920	40900	5360	104890	.36	.39
100	1850	42750	2360	107250	.78	.40

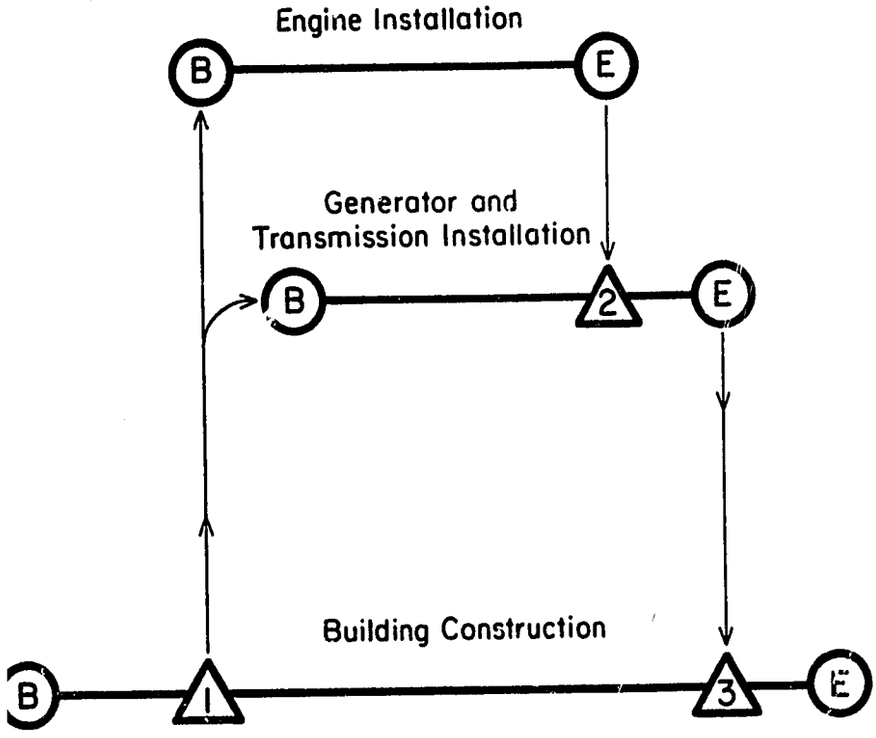
9.23 ACTIVITY NETWORK PRESENTATION

Let us note now that various modules are structured in a manner which largely reflects their technological function in the project implementation process. This format is thus amenable to an admittedly rough and highly approximative presentation by means of network diagrams. Figure 9-2 shows how such a presentation can be done. Note here that the technological interdependencies, already implied in the structure of leadtimes, can be made more explicit by introducing a few milestones. Each of these milestones corresponds to a technological event and is of key importance because it serves to trigger some dependent activity or activities.

It is worth recalling that the modular technique is most useful in the planning stage, when various alternatives are compared and accepted or rejected. As yet, we are not too interested in the precise networks of technological interdependencies. They become crucial only later during the implementation phase. Then there is a need to project all minutiae of interrelated activities.

FIGURE 9-2

ACTIVITY NETWORK - POWER PLANT CONSTRUCTION



MILESTONES:

1 Building sufficiently advanced to allow start of installation of engine and generator

2 Event in generator installation preconditioned by end of engine installation

3 An event in building construction preconditioned by end of generator and transmission installation

9.300 HOW TO EXPLOIT THE MODULAR CONCEPT

9.31 NATIONAL PLAN

The modular technique, based on statistical averages of typical projects, permits certain choices to be made on a sectoral or national plan level without necessitating the time-consuming individual project studies. Suppose, for example, a situation in which a national plan provides for a total of forty million monetary units to be allocated between two competing groups of projects, one for food processing and another for metal working. Suppose further that, on the basis of the accepted philosophy of priorities, the planning agency is inclined to divide its resources equally between these groups, i.e., twenty million to each, unless such division would greatly strain the available engineering skills and foreign exchange reserves.

A rapid application of the expansion factors and the leadtimes of inputs and input modules, appropriate for each project group, will yield their respective input demand schedules evaluated for the level of twenty million monetary units. If it is then found that one group places too high a demand on engineering skill or foreign exchange during the relevant time period, an alternative allocation can be tested of, say, fifteen million for the high-demand project group as against twenty-five million for the less demanding project group.

In this manner, the plan and its component sectors can be studied, modified, and finally selected by means of the same measurement concepts that will later be used for the detailed programming and implementation of specific projects. At the same time, there is no need for time-consuming detailed elaboration of specific projects in the initial planning stage. These merely waste the scarce human resources of skilled project planners.

9.320 MODULAR TECHNIQUE IN PLAN AND PROJECT IMPLEMENTATION

9.321 Once the definitive choice and approval of projects for implementation is made, the modular technique can become a very helpful tool for the project planning and management. Indeed, a skillful project manager and planner should be able to use it in three different ways to maximize the chances of success of the project.

9.322 "Rolling Refinement of Programming"

No project can ever be executed according to a completely rigid time schedule. A host of contingencies, both natural (weather, unexpected geological situation, etc.) and socio-economic (changes in prices, in availability of resources, delays of delivery, accidents, etc.), constantly affect implementation. The more distant a future point on an

activities network, the greater the uncertainty with respect to its actual timing and the input demand associated with it. The manager of a complex, long-range project ought to be aware of the possibility that entirely new activities may appear later that could never have been foreseen in the original planning stage, let alone specified in detail. To draw again on our example of the irrigation project: a geological fault anywhere near the rim of the plateau where the main water transmission canal is to be excavated may necessitate a new activity of subsoil consolidation which was not contemplated in the original network.

It would be an absurdly wasteful procedure to start by elaborating the whole network in great detail, both with respect to input schedules and to timing, and then have to rework constantly the planning document in the light of new contingencies. Clearly, a more flexible method of work is called for. This is where the modular technique can be used to advantage in combination with the technique of networks and input schedules.

A rational method of proceeding with a project is to start with modular calculations and presentation. In this format, the average project can be tested by means of feasibility studies and cost/benefit studies. Moreover, it can be considered as a candidate for inclusion in various sectors of the national plan. As shown above, the fundamental questions concerning a project's ranking with respect to the strategic priorities of

the resource allocation can be answered on the basis of the input demands and their timing, implied by the configuration of modules in the project. The modular format of presentation is also sufficiently precise to articulate projects extending over a number of years into annual development budgets.

Once a project becomes part of the plan and the beginning calendar date of its implementation is set, the time comes to start gradually refining simplified modular networks into detailed activities networks for actual implementation. However, this stage of programming can also be made flexible. In projects of considerable duration, the programming of detailed networks extending far into the future can proceed stage by stage as implementation progresses. Consequently, the feasibility of executing such programmed activities is strengthened by the work already done.

In a project with a four-year planned implementation time, like the irrigation one discussed throughout this study, the management could carry on the "evolving refinement" of programming in one-year stages. This manner of proceeding is also to be recommended because such a project encompasses a full cycle of seasons, and the latter in large measure determines the rhythm of works. Furthermore, in certain climates, a passage of the rainy season and the changes wrought by it in the

features of the earth's surface may determine to a large extent which activities can be executed in the following twelve months. Thus, each year a consecutive stage of the project will be drawn from the broadlined modular format and programmed into detailed activities network. Figure 9-3 illustrates this process of "rolling refinement" of project programming.

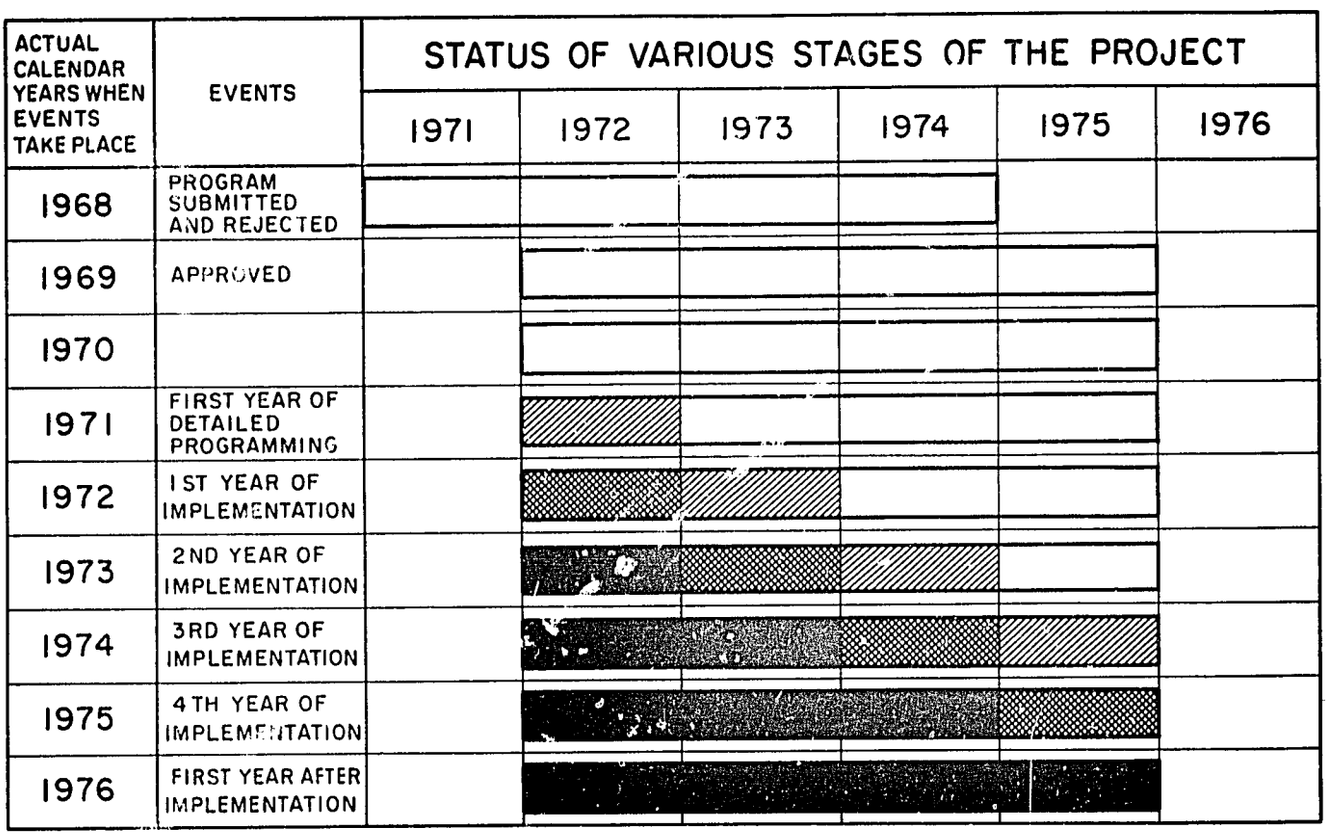
9.323 Estimates of Contractors' Inputs

In the foregoing text (Chapter VII-3), we noticed a major difficulty that planners are likely to meet in their efforts to estimate amounts and timing of various inputs. This problem appears when parts of projects are slated to be implemented wholly by outside contractors. It is reasonable to doubt whether in all cases a programming discipline could be imposed on these contractors to such an extent that they would elaborate activities networks and input-and-cost schedules with sufficient precision and clarity so that they could be aggregated and used to forecast input requirements, along with the documents prepared under the direct supervision of planning agencies.

This difficulty could be greatly relieved if tables of modular input demands for typical components of development projects were made available. Such a body of data, if based on constantly accumulating

FIGURE 9-3

"ROLLING REFINEMENT" OF PROJECT PROGRAMMING



Prepared in modular format

Prepared in detailed format

Being implemented

Completed *(actual figures being compared with programmed figures and with cost benchmarks, for evaluation).*

experience and updated continually, would serve the planning agencies to calculate rapidly the approximate input-demands, without having to try to impose advanced estimating techniques prematurely on enterprises which, while technically competent, may not yet possess the required programming know-how.

9.324 Advance Procurement

Even though it may not be possible to program certain project activities in detail until long after the initiation of the implementation stage, this need not cripple major procurement decisions. Important items that are due to be installed late in the project, such as heavy machinery, generators, costly instrumentation, etc., will be indicated with sufficient clarity in the early modular format. Thus, procurement will be able to place timely orders for these items. Once their scheduled delivery dates are assured, the dovetailing of complementary activities of installation, etc., will be done at the time when, under the method of "rolling refinement," the respective stage of implementation becomes ripe for the detailed activity programming.

9.33 HEURISTIC VALUE OF MODULAR TECHNIQUES

There are no perfect managers in this world, as there are no perfect physicians or engineers. It is only to be expected that a project planner and project manager, working often under pressure and in unauspicious conditions, will be likely to commit errors in programming a project. Where experience with projects of a given type is scanty, errors of omission are likely. Overly-optimistic time schedules are set, the resources needed for particular activities are underestimated, and even sometimes whole activities are forgotten. Such errors, of course, make it necessary for the planner to improvise as best he can later and sometimes permanently damage the effectiveness of the project.

If planners had access to detailed modular tables that indicated the fundamental technological structure of the project, its elements and its inputs ordered in meaningful subtotals, this would constitute an invaluable check list" of necessary steps of planning. To an intelligent planning and management team it would be a most powerful instrument to minimize the ever present danger of costly errors of omission.

9.400 WORK TO BE DONE IN APPLICATION OF MODULAR TECHNIQUES

9.41 FUNDAMENTAL CLASSES OF PROJECTS

In the foregoing sections, we have presented a case in support of using the modular approach to project design as a means of significantly improving the effectiveness of development planning. What is needed now is to extend the modular technique from the category of manufacturing industry project, to which it is as yet restricted, onto other categories of development projects.

Two fundamental classes of projects have to be distinguished in this attempt to apply the technique in question:

- Projects resulting in permanent physical assets.
- Projects consisting of campaign-type efforts.

This distinction has been made already in an earlier chapter. There we found that despite the apparent difference between the two classes, the network technique as well as that of input-and-cost schedule could be applied successfully in both of them. The same is true of the modular technique.

9.420 PROJECTS RESULTING IN PERMANENT PHYSICAL ASSETS

9.421 Technical Approach

The great variety of efforts to increase a nation's welfare by a judicious accumulation of fixed productive capital--an investment plan--becomes meaningful from both an economic and technological viewpoint when these efforts are classified by their function in satisfying human needs. This is the same principle which underlies the structure of Gross National Product accounts. With a few modifications, it can be also applied to the widely used standard industrial classification. In the light of this principle, the picture of economic endeavors over the different areas of the world becomes much clearer and easier to comprehend. It can be seen then that a relatively small number of basic functional categories exhaust the bulk of all important projects.

When we further analyze the technological contents of the great mass of projects, we find again that they can be reduced to a fairly limited number of basic elements, typical for given project categories (like dams and canals in all irrigation works, etc.) or even for large groups of categories (like power plants, general purpose buildings, etc.). These elements are repetitive; we come across them in project after project and even in category after category. A simple reflection suggests that we have

found an important opportunity: the modular technique applied here is bound to reap great economies in time and effort of scarce skilled talent.

The following pages present the guidelines for elaboration of a compendium of modules, a basic store of "building blocks," which could be applied for the benefit of development projects.

A list of candidate physical facility input modules is suggested for (1) Specialized buildings, (2) Specialized fixed on-site equipment, (3) Specialized mobile equipment, and (4) Specialized facilities for each of 16 major functional sectors (excluding manufacturing). The input list of modules is by no means complete but is represented as an initial listing of significant capital investment modules which are highly characteristic of each major economic sector, exception noted. Specifics of the modular input composition are beyond the scope of this analysis; however, the logic of modular input structuring is explained in Capacity Expansion Planning Factors[5] and can be developed by the user of this list from published engineering and other available statistical literature.

Analytical procedures with associated criteria for separation of functional sectors and input modules follow.

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[5] Ibid.

9.422 Functional Sectors

The first procedure involved the selection of a list of economic activities bracketing the national economy. The Standard Industrial Classification Manual (SIC)[6] provided useful guidance in separating the economy into major sectoral groups. This modular analysis generally conformed to these SIC major groupings of establishments but differed in several important respects.

(a) Definition of major sectors in this analysis was governed by functions rather than by SIC's nominal establishment classification. For example, in this analytical composition of functional sectors, natural gas pipeline transmission was placed in the Transportation sector. SIC classified this industry in the Gaseous Fuels sector. The transfer of gas pipeline transmission from Gaseous Fuels sector to the Transportation sector was entirely consistent with SIC classification of oil pipeline transmission in the Transportation sector. Both oil and gas transmission pipelines will thus be found in the Transportation sector of this analysis.

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[6] Standard Industrial Classification Manual, 1967, U. S. Bureau of the Budget, Executive Office of the President.

(b) This analysis of major sectors ignored ownership which characterizes the SIC. For example, housing will be found in SIC groups: Agriculture, Construction, Real Estate, and Government. This analysis reclassified all housing under one major sector, Housing. This reclassification appears to be more aligned with contemporary input-output analytical classifications. One of these found in the final demand sector of basic transactions tables is Households. The inputs to Households, by rudimentary economics, are food, clothing, and shelter. Evidence in support of this concept is found in Development Planning.[7] This fundamental is exercised in the functional composition of major sectors of this analysis.

(c) The third pertinent distinction between SIC and this analysis involved the transfer of some government activities from the SIC Government sector to functional sectors in this analysis. For example, postal activities were transferred from the SIC Government sector to the Communications sector of this analysis.

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[7] W. Arthur Lewis, Development Planning, The Essentials of Economic Policy (New York: Harper & Row, 1966), pp. 210-221.

In summary, this functional sectoring resulted in 17 groups:

1. Agriculture
2. Forestry
3. Fisheries
4. Mining
5. Manufacturing
6. Transportation
7. Communications
8. Electric Power
9. Gaseous Fuels
10. Water
11. Sanitation
12. Wholesale Trade
13. Retail Trade
14. Finance, Insurance, Real Estate
15. Services
16. Government
17. Housing

9.423 Candidate Input Modules

It is presumed that the reader by this time is acquainted with the principles of modular analysis of the Manufacturing Sector which were explained earlier in this chapter. A very brief review of modularized Manufacturing appears appropriate to place in perspective the suggested list of candidate input modules covering the balance of the economy.

The modularization of the Manufacturing sector capital stock was achieved primarily by separating those facilities which were common to many or all industries from those facilities which were specifically characteristic of each manufacturing industry.

Those facilities which were found in many or all industries were expressed in the commonality of function performed. To illustrate by example:

Auxiliary Facilities Module	Plant Function
Water	Production, treatment, storage of water
Steam Generating	Production of steam
Electrical Generating/Transforming	Generation and transformation of electrical power
Electrical Transforming	Transformation of purchased electrical power
Air	Production of compressed and treated air
Refrigerating and Cooling	Production of coolents for product or environment
Industrial Gas - Build	Production, storage of industrial gases
Industrial Gas - Buy	Storage of purchased industrial gases
Product Storage - Solids	Storage of solids products
Product Storage - Fluids	Storage of fluids products
Waste Disposal	Collection and disposal of wastes
Administration and Shops	Administration and maintenance
Control Laboratories	Quality control of product
Dock	Water transportation

Auxiliary Facilities Module	Plant Function
Off-Site Vehicle Operation	Land transportation, off-site
Plant On-Site Outside Lines	Interconnection of pipe and electrical lines
Plant On-Site General Facilities	Roads, walks, railroad spurs, etc.

If a specific industry required the function of any of the foregoing common Auxiliary Facilities Modules, a demand coefficient was placed for the module and included in the total plant capital requirement.

Those facilities which were specifically characteristic of each manufacturing industry were grouped under the broad class of inputs, termed process component. Each industry process component thus contained specialized equipment (fixed or mobile), buildings, and facilities, such as the extensive railroad systems typical of the larger logging establishments.

It is primarily this desire to identify specialized buildings, fixed or mobile equipment, and other facilities which governed the composition of candidate input modules for all other economic sectors. Common modules in this analysis are omitted but may be added by the user of this system according to his judgment of group demands for such common modules. Guides for appraising common modules will be found in the previously referenced publication, Capacity Expansion Planning Factors.[8]

Examples of each type of specialized input modules are given below, referenced to the Agriculture sector of Table 9-11, CANDIDATE CAPITAL INPUT MODULES, which follows these examples.

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[8]Robert M. Waddell, et al, Capacity Expansion Planning Factors (Washington, D. C.: Economic Programming Center, National Planning Association, 1966).

(1) Specialized Buildings

Hothouse Module

This type of building, not found in the list of 35 manufacturing buildings published in Capacity Expansion Planning Factors, consists of foundations usually concrete; frame of wood or light structural metal, open to hold glass panels; pitched roof of light structural metal, open to hold glass panels; glass panels; enclosing wooden tables and bins, water sprinkling system, electric lighting systems, ventilating fans, and radiators or electrical heaters. Equipment associated with the hothouse is a hot water or steam generator, and perhaps an air cooler.

(2) Specialized Fixed, On-Site Equipment

Animal Feeding Module

This package of specialized equipment includes mechanical feeding machines for livestock, such as electric powered bulk feeders, chicken feeders, hog feeders, etc., and their associated conveyors.[9]

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[9] 1963 Census of Manufactures, U. S. Department of Commerce, Bureau of the Census.

(3) Specialized Mobile Equipment

Clearing Land Module

This package of specialized equipment includes bulldozers, graders, land levelers, rollers, and hand tools such as augers, saws, sledges, and wedges.[10]

(4) Specialized Facilities

Irrigation Water Distribution Module

This package of pumping stations and distribution canals includes the construction of sheds with associated pumping equipment, initial distribution waterways, piping, and sprayers constituting the irrigation system on the farm site.[11]

The foregoing examples of modular inputs are given to assist the user of this analysis in the preparation of his modular input structure. The comprehensive Table 9-11, CANDIDATE CAPITAL INPUT MODULES BY MAJOR FUNCTIONAL ECONOMIC SECTORS, follows.

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[10] Ibid.

[11] Ibid.

TABLE 9 - 11 (page 1 of 3)

CANDIDATE CAPITAL INPUT MODULES BY MAJOR FUNCTIONAL ECONOMIC SECTOR

Separated into (1) Specialized Buildings, (2) Specialized Fixed, On-Site Equipment, (3) Specialized Mobile Equipment and (4) Specialized Facilities for each Major Functional Sector

Functional Sector	Specialized Buildings	Specialized Equipment: Fixed, On-Site	Specialized Equipment: Mobile	Specialized Facilities
1. Agriculture Production of crops or plants; vines or trees (exc. forestry); & in keeping, grazing, feeding of livestock for animal products, for animal increase, or value increase	Hothouses Smokehouses Barns Silos Incubators	Animal feeding Product extraction Product processing Power Water supply Water distribution	Clearing land Plowing, fertilizing, planting cultivating, harvesting Pesticide control Product & material transportation	Irrigation water distribution Forest windbreak Dike Impounding reservoirs and dams
2. Forestry Operation of timber tracts, nurseries, & related activities	Greenhouses	Nursery Latex concentration Gum concentration Seed extraction	Fire-fighting trucks Fire-fighting airplanes Road construction & maintenance vehicles	Fire look-out Fire trails Fire breaks
3. Fisheries Commercial fishing, oyster farms, sponges, seaweed, etc.	None	Fish hatching Fish processing Oil Extraction	Ships Boats Diving gear	Oyster beds Pear cultivation beds
4. Mining Extraction of minerals, both solids & liquids. Includes quarrying, well operation, milling & other preparation needed to make material marketable.	Tipples	Solids extraction Liquids extraction Gaseous extraction Solids treatment Fluids treatment Control instrumentation	Solids extraction Fluids extraction	Derricks Exploration Off-shore towers
5. Manufacturing (Reference: "Capacity Expansion Planning Factors," 1966)				
6. Transportation Passenger & freight transportation by railway, highway, water, air, or pipelines	Railroad stations Traffic control stations Maintenance & repair shops Airports Hangers	Traffic control Communications Pumping	Railroad locomotives & cars Passenger motor vehicles Freight trucks & trailers Ships, boats & barges Airplanes Maintenance & repair vehicles	Rail trackage, bridges, tunnels & viaducts Highways, bridges, tunnels, & viaducts Airfields Transmission pipelines

TABLE 9 - 11 (page 2 of 3)

CANDIDATE CAPITAL INPUT MODULES BY MAJOR FUNCTIONAL ECONOMIC SECTOR

Functional Sector	Specialized Buildings	Specialized Equipment: Fixed, On-Site	Specialized Equipment: Mobile	Specialized Facilities
7. Communications Telephone, telegraph, radio, television, radar, and postal communications	Post Offices	Telephone exchange Telegraph exchange Radio transmission & receiving Television transmission Radar transmission & receiving Postal sorting & delivery	Radio transmitting vehicles Television transmitting vehicles Telegraph delivery vehicles Postal collection & delivery vehicles Construction vehicles Maintenance & repair vehicles Telephones	Telephone lines Telegraph lines Radio broadcasting towers Television broadcasting towers Radar transmitting & receiving towers
8. Electric Power Generation, transmission & distribution of electricity to the public	None	Fuels storage and handling Steam production Water power Nuclear power Electrical generation Electrical transformation Switchgear Control instrumentation	Construction vehicles Maintenance & repair vehicles Customer meters	Transmission lines Distribution lines
9. Gaseous Fuels Production, & distribution of gaseous fuels & derived products	None	Manufactured gas processing Liquidified gas processing Above-ground storage Control instrumentation	Liquidified gas cylinders Tank-truck vehicles Construction vehicles Customer meters	Distribution pipelines
10. Water Production, treatment, transmission, & distribution of potable or irrigation water	None	Ground water supply Surface water supply Purification Desalination Storage Control Instrumentation	Construction vehicles Maintenance & repair vehicles Customer meters	Dams & reservoirs Ditches Distribution pipelines Canals Irrigation ditches Beach & soil conservation Navigation Locks
11.. Sanitation Collection, disposal of solids and fluids wastes, & other related services	None	Liquid waste treatment Solids waste disposal	Collection trucks Ships & barges Construction vehicles Mosquito control vehicles Malaria control vehicles	Sewerage pipelines Storm sewer pipelines Burning pits Burying grounds
12. Wholesale Trade Buying & selling of goods to others for resale or incorporation in other goods or capital stock	None	Breaking bulk & repackaging Liquid storage and dispensing Automated product storage & retrieval	Bulk delivery trucks & trailers	None

TABLE 9 - 11 (page 3 of 3)

CANDIDATE CAPITAL INPUT MODULES BY MAJOR FUNCTIONAL ECONOMIC SECTOR

Functional Sector	Specialized Buildings	Specialized Equipment: Fixed, On-Site	Specialized Equipment: Mobile	Specialized Facilities
13. Retail Trade Selling goods and capital stock items directly to consumers	Stores Restaurants Drinking places Gasoline stations	Building materials retailing Food preparation & serving Automobile servicing Apparel altering	Customer delivery trucks	None
14. Finance, Insurance, Real Estate Services of fiduciary & banking, insurance, and real estate	Large office buildings	Vaults, safes Communications Electronic data processing	None	None
15. Services Services of personal, business, repair, amusement, medical, legal, engineering, accounting, education, nonprofit organizations, etc.	Office buildings Repair shops Theaters Gymnasiums Bowling lanes Hospitals Medical & dental Museums Zoos Research Laboratories Schools Jails & prisons	Laundry & dry cleaning Hair dressing Sewing Auto repair Plumbing repair Electrical repair Machine shop Amusements Medical & dental Educational Research Engineering Drafting Library Museum Zoo	Pick-up and delivery trucks Police vehicles Fire vehicles	Stadiums
16. Government Services of Federal, State, & Local governments for administrative functions of the legislative, judicial, and administrative branches, not elsewhere classified	Large office buildings Monumental buildings	None	Specialized passenger motor vehicles Army ordnance & vehicles Navy ordnance & vehicles Navy ships & boats Space vehicles Specialized AEC vehicles	Army installations Navy installations Air force installations Coast guard installations Reserve armories Welfare installations Space exploration installations Atomic energy installations
17. Housing All forms of shelters, permanent or transient	Residences Apartments Rooming houses Lodging houses Hotels Motels Dormitories	Household heating Household cooling Water well pumping Electrical power generation Elevators	Household furniture Household furnishings Household appliances Household tools	None

9.424 How to Modularize a Specific Industry

The foregoing discussion of modular programming has dealt with broad sectors of the economy. Emphasis has been placed on candidate input modules which were highly characteristic or specialized.

The following discussion will concentrate on the modular programming of an industry within one sector. Railroad Transportation is the industry that will be used to illustrate the procedural steps in modularizing all inputs required to construct its physical facilities.

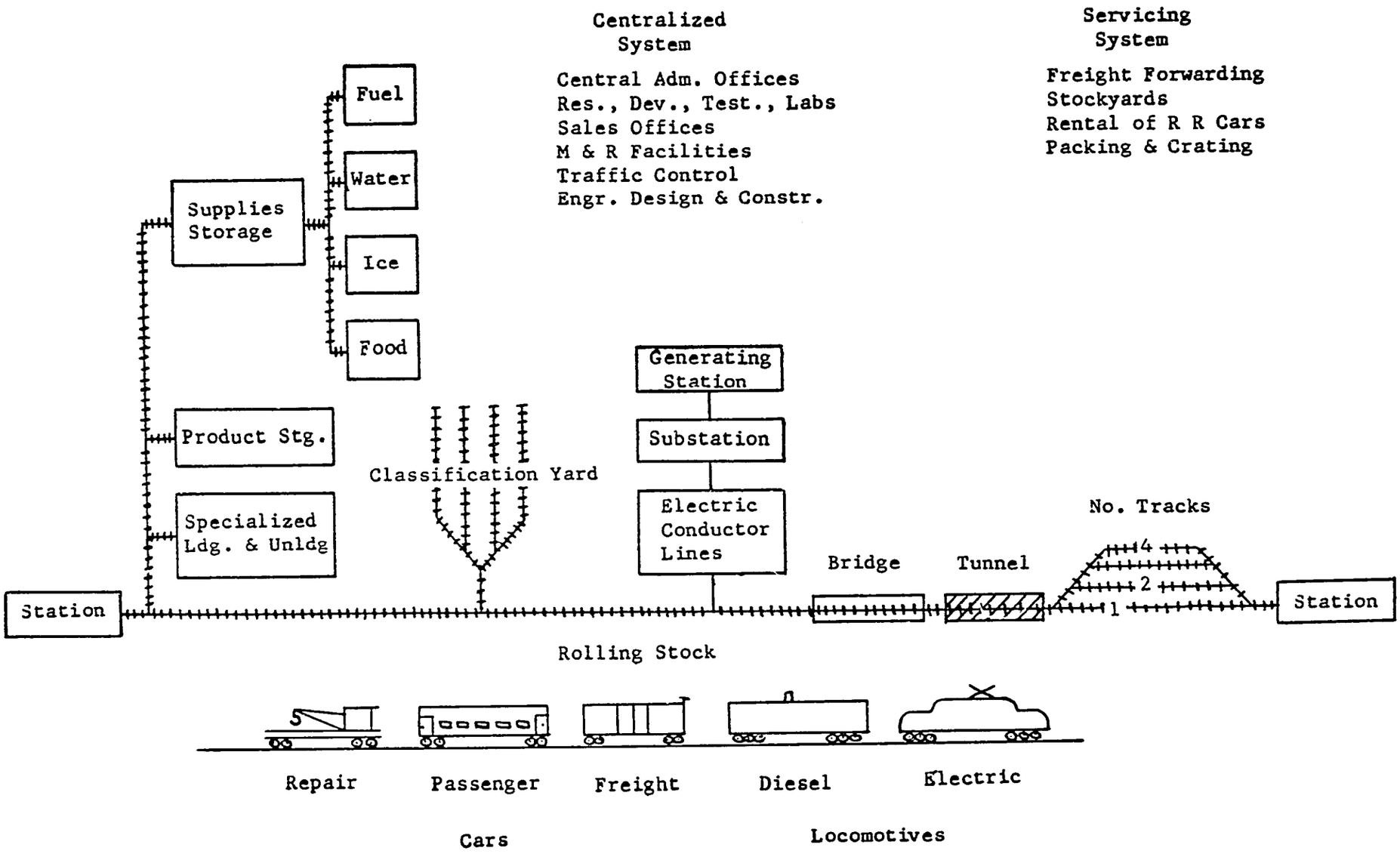
First, a schematic functional facility layout of the industry should be prepared. It is roughly divided into three parts: the operating (process) facilities, the centralized system, and the servicing system. Refer to Figure 9-4, RAILROAD TRANSPORTATION.

The operating facilities have two terminal points, stations, which bracket all other possible operating facilities. Included are product storage, specialized loading and unloading facilities, supplies storage, classification yard, electrical power system, road bed of alternate track capacity, bridge, tunnel, and rolling stock.

The centralized system consists of facilities for central administration offices; research, development, and testing laboratories; sales offices; maintenance and repair facilities; traffic control; and engineering design and construction.

FIGURE 9 - 4

RAILROAD TRANSPORTATION



The servicing system is composed of facilities for freight forwarding, stockyards, rental of railroad cars, and packing and crating services.

This schematic functional layout should next be reviewed by industry experts to ascertain that all major possible functions are provided.

Following this review, the facility components (input modules) should be tabulated on a summary, RAILROAD FACILITY EXPANSION TABLE, shown on Table 9-12.

The foregoing enumerated modules of the RAILROAD FACILITY EXPANSION TABLE represent capitalized component costs. Another capitalized component, not represented by a physical facility, is indirect cost. Indirect cost provides for design, construction supervision, procurement of materials, and other distributive costs. Therefore, an additional module, Distributive Cost, should be entered as the last item on the RAILROAD FACILITY EXPANSION TABLE.

Next, each module should be quantified and priced. Pricing may be updated from prior experience, approximated, or vendor-furnished, depending on the desired accuracy of the program.

Costs of each module are derived by multiplying quantity by price. For example, 100 miles of 2-track road bed at $500,000 per mile

TABLE 9-12

RAILROAD FACILITY EXPANSION TABLE
MODULARIZED
Excludes Land and Right of Way
(All Figures Arbitrary; Cost in 1963 Dollars)

Module Title	Unit	Quantity	Unit Price	Cost $ M	Factor
(1)	(2)	(3)	(4)	(5)	(6)
PROCESS					
Railroad Station, Freight	SQF	1000M	20	20,000	.0242
Railroad Station, Passenger	SQF	500M	30	15,000	.0182
Railroad Station, Freight and Passenger	SQF	2000M	25	50,000	.0606
Product Storage	SQF	200M	10	2,000	.0024
Electrical Generating Station	KW	500MKW	6	3,000	.0036
Electrical Substation	KW	1000MKW	1	1,000	.0012
Electrical Power Conductor Lines	Mile	200	30M	6,000	.0073
Fuel Storage	GAL	100M	2	2,000	.0024
Water Storage	GAL	500M	2	1,000	.0012
Ice Storage	LBS	300M	15	4,500	.0055
Food Storage	SQF	100M	20	2,000	.0024
Specialized Loading and Unloading Facilities	Each	5	1000M	5,000	.0061
Classification Yard	Each	2	2000M	4,000	.0048
Single Track Road Bed	Mile	-	-	-	-
Double Track Road Bed	Mile	100	500M	50,000	.0606
Four Track Road Bed	Mile	750	550M	412,500	.5000
Bridge	Each	8	1000M	8,000	.0097
Tunnel	Each	2	2000M	4,000	.0048
Diesel Locomotives	Each	30	193M	5,800	.0070
Electric Locomotives	Each	15	400M	6,000	.0073
Freight Cars	Each	2094	16M	33,500	.0406
Passenger Cars	Each	100	137M	13,700	.0166
Repair Cars	Each	4	25M	100	.0001
CENTRALIZED SYSTEM					
Central Administration Offices	SQF	50M	40	2,000	.0024
Research, Development, Testing Laboratories	SQF	10M	50	500	.0006
Sales Offices	SQF	100M	40	4,000	.0048
Maintenance and Repair Shops	SQF	40M	60	2,400	.0029
Traffic Control Facilities	Sets	300	150M	45,000	.0545
Engineering Design, Construction Facilities	SQF	200M	30	6,000	.0073
SERVICING SYSTEM					
Freight Forwarding Facilities	SQF	10M	40	400	.0005
Stockyards	SQF	30M	2	600	.0007
Rental of Railroad Cars Facilities	SQF	25M	40	1,000	.0012
Packing and Crating Facilities	SQF	40M	50	2,000	.0024
DIRECT COST				713,000	
INDIRECT COST					
Distributive Cost at 15.7% of Direct Cost				112,000	.1361
TOTAL COST				825,000	1.0000

Unit Symbol Legend
SQF = Square Feet
KW = Kilowatt
GAL = Gallons
LBS = Pounds

Summary Statistics
a. Capitalized Cost (1963 Prices) Per Track Mile = $258,000
b. Planned Rolling Stock Distribution

		Freight				
			Customer	In Transit		
	Passenger	Switching	Location	Home	Foreign	Work
Locomotives	8	5	-	30		2
Freight Cars (round figure)		300	300	1200	300	
Passenger Cars	100					
Repair Cars						4
Cars/Locomotive	12.5	60.0	-	40.0	-	2.0

equals $50,000,000 cost. Costs of each module are entered on the RAILROAD FACILITY EXPANSION TABLE. Module costs may then be normalized to unity. This calculation shows each module's proportioned part (coefficient) of the total cost in designing and constructing a railroad for a given set of facility modules. Proportional parts are useful for emphasizing module significance, for reporting construction progress, for PERT or CPM scheduling, and for comparing components with other experiences.

Time-phased leadtimes should be entered for each module's coefficient. For the program to be successful, it should be carefully time-phased to conform with normal construction engineering practice. Time-phasing has been discussed in earlier chapters, and here again its importance in this case of a planned railroad expansion should not be minimized.

Development of modular programming to other industries will reveal some of the principal advantages of this emerging system.

The module, bridges, is not used solely by railroads. Bridges are also used in highways. Tunnels occur in both railroads and highways. An electrical substation is another common module occurring in many industries and sectors of the economy.

To reiterate, a bridge is a bridge is a bridge; a tunnel is a tunnel is a tunnel, and a substation is a substation is a substation. As modular programming by industry is explored, progress will undoubtedly show that many modular components are used by many industries and that, once the input structure of a module is composed, it may be used in many industries. This represents the power of the system.

9.425 Enlargement of Existing Facilities

One of the early questions to be answered by economic planners involves the decision to: (1) invest in new facilities at new sites, or (2) invest in enlargement of existing facilities at existing sites. Both types of investment have certain distinct advantages.

New facilities can incorporate the latest technological advances in equipment and buildings, the increasing productivity of operating labor, and the utilization of raw materials. These facilities can be strategically located between sources of raw materials and product or service customers, thereby gaining the optimum movement from both directions. Often, nations will offer tax reduction incentives to encourage growth and dispersion of new productive capacity. The possibilities of utilizing the economies of scale can be taken into account when constructing new facilities. Quick reference to most equipment catalogs will give

adequate proof that unit price of equipment capacity diminishes as capacity increases.

Consider tank capacity:

> "Given a tank whose capacity or volume is equal to $\pi r^2 h$, where r is the radius and h is the height, let the height be constant. To double the capacity:
>
> $$V = \pi r^2 h$$
> $$2V = 2(\pi r^2 h)$$
> $$2V = \pi(\sqrt{2}r)\ (\sqrt{2}rh)$$
>
> So that the original radius does not have to be doubled.
>
> The diameter of any circle is equal to twice the radius. The diameter of the circle which would be the base of the tank with twice the capacity of the original would be $2(\sqrt{2})r$ as opposed to 4r which would be the diameter if the radius had to be doubled. The scalar factor in this case is $\sqrt{2}$, not 2."[12]

Many engineering studies and practices of this economy of scale offer ample proof of this fact.[13]

On the other hand, enlargement of existing facilities has its advantages. Foremost is the advantage of lowering unit cost of the

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[12] Agnes Imregh (unpublished notes on capacity increase, National Planning Association, Washington, D. C., 1967).

[13] O. T. Zimmerman and I. Lavine, Scaling Equipment Prices (Dover, New Hampshire: Cost Engineering, Industrial Research Services, 1965).

output--product or service. This reduction of output unit cost is caused by selective new investment in those component modules which contribute most to the production of the output. For example, an increase in the manufacturing or process module component might be made without an additional investment in the administration and shop facility module.

Economies of scale represented in enlargement of existing facilities have been known for some time. Engineering literature is abundant with references. One of the earlier studies was made by C. H. Chilton,[14] Editor of Chemical Engineering; and one of the latest studies was made by Dr. Thomas Vietorisz for the United Nations.[15]

Guideline questions to be answered when considering how to achieve the required additional capacity would be:

(1) Should added capacity be obtained from a change in operating procedures, such as schedules, flow of materials, or conversion of equipment?

(2) Should added capacity be obtained from an investment in the manufacturing or process modules of existing facilities?

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[14]Cecil H. Chilton, "Sixth-Tenths Factor Applies to Complete Plant Costs," Chemical Engineering (April, 1950).

[15]Thomas Vietorisz, "Programming Data Summary for the Chemical Industry," Industrialization and Productivity, Bulletin 10, United Nations, Department of Economic and Social Affairs (New York: 1966).

(3) Should added capacity be obtained from an investment in totally new facilities?

Economic planners will recognize the horizon distance of each of the foregoing questions. The first is extremely short-range and can be achieved quickly. The second is medium-range and must wait for design, construction, and trial run before accomplishment. The third is definitely long-range and weds current technologies to long-range output extrapolations. Of the three possibilities, achieving added capacity obviously consumes the most time.

This discussion leads us to an important use of modular programming in planning capital investment.

All previous suggested candidate modules referred to the design and construction of new facilities. Once a modularized data base has been established for new facilities, an opportunity is presented to derive a modularized data base for enlarging existing facilities or analyzing existing procedures.

Refer to Table 9-12, RAILROAD FACILITY EXPANSION TABLE.

To answer the question--should added capacity be obtained from a change in operating procedures, such as schedules, flow of materials, or conversion of equipment?--examine the referenced table, section Summary Statistics, item (b), Planned Rolling Distribution. One of the

alternatives open for increasing capacity would involve raising the demurage rates on cars at customer locations, thereby putting more cars in transit. Assume that stiff demurage penalties moved 200 cars from "customer locations" to "in transit on home rails," which now total 1400 cars. The "cars per locomotive" would thus be increased from 40.0 to 46.6, or an increase of 17 per cent in the primary function or capacity of railroad transportation. Other similar alternatives to increase capacity without additional investment might be achieved through examination of the number of cars tied up in switching or on foreign tracks.

To answer the question--should added capacity be obtained from an investment in the process modules of existing facilities?--examine the referenced table, section Process. The mobile transporting equipment of locomotives and cars readily suggests selective candidacy for enlargement of existing facilities. Through investment in 1000 new freight cars and 25 new diesel locomotives (40 cars per locomotive) a net increase of 575 cars "in transit on home rails" could be conservatively obtained (all other proportions of car distribution assumed to remain the same as given in the section, Rolling Stock Distribution, item (b) of Summary Statistics). This, in effect, increases the productive capacity from 1200 cars to 1775, or 48 per cent.

This selective investment in terms of railroad expansion was used by Robert N. Grosse in the U. S. Interindustry Study conducted by the United States in 1953.[16]

Each of these alternative possibilities should be evaluated for practical feasibility. For example, the possibility of increasing rolling stock might be evaluated in terms of track-mile per train:

	Miles of Track	Trains	Track-Miles Per Train
Existing			
Passenger		8	
Freight		30	
Total	3200	38	84.2
Contemplated			
Passenger		8	
Freight		55	
Total	3200	63	50.8

The reduction of track-miles per train should be further evaluated in terms of the total system facilities and safety.

In summary, we have probed the potential use of modular programming technique applied to capital investment problems. We can reason that its analytical power can be expanded to the operation of the

[16] Robert M. Grosse, Capital Requirements for the Expansion of Industrial Capacity, United States Bureau of the Budget, Executive Office of the President, November 30, 1953.

facilities and thus project its use to current input-output analysis of the economy, first proposed by Wassily Leontief[17] of Harvard University and widely accepted and currently used as an analytical tool by the United Nations.[18] We believe that modular programming will add its contribution to the science of management information systems at both the macroeconomic and microeconomic levels.

9.43 CAMPAIGN TYPE PROJECTS

Here, we shall distinguish two major groups of modules. First, there are those modules connected with a campaign's logistics--the word "logistics" being used in its widest sense. A second group comprises those modules related to the respective contents (i.e., the function) of a campaign.

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[17] Wassily Leontief, Input-Output Economics (New York: Oxford University Press, 1966).

[18] Charlotte E. Taskier, Input-Output Bibliography, 1955-1960 and 1960-1963 (New York: United Nations, 1961 and 1964).

Campaign Logistics Modules

Transport a) people
b) materials and equipment

Lodging people

Storing materials and equipment

Accommodation and organization for the personnel training
" " " " " motivation of people to be reached by the campaign
" " " " " handling people

a) in groups (e.g., teaching)

b) one-by-one (e.g., clinics, home visits)

Printing and reproduction module

Photography, film, tape recording, etc., module (gathering and registering information)

Audio-visual systems module (spreading information)

Short-wave radio, etc., communication module

Laboratory, refrigeration, sterilization, etc., module

Aerial data gathering module

Paymaster and accounting module

Records and archives module

Security module

Command staff module

Campaign Contents Modules

Instrumentation modules

a) geological surveys module

b) botannical surveys (including infrared aerial photography

c) surveyor's module

d) X-ray module

e) vaccination modules

f) blood, etc., tests modules, etc.

Equipment and utensil modules

a) spraying

b) dusting

c) disinfecting, delousing

d) home economy, etc.

Material modules

a) medicaments

b) chemicals

c) seeds

d) animals, etc.

Specialized staff modules

a) medical

b) educational

c) surveying

d) geological

e) social

f) agricultural, etc.

Table 9-13 illustrates the conception of a modular "building block" in an imaginary anti-cholera vaccination campaign.

It is easy to see how each of the modules composing the complex campaign module could, in turn, be expanded into their simple inputs as explained previously in this chapter. All these modules would relate to a campaign aimed at 100,000 people. (Compare Tables 9-1 through 9-5.) The total absolute demand for inputs would be calculated in a table with a format identical to that of Table 9-6, after it is decided how many people should be reached by the contemplated campaign.

We can also see how a network diagram, containing such principal activities as transport, lodging, training, etc., can be constructed. Roughly speaking, "logistics modules" will correspond to service activities, and "contents modules," to direct activities.

TABLE 9-13

A MODULE OF AN IMAGINARY CHOLERA VACCINATION CAMPAIGN

(Data: historically established cost was $25,000 per 100,000 of population. Total duration, including training and motivation, 12 months.)

Input (1)	Leadtime Months Mean (2)	Leadtime Months Range/2 (3)	Factor (4)
Logistics Modules			
Transport Module	4.5	4.5	0.20
Lodging Module	11.0	1.0	0.15
Training Module	11.0	1.0	0.05
Motivation Module	9.5	0.5	0.05
Accommodations Module	4.5	4.5	0.01
Command Staff Module	6.0	6.0	0.02
		Subtotal.....	(0.48)
Contents Modules			
Instrumentation Module	4.5	4.5	0.02
Materials Module	4.5	4.5	0.20
Personnel Module	6.0	6.0	0.30
		Subtotal.....	(0.52)
		Total.....	1.00

9.5 THE ROAD AHEAD

Modular programming is a concept which exists in the mind of the beholder. We might say it first appeared in a rudimentary, unevaluated form when man fashioned a stone axe. He sharpened a stone, added a wood handle, bound the two together with a rawhide thong--a module--which could be used repetitively to perform a continuing cutting function--the program--to satisfy a recurring need--fuel, food, or elimination of competition.

This simple action demonstrates the fundamental characteristics of modular programming: a recurring need, programmed functions, and a modularized physical tool or instrument to perform the necessary function.

Our contemporary civilization has grown complex. Its needs have expanded considerably; its functions have diversified and multiplied; and its modules have grown astronomically.

We no longer enjoy the simple relation of stone, wood handle, and rawhide thong of an axe. Now our concern is with the relationships among the economic, social, and political sectors of our society, one of which has been described in our probe of railroad design and construction. Recall its relationships of stations, tracks, bridges, tunnels,

classification yards, rolling stock, etc. If we quantify these complex integral component relationships and prove the interdependence of components with each other, we should be in the favorable position to use the unified whole reliably. The cycle includes: evaluation, decision selection of optimum alternative, specific modification from average relationships, implementation, and realization of increased benefits and returns.

The application of modular programming is universal. It is not confined to capital investment, though the first glimmer of the system's power was seen in this field. Modular programming may be universally applied because recurring needs--current operations accounts--exist. Programs can be written to satisfy these needs through modularizing their components and creating sized and balanced demand coefficients for the modules.

What is required to design and implement a modularized program? These steps are involved:

(1) Determine recurring needs.

(2) Distinguish those physical or service requirements necessary to satisfy these needs.

(3) Separate those requirements which are highly characteristic of each need from those requirements which may be common to many needs.

(4) Modularize inputs of those requirements which may be common to many needs.

(5) Unitize total requirements for each need using specialized requirements and demands for common modularized requirements.

(6) Time-phase total requirements for each need.

(7) Program time-phased total requirements for rapid data processing.

(8) Test, debug, and validate the modularized program.

The ROAD AHEAD is a challenge. Its concept is sound; its application limited only by the imagination, perseverence, and funding of the user: development planner, resource manager, economist, engineer, or operator. Its motivation is payoff in increased benefits, services, and returns. It is hoped that this chapter has described, in some small measure, the challenge of modular programming.

APPENDIX B

INFORMATIVE PRESENTATION OF FUTURE EFFECTS OF A PROJECT

	Following Page
Table B-1 Iterative Effects of Operation of the Completed Irrigation Projects	B-4

APPENDIX B

INFORMATIVE PRESENTATION OF FUTURE EFFECTS OF A PROJECT

Economists have argued for a generation that the decision to undertake or reject a project ought to be made on the basis of the whole stream of costs which a project generates throughout its life (original investment, cost of subsequent operation, maintenance and replacement of assets), as compared with the whole stream of benefits (value of outputs) over the same period. If this comparison, which involves a rather sophisticated formula, between these two streams proves satisfactory for a project, then it ought to be chosen for execution in preference to other projects for which such comparisons proved less satisfactory. This method of choosing between competing projects is gaining more and more adherents among managers. To give just one striking example: recently, in the second quarter of 1967, the U. S. Department of Defense decided to order a computer system which required a higher original investment than the systems of other producers bidding. The decision was based on the belief that, considering the costs of operation and maintenance over the whole useful life of the various systems, the chosen one was the cheapest, despite the higher initial outlay required.

If monetary prices, and thus the money value of costs and benefits, truly and fully reflected the relative abundance or scarcity of goods and services, the difficulty or ease of securing them and their relative importance for a nation's economy, then a cost/benefit calculus in purely monetary terms would be sufficient to determine the advisability of undertaking a project. We know, however, that a "perfect market" does not exist and that the observed prices of capital, goods, labor, and foreign exchange often may bear little relation to their true rarity or plenty. The ambitious method of "accounting prices" (or "shadow prices") attempts to remedy this situation by determining the prices of inputs and outputs as if a perfect market existed. There is no way, however, of knowing how valid the results of this method would be, and there is no example of its being applied in practice. Besides, the old problem of pricing such benefits as health, natural beauty, etc., still remains.

One is forced to conclude, therefore, that to make a politically and administratively valid and successful decision for or against a project, public managers must see a project's costs and benefits not only in terms of positive or negative streams of money but also in terms of streams of specific inputs and outputs: goods, services, rights, claims, and obligations in foreign exchange.

Another overwhelming reason for specific presentation of streams of inputs and outputs is the question of a project's complementarity with other projects in a national plan.

The format recommended in this study can very easily be extended to cover the whole two streams of future costs and benefits. This is due to the adoption of the budget-national accounts classification principle for the project's inputs, which can be extended over the whole future stream of inputs in operating the completed project. Moreover, by dropping the budgetary digits, which would here be meaningless, we extend the national accounts part of the classification to the whole stream of future outputs: goods and services rendered by the project in operation. The future effects of the project in operation are thus measured in the same terms in which the operation of the whole economy is measured. They can be aggregated at any level, and in any cross section, with the rest of the national economy.

The following example (Table B-1 at the end of this appendix), which refers to the irrigation project discussed throughout this study, shows the simple principles of presenting a stream of inputs and outputs in a project's future operation. The form at shows the future iterative budgetary expenditures under appropriate budget headings and the future iterative demands on the economy's resources under appropriate national

accounts headings in the same manner in which it was done for the project's implementation impact. In addition, it shows the iterative additions to the economy's resources due to the project's output. The foreign exchange effect can also be estimated by techniques recommended in this study.

TABLE B-1

ITERATIVE EFFECTS OF OPERATION OF THE COMPLETED IRRIGATION PROJECT

BENEFIT AND COSTS		YEAR OF COMPLETION 1975	1976	1977	1978	1979-1985 ...	1986	1987	1988	1989-1995 ...	1996	1997	... ETC.
OUTPUTS													
CODE	DESCRIPTION												
1.02	Sales of wood from reservoir area	—	—	150	200	...	200	200	200	...	200	200	... etc.
5.22	Water services – irrigation	—	100,000	120,000	140,000	...	140,000	140,000	140,000	...	140,000	140,000	... "
11.84	Tourism and recreation on the lake	—	—	—	1,000	...	5,000	5,500	6,000	...	10,000	10,500	... "
	TOTAL MONEY VALUE *	—	100,000	120,150	141,200	...	145,200	145,700	146,200	...	150,200	150,700	... "
INPUTS													
CODE	DESCRIPTION												
0 1-11.50	Administration workers	—	1,000	1,000	1,000	...	1,000	1,000	1,000	...	1,000	1,000	... etc.
0 8-72.80	Dam operators	—	500	500	500	...	500	500	500	...	500	500	... "
	Etc. ⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
2 2.4.421	Construction sand for maintenance	—	20	20	20	...	50	20	20	...	70	20	... "
2 3.33.410.11	Cement	—	40	40	40	...	100	40	40	...	120	40	... "
	Etc. ⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
3 3.36.19210	Diesel engine – replacement	—	—	—	—	...	—	—	—	...	25,000	—	... "
3 3.37.21	Generator – replacement	—	—	—	—	...	10,500	—	—	...	10,500	—	... "
	Etc. ⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	TOTAL MONEY VALUE *	—	1,560	1,560	1,560	...	12,060	1,560	1,560	...	37,690	1,560	... "

For some purposes this table should be presented in physical volumes rather than money values.