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B. MILNER, V. RAPOPORT, AND L. YEVENKO

DESIGN OF MANAGEMENT SYSTEMS IN U.S.S.R. INDUSTRY

A Systems Approach

THE INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS

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PART III. The Development of Management Organization Structure

Preface

This book is the result of extensive studies by the authors in the fields of research in, and analysis and design of, the system of management of production organizations under a socialist economy.

The management of the national economy in the USSR is developed on a planned basis. This work is part of the general state-sponsored strategy of economic development which is discussed and laid down by the Congresses of the CPSU (Communist Party of the Soviet Union) and is then translated into concrete decisions of the government and other bodies of economic and regional management.

The general policies on management improvement are closely scrutinized by these bodies, the leaders of the Party and the State, and the Soviet press. In the recent years this work has acquired special importance. The party and economic management of all levels, scientists, and experts are faced with the task of introducing, in a short period of time, radical changes in the planning and operating, creating thereby a holistic management system based on scientific recommendations and effective practical experience.

The adoption of state decisions and the elaboration of guidelines and methodological material in the field of management is usually accompanied by the collection and summarization of a

great number of proposals from different levels of industrial management, from trade unions at amalgamations and enterprises, from numerous research and engineering organizations of the USSR Academy of Sciences, from ministries and other government agencies, and from higher education institutions. Change in the organizational structures and management systems for the national economy are the subject of decisions at the highest levels of government, which take into account the complete range of relevant factors.

The distinguishing feature of the work on improving the management organization in the USSR is that it is based on extensive developmental research in this field.

The study, whose results are presented in this book, is a result of such a combination of academic research, elaboration of guidelines, and applied projects, which aimed to develop a systems framework for the analysis and design of management structures for economic organizations, as well as to assist a great number of managers and staff specialists in the solution of the management organizational problems that they face.

The history of the writing of this book goes back to the beginning of the 1970s when a group of researchers, headed by B. Milner with the active participation of the other two authors, was set up at one of the institutes of the USSR Academy of Sciences. The group faced the task of working out and putting into effect a research and development program in the field of management, based on studies of theory and worldwide experience in designing management organizational structures which would provide practical results.

In the course of the research it was discovered that in management science the problem of designing organizational structures for social systems, such as economic organizations and goal-oriented programs, had, in most cases, never been solved systematically but only partially or indirectly. An empirical approach dominated the design of management organizational structures, and its characteristic "trial and error" method, relying heavily on the experience and intuition of practicing managers and their intimate knowledge of real conditions of production and management processes in specific organizations, played a more important role than the science of organizational

design. Analogies, imitation of the management structures of the most successful organizations, and expert judgments on the applicability and efficiency of various organizational forms were widely used. Although the empirical approach provided excellent results in some cases, it did not permit the wide use of modern scientific techniques of organizational development. It was based mainly on already-tested experience and required a great number of highly skilled consultants. Nor did it help to fulfill the task of considerably improving organizational management in all the links of the national economy in the shortest possible time.

Of course, management science continued to search for answers to the following questions: How is the problem of designing management structures to be approached? What organizational variables are subject to manipulation and change in the course of management organizational design, improvement, and development? What methods should be proposed for the diagnosis, analysis, and solution of organizational problems? How are research-based methods that have practical applicability to be developed?

An interesting approach to the study and design of management structures, which is rather effective under certain circumstances, was adopted during the 1960s in the USSR. This approach may be described as "prescriptive–functional". It includes the following steps:

(1) To identify and clearly define the functions that the management of a typical production organization performs.
(2) To conduct a broad survey of industrial organizations in order to obtain quantitative characteristics of the actual functions performed by management units, the number of managerial and administrative personnel at these units relative to the size of the enterprise, the type of technology, economic indexes, etc.
(3) To calculate the correlations between these quantitative characteristics of the production and management subsystems.

Using these data progressive norms were set for the number of managerial and administrative personnel in enterprises in most

branches of the national economy. The application of these norms played an important role in rationalizing the management organization of many enterprises.

However, this approach, although widely used, had several deficiencies. In particular, it took into account only a limited number of parameters of the organizational management system and it was confined to the statistical methods of study and analysis of management structures of industrial enterprises that were already in operation. It therefore produced practically nothing that could be used to solve either the problems of management-structure design for new economic entities (large amalgamations, goal-oriented programs, etc.) or the problems of adaptation of existing management systems to changing conditions. Thus, this prescriptive–functional approach has only limited application in the present economic environment.

The other approach which was widely used in the USSR, as well as in other countries (especially in connection with the development of computerized management-information systems), may be described as "functional–technological". Under this approach, management structures and methods were adapted to a computerized management information system and its functional subsystems (production, finance, sales, etc.), which were taken as the new basic management technology. This approach has certain strengths which make it useful for the solution of problems dealing with the improvement of the management organization in separate functional subsystems and organizational units. However, it is of little use as an aid to improving the structure of either the organization as a whole or of its major managerial processes. In addition, it ignores almost completely the role of human factors and social and psychological relationships in organizations.

Generalization of both Soviet and foreign theories and practice of management-structures design shows that the whole range of approaches to this problem advocated by different schools may be reduced to four basic types:

(1) Synthesis of the management structure from functional building blocks, using classical management principles and/or mathematical models.

(2) Development of the management structure through the design and rationalization of management processes, such as planning, decision making, and information processing.
(3) Improvement of the management structure through the "organizational development" techniques of changing organizational behavior, climate, interpersonal relationships, leadership styles, etc.
(4) "Situational choice" of the most appropriate management structure for the particular environment of a given organization, which is based on the ideas of a contingency approach, comparative research, typologies of organizational forms, etc.

Each of these approaches deals with only one of the major dimensions of the very complex phenomenon that is the modern organization. They all have their advantages, shortcomings, and most valuable spheres of application.

Concurrent with these approaches, which have a predominantly monodisciplinary character, in the 1960s and 1970s, both in the USSR and abroad, the methodology of systems analysis was actively developed. The distinguishing feature of this methodology is a multifaceted, multidisciplinary consideration of complex sociotechnical systems. The methodology seeks to take into account all the intricacies of the internal structures and processes of such systems, as well as the whole set of their relationships with the external environment.

For such complex social systems as production organizations, branches of industry, and the national economy as a whole, the systems approach is the only way to solve effectively the organizational problems that arise from the influence of various technological, economic, social, and other factors. Accordingly, the authors have focused their efforts on the application of the methodology of systems analysis to the design and improvement of management organizational structures.

An important impetus to research in this field was the creation of IIASA (the International Institute for Applied Systems Analysis), with which the authors have cooperated from the time of its foundation. The IIASA Management and Technology research project corresponded to a large degree with the

authors' personal research interests from 1973 to 1979. Our participation in a number of projects studying the management systems of large-scale goal-oriented programs in the USA, USSR, Japan, and the UK over the period 1975–1977 was especially helpful, because it allowed us to single out some principles of organization of program management and to make useful comparisons and generalizations.

It should be emphasized, however, that the main objective during the first stage of the work of our research group was more pragmatic than theoretical. The intention was not to develop new theories or models of organizational systems, but to create a conceptual framework in which the ideas of the systems approach and the available repertoire of scientific techniques could be applied to the solution of practical problems of the design and improvement of management systems.

For just this purpose, from 1972 to 1977 attempts were made to apply some general ideas of the systems approach to the design of management structures for large production enterprises, in particular, the Kama River automative complex (KAMAZ) and the electrotechnical amalgamation *Uralelectrotyazhmash* (UETM). Both projects, described later in this book, proved to be successful and our recommendations were implemented. They also attracted the attention of Soviet business managers and specialists. The major concepts of the systems approach were then applied to the solution of another kind of problem: the design of management systems for complex goal-oriented programs. Goal-oriented programs are the new tools of Soviet economic policy, and are widely used for the implementation of large-scale innovations in our national economy.

Together with the discussion of general organizational problems of program management, this book contains a case study of management structure design for the complex program of environmental protection and the rational use of natural resources in the Latvian SSR. This project was also worked out by the authors and implemented successfully.

Our intensive research and consultation activities on the application of systems methodology to the practical problems of management of various economic entities has allowed us to formulate and develop a rather original methodological approach to the

design of organizational structure. We call it the "systems–goal" approach to distinguish it from other approaches. This methodological approach is based on the general principles of systems analysis of organizational management problems and considers a business organization as a special kind of social system that combines technological, economic, informational, and behavioral elements and processes. The overall approach is based on the concept of management structure and systems as tools for achieving the many complex production, economic, technological, and social objectives of a modern economic organization. This means that the design and development of the organizational components is not an end in itself, but is subordinate to the overall goal of effective and efficient performance of an organization. Hence, the management structure analysis and design choices must be based on situational criteria and characteristics of the social system of an organization. Some conceptual foundations of our approach are briefly presented in Part II.

In view of the importance of the results of the research and applied projects it was decided to make them available to management specialists as well as to managers and executives. For this purpose the State Committee on Science and Technology of the USSR (GKNT) launched a project for the elaboration of general methodological recommendations for the formation of organizational management structures of amalgamations and enterprises based on a systems–goal approach. This project, headed by the authors, involved a whole range of organizations: institutes of the Academy of Sciences of the USSR, institutes of the GKNT, the Academy of Sciences of the Ukrainian SSR, and others. The resultant guidelines were then discussed at an All-Union conference of scientists and managers, were approved by the GKNT, and were passed to branch ministries as an official organization planning manual for implementation. The results of this work on the development of methodological principles and methods of management structures design for industrial organizations are presented in Part II, which contains a description of the most recent trend in the science and practice of management in the USSR, namely the systems–goal approach to organizational change and development. This approach has gained wide recognition in the USSR and is being developed intensively.

The systems approach itself is a universal research methodology which can be applied to the solution of organizational problems under different types of social systems, both in market and planned economies. However, the application of this methodology to the tasks of management improvement in socialist organizations has given rise to original and rather interesting theoretical, methodological, and applied results.

In order to facilitate understanding by non-Soviet readers the book begins with an outline of the major organizational features of national economic management in the USSR and the main current problems involved in its improvement (Part I). We hope that this part will also be of some interest in itself.

We have given the story of this book and the rationale for its structure and contents. Of course, the book is far from covering the whole range of the authors' current research interests, but it does present a fairly full account of the state of the art in the field of management organizational design and development in the USSR.

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This book was coauthored by B. Milner, V. Rapoport, and L. Yevenko, except for Section 1 of Chapter 1 and Sections 1 and 2 of Chapter 2, which were written by D. Levchuk.

B. Milner
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D. Levchuk

PART I

Basic Characteristics of Socialist Economic Organizations

CHAPTER ONE

Organizational and Economic Principles of Socialist Public Production Management

1.1. The Organizational Structure of Socialist Public Production

Socialist public production is an integrated complex of production and economic activities that embraces the production, exchange, distribution, and consumption of goods and services required to satisfy the needs of society as a whole and of its individual members. The socioeconomic foundation of socialist public production is the public ownership of the means of production, transport, and communications. Banks, the property of the state-run trade establishments, most urban housing, etc., are also state property, i.e., they belong to the entire nation. Collective farms and other cooperative organizations have their own means of production and the required assets. Collective farms are granted the right to free use of the land.

The Constitution of the USSR defines the supreme goal of socialist public production as the fullest possible satisfaction of the people's growing material, cultural, and intellectual needs. In terms of its organizational structure, socialist public production may be described as a hierarchical system of organizationally

independent economic subsystems, referred to as "links". Between these links there are complex organizational relationships that reflect their functional nature and hierarchical level of economic organization. The complete system of socialist public production and its components (links) have a corresponding system of goals that can also be represented by a hierarchical structure. Any goal or subgoal is achieved through the activities of a particular economic entity or group of such entities.

Links are characterized by a certain economic autonomy and internal integrity as follows:

(1) *Technological integrity.* This is based on stable, permanent cooperation in the implementation of the complex technological cycle from R&D through to marketing and consumption by the end user, on the similarity of scientific, technological, and production tasks, and on the centralization of certain functions providing services to the link itself or to most of its subsystems.
(2) *Economic integrity.* This is based on the state property allocated to the link; this property includes financial, materials, and technical resources, whose utilization by the given link is formalized by special legal rules. This integrity is emphasized by the link's independence in the circulation and reproduction of its capital. This aspect is connected with the specific nature and structure of the link's costs and benefits, as well as with the specific economic functions realized by the link in the public reproduction process.
(3) *Social integrity.* This is determined by the existing intralink social relations.
(4) *Organizational integrity.* This is determined by the single goal or group of goals to be attained by the link and by the unity of its operational and management subsystems.

Development of the public production organizational structure involves two processes:

(1) Differentiation of economic activity due to increasing specialization of production.

(2) Integration of different types of activity having stable scientific, technological, production, and economic relationships, which ensures the achievement of the common goals and allows the maximum production efficiency to be attained on the basis of economic integration and management centralization in economic complexes.

Links can be classified by the hierarchical level of their public production organizational structure, in which three basic levels can be distinguished: primary, middle, and top. Links may also be either stable or temporary. The former have correspondingly stable goals, which are reproduced in the link's activity and ensure the functioning of the economic systems. One can also distinguish between sectoral and regional links.

1.1.1. Basic (Primary) Links: Production Amalgamations

The primary economic unit of the public production organizational structure is a production enterprise. Socialist enterprises have passed through two basic stages in their organizational evolution. During the first stage they were formed, operated, and developed as single production and technological units (a factory, plant, transport agency, communications agency, building enterprise, etc.). In this context an enterprise is the totality of production, support, and management subunits located in a limited area. The current stage of evolution is characterized by a certain spatial dispersion of previously established production and by a wider cooperation of specialized divisions. We now have organizations of a new type: production amalgamations. These are integrated production and economic complexes incorporating independent enterprises, manufacturing units, and branches. The production amalgamation is a modern form of multiplant enterprise.

Production amalgamations in Soviet industry may be divided into two basic types, according to their organizational structure. The first type includes the so-called vertical amalgamations, i.e., highly integrated complexes of production units closely cooperating on the basis of technological stages of production and turning out complex, uniform products. These amalgamations are most common in the automobile, transport, and agricultural machinery industries. Another example of integration is given by the

combines based on complex raw-material processing. The second type of amalgamation includes industrial enterprises that turn out final products independently, but are interconnected by partial internal cooperation. They also have common centralized services, support units, procurement, marketing, R&D, etc. These horizontal production amalgamations exist in many subbranches of the chemical, building materials, food and dairy, and metallurgical and chemical-engineering industries.

Along with production amalgamations, research–production amalgamations are being set up in the USSR. Their structural units include research, design, and technological organizations, plants, factories, and other units depending on the specific goals and functions of the amalgamation. The main objectives of research–production amalgamations include:

(1) The creation and introduction into the national economy of new machines, instruments, equipment, materials, technological processes, computer-based management systems, and machine systems (equipment complexes) for the mechanization and automation of production processes.
(2) The transfer to production amalgamations (combines) of the newly developed technologies or processes for mass production.
(3) Utilization of these new processes or technologies in industrial engineering to generate new products.

A branch of industry forms research–production amalgamations by the addition or subordination of other enterprises and organizations to a basic R&D or design organization. The R&D organizations become research and design centers of a branch or a subbranch and concentrate efforts on the most important R&D, thereby contributing to the technological development of their branch of industry.

In agriculture, agroindustrial complexes, where agricultural production and subsequent processing are coupled, have recently become more popular. These complexes are of the vertical type and include various combinations of the links in the technological cycle from agricultural production to storage and marketing through a network of outlets. Currently, specialized economic

complexes are being widely established in agriculture (the so-called intereconomic complexes) for the production of meat and dairy products, fodder production, etc.; these are joint ventures of collective farms, state farms, and state-run organizations.

1.1.2. Middle Links: Industrial Associations

An industrial association is an economic complex consisting of industrial enterprises and research, design, technological, and other organizations. It can include production amalgamations and combines. An industrial association operates on a much larger scale than a production amalgamation and as a rule covers a certain subbranch of industrial production either on a national scale or on the scale of an individual region, e.g., a Union republic.

There are two types of industrial association. All-Union industrial associations represent a complex of enterprises and narrowly specialized production amalgamations covering a certain subbranch of industry. Their enterprises and organizations are, as a rule, dispersed all over the country. Unlike the All-Union industrial associations, republic industrial associations represent a particular industrial branch on a republic scale. They have wider specialization (often corresponding to that of their branch), include a number of subbranches, and are designed to supply their products mainly to the given republic, though this does not rule out consumption of a republic industrial association's produce outside the republic's boundaries. In line with increasing and extending specialization, republic organizations specialize within certain subbranches of industrial production and therefore may market their products in a wider zone than the given republic [1].

1.1.3. Top Link: The Branch Ministry

A branch is a major subdivision of the national economy. It includes a group of enterprises, production amalgamations, and industrial associations characterized by a certain similarity in technological and economic functions. A set of branches with similar production technologies constitutes a complex branch (the engineering industry, industrial construction, transport, etc.). A group of complex branches characterized by a particular role in

the public division of labor forms a "national economic branch". Being a link of the public production organizational structure, a branch consists of primary and middle economic links, which have a certain similarity in their technological and economic functions and are headed by a single, top-management body, which is, in fact, the relevant ministry. A number of the most important production and economic functions (centralized repairs, production of components or units, instruments, and nonstandard technical equipment) are centralized within a branch of industry. An important role is given to centralized R&D and design support of the development of branch enterprises. Thus, any economic branch represented by a ministry is not a simple sum of enterprises and organizations of primary- and middle-level links, but an economic complex – an object of centrally planned state management through the single, state-management body [2].

There are three types of organizationally autonomous branch complexes (ministries) depending on their scale, sphere of activity, and level: All-Union, Union–republic, and republic ministries. The All-Union ministries (e.g., the ministries in charge of the automobile, aircraft, heavy and transport machine-building industries, power machine building, and foreign trade), run the enterprises in their particular industries throughout the whole country. These industries require centralized management because of their particular manufacturing processes. Machine building, for example, needs for its development extensive specialization, cooperation, and standardization of machine parts and assemblies. Here it is especially important to pool the efforts of R&D centers and enterprises for the production of new and up-to-date machines and equipment. Union–republic ministries function both on a national scale and as ministries of Union republics. For this reason they are subordinate simultaneously to the respective All-Union ministries and to the Council of Ministers of their respective republics. They have charge of finances, the health service, and agriculture, and run the timber and wood-processing industries, the oil-extracting, oil-refining, and coal industries, geological prospecting, home trade, the production of foodstuffs, etc. The Ministries of Defence, Foreign Affairs, and the Interior are also Union–republic ministries. Republic ministries are the ministries for individual Union republics and report

to the Council of Ministers of their respective republic. They include ministries of motor transport, river navigation, civil housing, housing and municipal services, the fuel industries, local industries, etc. [3].

1.1.4. Territorial Industrial Complexes: Regional Links

An essential role in the public production structure is played by territorial industrial complexes. The formation of a territorial industrial complex as an autonomous economic subsystem of the national economy is determined by objective factors of the geographical distribution of industry, the territorial division of labor, and labor cooperation. Cooperative interactions of various kinds (production, economic, scientific, and technological), characterized by a certain system and stability as well as by long duration, are established between the enterprises of a given region. Similar intercommunication is established between regional industry and the sociodemographic and administrative structure of the region. The development of interconnected production–economic and socioeconomic relations of a regional nature determines the consistency of the region's industrial objectives and creates the prerequisites for transformation of territorial industrial complexes into independent links in the public production structure.

The top territorial public production structure is a republic industrial complex. These complexes are integrated economic subsystems that are organizationally separated according not only to production, technological, and economic conditions, but also to administrative division boundaries. This accounts for the interconnections between economic and demographic district divisions and the political and administrative structures [4].

1.1.5. Goal-Oriented Programs: Temporary Links

A program is a specific component of public production that is usually considered as a complex of measures subordinated to a common goal. It has all the basic features of a separate structural unit. It is characterized by a system of stable technological and economic relationships among the economic units and is defined by the common, final goal.

Certain economic resources are allocated to the program. They may have various degrees of centralization and are allotted to the program management units of different levels.

Besides its technological and economic autonomy, a program is characterized by a special management organization. A program is a relatively independent economic as well as organizational system of economic units that performs a specific function. It can be divided into operational and management components with goals corresponding to this function. The function of a goal-oriented program is usually connected with the development of public production and the solution of a specific complex problem of this development, i.e., transformation of the economic system from one qualitative state to another. The nature and scale of the problems to be solved go beyond the functional possibilities of single, stable structural units. The program goals connected with the solution of development problems and formulated as inter-industry or interdepartmental complex goals do not coincide with the goals of the stable structural units. Therefore, the program plays the role of a temporary structural unit having different degrees of organizational integration depending on the form of its management. It becomes fully independent (economically and organizationally) when a special program management system is created [5].

1.2. The Economic Organization as a System

The term "economic organization" may refer to different management links in the national economy, such as ministries, industrial associations, production amalgamations, individual enterprises, and program management systems. Any organization is an integral part of society as an "organic" system, as Karl Marx pointed out. It functions in accordance with the laws of the particular socioeconomic system (e.g., socialism, capitalism) in which it is rooted. At the same time an organization is a social entity with its own principles of origination, development, and natural growth. An organization can also be viewed as an instrument for achieving certain goals (e.g., contribution to the growth of social well-being in a socialist society, or maximization of profit under capitalism).

The socially determined character of an organization's functioning makes it inappropriate from a scientific point of view to study an organization *per se*, without taking into account its relationships with the society in which it originates and functions, together with the specific socioeconomic and cultural conditions. At the same time there are some universal features of the formation and utilization of an organization "as an instrument": i.e., principles and techniques of designing organizational structures and information and decision-making systems, styles of management, patterns of behavioral orientation of an organization's members, etc. These instrumental aspects of an organization are of great importance in a planned socialist economy.

It is important to note that, unlike other social systems, an economic organization is a controllable system where control actions (influences) aimed at stabilizing and developing the system are consciously elaborated and implemented. From this point of view an economic organization is an adaptive, self-organizing, and self-developing system. It is a cognitive and a self-instructing system functioning with information about the problem to be solved that is inadequate to a greater or lesser extent.

The modern approach to economic organizations as systems involves identification of the organizational components, aggregation of these components into subsystems, and study of the structure and dynamics of their interrelationships. It is possible to identify the following conceptual subsystems of an organization considered as an open system:

(1) The organization's external environment. This is characterized by the economic, social, political, and other types of societal relationships, as well as by the particular input–output relationships at the organization's boundaries that arise from its objectives.
(2) The organization's objectives and strategies. These also stem from its role in a larger system (i.e., production, research, educational, etc.) and define the desired end-results in more specific qualitative terms under the given resource constraints and external conditions. The objectives and constraints together define the "organizational task".

(3) The organization's technological subsystem is the totality of its facilities, buildings, raw materials, and other physical resources, skills, and know-how, together with its technological processes of operation. The composition of this subsystem determines the primary resource potential, size, and territorial dispersion, as well as the logistic and information networks of the organization.

(4) The organization's management subsystem. This embraces the structure and processes of management, leadership, and behavioral characteristics of the organization (motivations, attitudes, climate, etc.).

The organization's external environment, goals, and strategies, as well as its technological subsystem, are the ***primary variables*** that determine the ***management system variables***. However, the most important point is that there are complex, reciprocal relationships between the primary variables and the management variables; changes in one of the above four blocks of the organizational system necessarily cause changes in other blocks. Moreover, there are certain regularities or patterns that define the interrelated values of the variables of the four blocks.

In designing management systems one should view an organization as an intergrated set of matter–energy and information processes. The matter–energy processes involve transformation of raw materials into final products and/or services. The information processes lead to "information models" of the matter–energy processes and also of the results desired by members of the organization. Both types are essentially labor processes consisting of purposeful human activity, the specific object of the work, and the means chosen to carry it out.

Information processes (retrieval, recording, storage, etc.) are carried out through particular means of information heading, such as computers, printing machines, telephones, and communication networks. These constitute the technical basis of management. The management itself (information processing and decision making) is a goal-oriented joint activity of the organization's members aimed at bringing order and coordination into all the organization's work processes.

Organizational effectiveness can be increased both by the introduction of more productive facilities, advanced technological processes, and modern information-processing technology, and by the exercise of a more direct influence on the activity of the organization's members participating in the production and management processes.

The organization as a complex system is comprised of qualitatively different, interrelated elements. A meaningful description of this complexity therefore requires an appropriate variety of qualitatively different terms and concepts. Hence, a multidisciplinary approach is needed in organizational research. In particular, Marxist–Leninist political economy and philosophy study the fundamental laws of development of socioeconomic structures and relationships, the functions of economic organizations in a larger society, and the nature of their goals. Jurisprudence and political sciences investigate the nature and mechanisms of the allocation of authority, responsibility, rewards, punishments, and contractual and legal relationships among economic organizations, etc. Cybernetics and mathematics develop formalized models of the functioning and development of organizations. Social science and social psychology investigate the patterns of social behavior of individuals and groups and the problems of work cooperation, subordination, mutual help, and motivation in organizations. Various branches of applied economics deal with problems of concentration, specialization, and cooperation in production, with problems of planning and economic profit-and-loss accountability, with economic methods of management, with the economics of labor, etc.

Management science seeks to synthesize the insights of all these disciplines and to develop an integrated methodology and technique for the design, management, and development of economic organizations.

1.3. The External Environment of Socialist Economic Organizations

The external environment consists of everything that is outside a given organization and which essentially affects it. One can distinguish three main types of environment.

1.3.1. Socioeconomic Environment

The general socioeconomic environment of an organization includes the elements of a unified socioeconomic macrostructure of the socialist society, such as the basic socioeconomic characteristics (dominant form of ownership of the means of production, class division of society, type of state and political system, etc.), the economic strategy of the socialist state that determines the long-range development of society through a system of national economic planning, the current technological level of the economy, the economic and other legislation common to all organizations of a given type, the sociocultural conditions of activities both general and specific to the region in which the organization operates (national, climatic, etc.), the ecological conditions in the region, the international and defense factors, etc. As a rule the general environment dictates the general directions of and constraints on the activities of a particular type of organization and also influences these activities indirectly, though the state of some environmental components (ecological, defense, or other national requirements, etc.) may strongly influence the activities and development of specific organizations.

1.3.2. Organizational Task Environment

The organizational task environment is the productive (economic, financial, etc.) and nonproductive (social, educational, etc.) environment of a particular organization that directly affects the formulation of its specific goals and objectives and their implementation. The organizational task environment is as a rule more specific than the general environment, but is also fairly differentiated. The organizational task environment can be broken down into "subenvironments" such as the following:

(1) The administrative environment (superior and other economic authorities directly affecting the organization).
(2) The economic environment (suppliers, consumers, agents, product market, financial system, labor-force sources, transport, etc.).

(3) The technological environment (the R&D system whose results are employed by the organization, the system of information, personnel training and development, etc.).
(4) The regional environment (settlement patterns, social infrastructure, social environment, natural environment, etc.).

The internal structure of an economic organization is strongly influenced by the structure of its external environment. Note that individual subsystems of an organization may communicate independently with certain outside bodies: the planning and finance departments of an enterprise communicate with the planning and finance departments of an All-Union industrial association or ministry; engineering services have contacts with the engineering office of the ministry, with branch research institutes, etc. Relationships with other elements of the external environment (customers and consumers, trading, delivery system, labor force, etc.) may also be organizationally formalized. All this requires specific mechanisms and organizational forms with respect to organization–environment interaction. These can be both formal and informal, and exercised by the organization as a whole, by particular subsystems, or even by individual representatives of the organization.

1.3.3. Internal Organization Environment

The internal organizational environment consists of those general conditions within the organization that determine the goals, objectives, resources, and other constraints that are external to the individual subsystems and to the units of the organization in the implementation of the tasks assigned to them. Factors of internal organizational environment include the following: the type and general level of technology and production engineering; the organization's personnel; the availability of fixed assets, materials, and financial resources; the territorial location of organizational units and their administration; working conditions and the degree to which the needs of the personnel are satisfied; general regulations, directives, instructions, etc. Of special significance are the evaluation criteria, values, standards,

orientations, and attitudes of organization members, of external or internal origin, which determine their attitude to labor and the identification of personnel with organizational objectives and interests.

For socialist enterprises, the role of the market subenvironment (to the extent that socialist money–commodity relations operate in a given segment of the economy) is insignificant compared to that of the administrative environment. Each enterprise or amalgamation enjoys a certain degree of autonomy in business operations, but is at the same time part of a larger hierarchical system that is centrally controlled and managed. Thus, an industrial enterprise may constitute a subsystem of a production amalgamation which, in its turn, is a subsystem of some branch (subbranch) of industry, i.e., of a ministry (All-Union industrial association). The latter is a subsystem of socialist industry as a whole, which is part of the total national economy, and so on. Sometimes an enterprise is treated as a subsystem of a territorial industrial complex, which is part of a republic economic region. Thus, the major inputs and outputs of an enterprise are controlled by the centralized planning and administrative agencies and the management of the enterprise may influence its environment through the superior agencies.

1.4. Goals and Strategies of Economic Organizations

The main features of socialist economic organizations are the close ties between their goals and those of branches and subbranches of the economy that are, in their turn, linked with the goals of the entire national economy. The goals of the socioeconomic development of the USSR are the central issue of the economic policy of the CPSU, as spelled out in its various program documents. These goals are behind the five-year and current plans approved by the Supreme Soviet of the USSR. This policy reflects the basic economic law of socialism whereby the primary goal of public production is the *fullest possible satisfaction of the material and cultural needs of the people*. The highest goal of the economic policy is specified in a system of national economic plan indicators (target figures), which form the

basis of planned targets for industries, regions, amalgamations, and enterprises in the economic system. Formulation and quantification of goals for economic organizations is the primary responsibility of economic authorities assisted by the broad masses of working people (the principle of democratic centralism) and is based on recognition of the objective laws of development and of the specific requirements of the entire economic and sociopolitical system [6].

At present the goals for the development and functioning of the organizations are closely integrated through the long-range, five-year, and annual plans of the USSR national economy. The framing of advanced plans starts with elaboration of a 20-year program of scientific and technological development (broken down into five-year periods). The primary responsibility for this is assigned to the Academy of Sciences of the USSR, the USSR State Committee for Science and Technology, and the USSR State Committee for Construction. On the basis of this program the USSR State Planning Committee (Gosplan) elaborates ten-year plans for socioeconomic development in which the key targets for the first five-year period are specified on a year-by-year basis, while the targets for the second five-year plan period are presented in aggregate form. Special emphasis is placed on goal-oriented, comprehensive programs in different areas of scientific, technological, economic, and social development.

To harmonize the plans for various branches, spheres, and types of activity with the development of the entire national economy, the most significant aggregate targets for production growth rates, volume of investments, standards of productivity and resource consumption, etc., for industrial branches (ministries, industrial associations), production amalgamations, and enterprises are elaborated and approved for the five-year plan period. On this basis ministries and agencies of the USSR, Councils of Ministers of Union republics, amalgamations, and enterprises work out their own detailed plans broken down by years.

The five-year plan of an economic organization is, on the one hand, a medium-term strategy for its development and, on the other, a yardstick for assessing its progress. In particular, the annual plan targets must not be lower than those detailed in the five-year plan for that specific year, and their accomplishment is

evaluated by incremental calculation. Thus, should an enterprise fail to fulfill the plan for the first two years, it will still have to both accomplish the plan set for the third year and compensate for the underproduction during the two preceding years.

Management of current business activities is carried out with a view to the directive targets of the organization's annual plans. Such targets include:

(1) Production targets (volume of output in physical terms, volume of contractual deliveries).
(2) Labor and social development targets [labor productivity, growth, limits on the total numbers of workers and employees, and (in certain industries only) the wages and salaries fund].
(3) Financial targets [aggregate profit (in some branches, reduced product cost) and payment relations with the state budget].
(4) Targets for the introduction of new technologies and advanced techniques (targets for the development, assimilation, and introduction of new processes and products, for the implementation of technological programs, and for the introduction of advanced techniques in technology, scientific organization of labor, production, and management).
(5) Procurement targets (volume of material supplies required for execution of the plan and the targets for reduced consumption rates).

This general basis for goal setting and the planning of business activities is determined by a host of factors: the economic, social, and technological goals of society at different stages of its development, the function of the particular economic organization and its place in the social division of labor (which determines the type of goals it will have), as well as other specific conditions within the system. Two points should be stressed in this connection:

(1) The goals of an economic organization involve indicators of two types, namely, physical and value indicators. Profit is an important example of the latter type. The profit

indicator has a dual nature. On the one hand, the excess of benefits (in monetary terms) over costs is the general basis for assessing the economic efficiency of any activity, irrespective of its socioeconomic environment. On the other hand, profit, depending on the matter of its distribution, is the realization of a certain form of economic relations. In particular, under capitalism it is appropriated (minus all payments) by the owners of the capital and is used for reinvestment and consumption, while under socialism profit is a value assessment of the "product for society", i.e., that part of the product which is used for reproduction on an enlarged scale and for improving the welfare of the members of the socialist society. The use of profit in a socialist economy as a special indicator of business activities is determined by its instrumental (and not socioeconomic) function as a basic indicator of efficiency.

(2) ***The degree to which the planned targets are achieved by a socialist enterprise is a criterion for evaluating its progress and the formation of its incentive fund.*** The incentive fund is formed from the profit of the enterprise. Thus, a five-year plan specifies a share of the profit to be allocated to an encouragement fund (fringe benefits), sociocultural measures (cultural programs, recreation, sports, etc.), and housing construction. This creates group (organization-wide) incentives to increase the profits.

From the managerial point of view, the directive (assigned) indicators described have one distinguishing feature: they cover both the final goals (output, growth of profit, productivity, etc.) and the intermediate objectives (limits on personnel, the volume of allocated resources, etc.). In describing an organization as an integral system, however, it is worthwhile to concentrate primarily on the formulation of its final goals and then on their disaggregation into a system of intermediate objectives.

There is a close relationship between the complexity of economic organizations and their multiobjective nature. The consideration of a variety of objectives in a single measure is an abstraction, which cannot be employed for the solution of concrete problems in economic management. In practice, although

conscious of the interrelations existing, managers have to consider, more or less separately, large classes of goals that primarily affect the specific requirements of their own organization, as influenced by political, production, economic, technical, social, and various other factors.

Theoretical research and design experience show that the top managerial level of economic organizations should be assigned four groups of major goals:

(1) *Production goals* connected with the particular needs of society for the organization's products or services.
(2) *Economic goals* characterizing the contribution of the organization to the national revenue, the maximum productivity of labor, and the optimal use of resources.
(3) *Technological goals* oriented toward the introduction of new technologies and production equipment, progressive materials and products, advanced scientific ideas, etc.
(4) *Societal goals* specifying the role of the organization in solving the program tasks of social progress, in meeting the social needs of working people, etc.

Objectively, these goals are closely interrelated, just like the activities they control. All four classes of goals are of the same order of significance, though some difference in their priorities may result from the principal role of the organization concerned. For example, the role of an amalgamation or enterprise is determined by its production goals (though it cannot function rationally without also reaching its economic, technological, and sociopolitical goals), while the basic function of an R&D and production amalgamation is determined by technological goals, etc. [7].

The formulation of an organization's goals is not only a formal act of planning and organizational design, but also a social and psychological process of the cooperative realization of the goals through attention to the interests, motives, and stimuli of the labor activities of many individuals who have consciously united for joint work. Their activities are formalized by the requirements and constraints that are common to the entire organization, but each one of them is assigned tasks aimed at different

subgoals, be it the development of new products, the accomplishment of a current production plan, the assimilation of capacities, etc. Because of the division of responsibilities for separate spheres of activity, the members of a team perceive (interpret) in different ways the meaning and significance of the various goals and subgoals of their economic organization. These goals, supplementing each other, may be formulated in different ways, but their socioeconomic substance is not contradictory at all, reflecting the unity of the socioeconomic foundation of socialism.

CHAPTER TWO

Management of the National Economy: Organizational Structure

2.1. The Bodies Responsible for State Management of Public Production

The organizational structure of the management of socialist public production includes management bodies of subsystems of public production and, through the links of these bodies, defines their functions and relations. In addition, this form of management organization requires a special mechanism to ensure goal-oriented and coordinated interactions of all the structural links in a single economic complex. This function is performed by special structural links, which are also part of the management organizational structure.

Under a socialist economy a considerable part of the functions of public production management is performed by the state represented by its various bodies. In the USSR, apart from the state bodies, other management units include public (nongovernment) organizations, citizens of the country, and political organizations, among which the leading and guiding role belongs to the CPSU. Public and political organizations, as well as individual citizens, participate in management at the stages of defining the directions of development of the national economy or of preparing the most important economic decisions. They also exercise

control functions. Their participation in management and the forms of such participation are defined by the Soviet legislature for all the levels of public production management. State bodies and organs of public and cooperative organizations cover the full range of the management functions of the national economy, each to the extent that it is responsible. For instance, CPSU bodies, from primary local organizations to the full party Congress, actively participate in the management of socialist production. In particular, the guidelines for the development of the national economy for the five-year period that are discussed and adopted by the CPSU Congresses are the basic documents for the elaboration of state plans for socioeconomic development and determine the goals of public production [8].

State bodies can be divided into two main groups according to their functions in public production management. The first group includes representative organs (the Supreme Soviet, the Presidium of the Supreme Soviet, Soviets of People's Deputies), which perform legislative functions, establish the most general objectives, and issue directives as to the ways in which these are to be achieved (thus, they formulate economic policy, consider and approve plans, budgets, make production laws, etc.). These bodies set up standing committees for individual spheres of production–economic activity. The committees do not make final decisions, but present their proposals to the Supreme Soviet. They also perform control functions. There are committees in the areas of planning, budget, industry, transport, communications, agriculture, etc.

The other group of bodies (the Council of Ministers of the USSR, the Councils of Ministers of Union republics, ministries, and some other agencies) performs mainly executive-directing functions. These bodies head separate economic subsystems of public production (links) and ensure their goal-oriented and coordinated functioning and development.

A special place in the system of public production management is occupied by the organs of the courts and the General Attorney's office, which ensure observance of the legally established order and protection of the economic rights of all the participants in economic activities.

The representative organs of power are formed in accordance with the state structure of the USSR on the federal principle and are divided into organs of the USSR (All-Union organs) and organs of the Union and Autonomous republics. Each republic has its own government organs, analogous to the All-Union organs.

The federal structure is a basis for delineation in the public production of large, territorial production complexes. In accordance with the territorial division there are the following territorial units in Union republics: ***krais***, ***oblasts***, autonomous ***oblasts***, districts, and ***okrugs***. All the territorial administrative units have local bodies that perform legislative and executive-directing functions. These are the Soviets of People's Deputies and the Executive Committees of local Soviets. The Soviets of People's Deputies have various standing committees that prepare and consider decisions concerning the management of production in the given territory and ensure control over their implementation.

Among the public production management bodies that perform executive-directing functions we can distinguish between those with general and those with particular responsibilities, depending on the scope of their functions. In accordance with the federal and regional principles on which the national economy is divided, there are bodies for general management of the national economy and its regional subsystems: the Council of Ministers of the USSR and the Councils of Ministers of Union and Autonomous republics and Executive Committees of the Soviets of People's Deputies (for each territorial administrative unit of the Union or Autonomous republic). The Soviets of People's Deputies contain specialized production agencies or departments which directly supervise production enterprises and economic organizations subordinate to them. The republic bodies are simultaneously administrative and economic centers of territorial links of public production.

In addition to regional subsystems in the organizational structure of public production there are branch links headed by bodies with special responsibilities: Union and republic ministries, chief agencies, branch agencies, and departments of the Executive Committees of local Soviets of People's Deputies.

The system of state bodies managing separate economic units includes the managerial staff of All-Union (republic) industrial associations, production amalgamations, enterprises, and research, design, and other economic organizations.

The intermediate position between the bodies that carry out general management of the national economy (and their republic counterparts) and the branch management bodies is occupied by the so-called functional, interindustry management bodies. These bodies can be conveniently grouped into two categories. The first category ensures coordinating, regulatory, and control functions of complex branches or large spheres of economic activity. The second category exercises individual, specialized management functions for all the branches of public production. These functions include state planning, accounting, control, and legal regulation. This second category forms a system of management links in the organizational structure that ensures interrelated and goal-oriented functioning of all the links of the national economy.

These bodies are usually set up in the form of USSR State Committees, though the functions of interindustry management are also performed by specific ministries (e.g., the Ministries of Finance or Justice). In the management structure there are two main types of body: those with collective management and those with unity of command. The former are bodies with general responsibilities, while the latter are bodies with specific responsibilities, mostly branch bodies of state management. Committees and other bodies of interindustry management are, as a rule, collective management bodies. Despite the unity of command principle established by economic legislatures for ministries and economic organizations subordinate to them, collective forms are acquiring an ever greater role in the preparation and adoption of the most important long-term economic decisions and decisions on social problems. In the implementation of the latter, an active part is also played by public and political organizations.

The Council of Ministers of the USSR is the highest executive and directing body of state authority in the USSR. The Council of Ministers has the power to pass decisions on all matters of state management within the authority of the USSR. It is appointed by the Supreme Soviet of the USSR and consists of the Chairman of the Council of Ministers of the USSR, first deputies

and deputies of the Chairman of the Council of Ministers of the USSR, ministers of the USSR, and Chairmen of the State Committees of the USSR. The Council of Ministers of the USSR also includes Chairmen of the Councils of Ministers of the Union republics.

Within its sphere of responsibility the Council of Ministers of the USSR directs and coordinates the activities of the Councils of Ministers of the Union republics in the implementation of the decisions of the higher bodies of state authority and management of the USSR. It thus ensures the necessary interaction between the Councils of Ministers of the Union republics, ministries and State Committees of the USSR, and other organizations subordinate to it in exercising their duties and responsibilities and implementing the plans for economic and social development, *viz.*, the important and comprehensive All-Union, interindustry, and regional programs (see *Figure 2.1*).

The Council of Ministers of the USSR integrates and directs the activities of the All-Union and Union–republic ministries, State Committees, and other subordinate bodies, undertakes measures for the implementation of the social and economic development plans and the state budget, and for the consolidation of the credit and monetary system.

The Councils of Ministers of the Union republics are the highest executive and directing bodies of state authority of the Union republics. The Council of Ministers of a Union republic integrates and directs the activities of ministries and agencies of that republic and undertakes measures for the implementation of social and economic development plans and the state budget of the republic. The Council of Ministers of a Union republic interrelates with its subordinate organizations on the whole according to the same principles, and exercises its authority in public production management along the same major directions as does the USSR Council of Ministers. It controls and monitors the management of enterprises of All-Union subordination located in the territory of the republic. The republic bodies also actively participate in defining perspectives and in planning the development of these enterprises during the preparation of the territorial dimension of the state plan of the USSR.

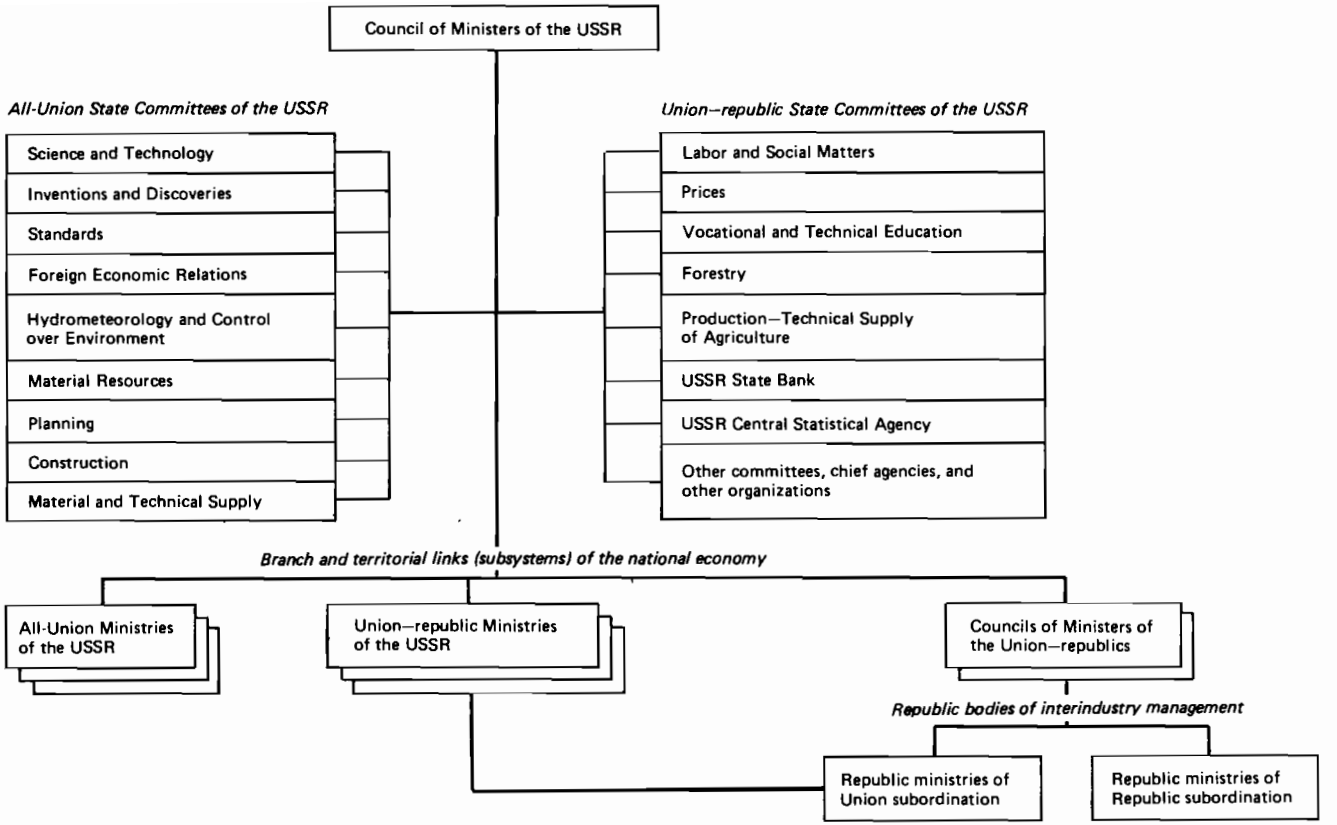


Figure 2.1 Structure of the management of the USSR national economy.

Interindustry management is realized through a system of management bodies engaged in activities that ensure the coordinated, goal-oriented functioning of all the economic links, integrated organizationally into branch and regional complexes. The first group of interindustry management bodies controls complex branches (the operational subsystems) of the national economy or spheres of economic activity (construction, forestry, R&D, scientific and technological progress, material and technical supply, marketing), resources (labor and material), and finance and the banking system. The second group of bodies performs separate, important functions of centralized state management: planning, accounting, control, and legal regulation.

The central place in the organization of the management of the national economy is occupied by the planning of public production, which is performed by a system of planning bodies, including the State Planning Committee of the USSR (Gosplan), the State Planning Committees of the Union and Autonomous republics (republic Gosplans), and the planning Committees of the Executive Committees of regional (*oblast*), city, and district Soviets of People's republics. These planning bodies, within the organs of general responsibility, carry out general, integrated planning of the national economy in close coordination with the planning units of other interindustry management bodies and economic units. All these planning bodies and planning units in economic organizations make a single planning system that is integrated by the overall procedure for preparing and approving plans of all levels and by common methods and forms of planning, planning accountability, planning targets, and sets of economic standards (*Figure 2.2*). Through this special functional link in the organizational management structure the entire economic mechanism of management of the national economy is brought into action.

Gosplan carries out state planning of the national economy of the USSR and controls the implementation of the national economic plans. The main task of Gosplan is the elaboration of national plans for social and economic development, based on the study of national needs in accordance with the directives of the Central Committee of the CPSU and the decisions of the Council of Ministers of the USSR. These plans ensure proportional development of the national economy of the USSR and a steady growth

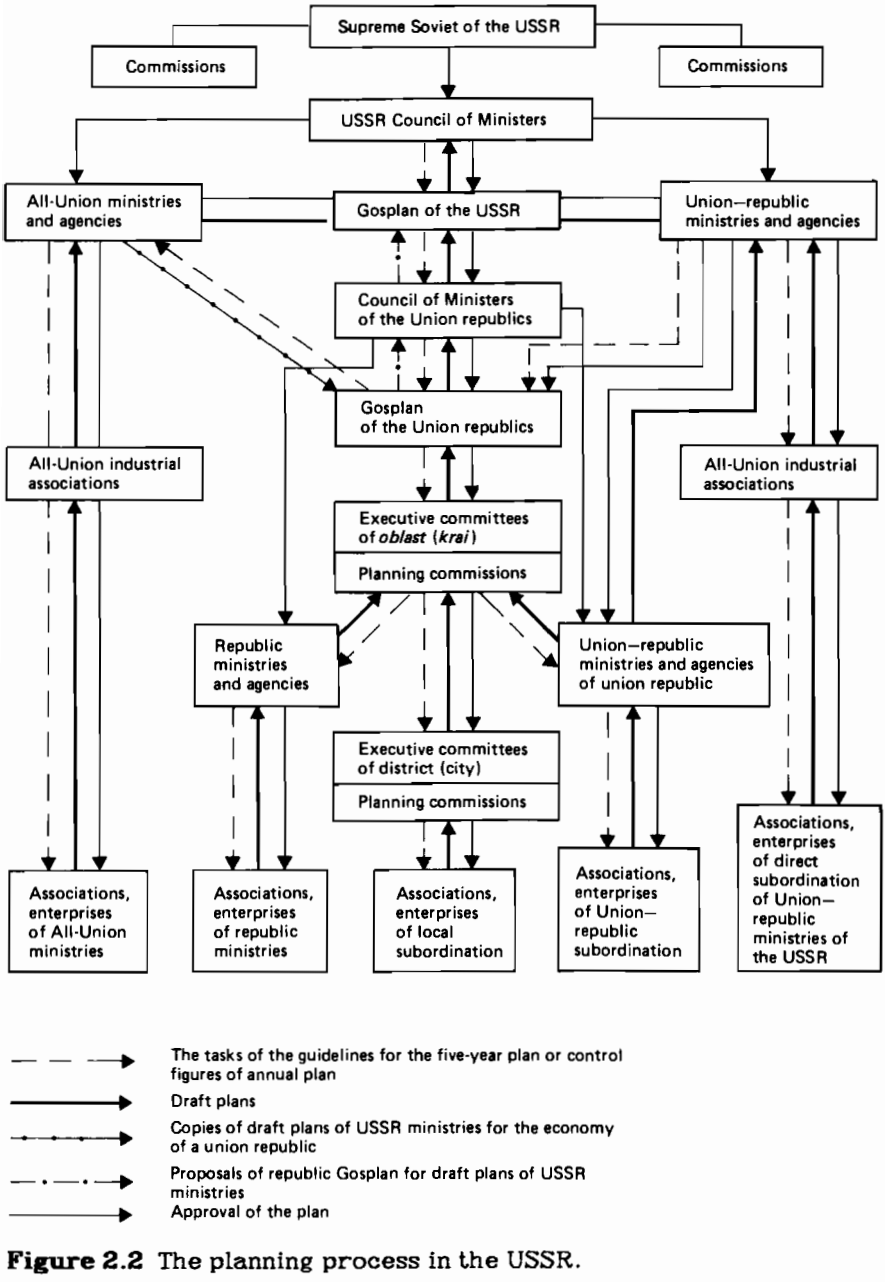


Figure 2.2 The planning process in the USSR.

and higher efficiency of public production for the fullest satisfaction of the material and nonmaterial requirements of the people.

Gosplan formulates draft long-term and annual plans, considers the draft plans of the Union republics, ministries, departments, and agencies of the USSR, and coordinates and mutually adjusts the plans of branch ministries, the Union republics, and comprehensive national economic programs. It approves plans for material balances and distribution, as well as allocation schemes aimed at economizing on material resources, and it controls the implementation of social and economic development plans by ministries, other agencies, and the Union republics.

Gosplan is also a planning research center. It elaborates and introduces advanced planning methods for all the links of public production, analyzes the implementation of plans, explores possibilities for achieving higher efficiency within the national economy, and spells out measures for preventing disproportionate economic development. It is responsible for providing a scientific basis for state planning and for introducing new methods and forms of planning. Gosplan performs its tasks and functions both directly through its own staff and indirectly through the system of subordinate planning bodies in the Union republics, regions, *oblasts*, districts, and cities.

Gosplan itself is a collective body with three main components: the top Gosplan management, the Gosplan staff, and affiliated organizations. The last named are planning research centers engaged in economic analysis and scientific methodological research into the planning process. The top management of Gosplan consists of members of the State Planning Committee, headed by the Chairman and his deputies; the Gosplan collegium is selected from this group. The Chairman of Gosplan is at the same time Deputy Chairman of the Council of Ministers of the USSR.

The central apparatus of Gosplan consists of branch, integrated, and balance departments, together with various other specialized structural units.

Branch departments deal with planning of the entire range of mandatory targets of the state plan with respect to branches of industry. The structure of these departments corresponds to

the structure of public production of the respective branch. The aim of the integrated departments of Gosplan is to coordinate plans for particular production targets (involving separate specifications for resources, capital investment, finance, production costs, etc.). The departments of territorial (regional) planning and territorial allocation of productive forces, as well as special departments for planning the creation and development of large-scale territorial production complexes, are also integrated departments. The balance departments prepare material balances for all kinds of production (fuel, metals, equipment, etc.) and integrated departments plan for the distribution of material resources over the whole national economy.

Among the integrated departments the department of the national economic plan has a special role. This department draws up the overall national economic plan and elaborates methods of plan formulation for other departments of Gosplan and other planning bodies. The Gosplans of the Union republics have an organizational structure similar to that of Gosplan of the USSR; they perform similar functions of planning the social and economic development of the republics and submit proposals for the plans of enterprises and organizations of All-Union subordination.

Like the bodies of interindustry management described above, other state committees and agencies also plan, organize, and coordinate activities of all the links of public production under their authority and also exercise control functions. As a rule they act through a wide network of subordinate local bodies and organizations and also via functional supervision of the activities of management units performing similar functions in other structural links of public production.

As an example, let us consider the R&D management organization that deals with the complete cycle of the generation and application of scientific knowledge for socioeconomic development. R&D proper forms the core of this process. Its organizational structure incorporates a group of specialized organizations and units that form part of various branch units of public production. In branch units scientific and design organizations support production activities, while the respective basic and applied research is largely effected within the framework of the USSR

Academy of Sciences. A great volume of research and development pertaining to different fields of science is pursued in the higher educational institutions.

Although R&D is organized mostly along branch lines, it constitutes a specific sphere of activities, having its own dynamics, expenditure of resources, outcomes (yields), internal relationships, and forms of organizations.

An R&D complex in the system of the national economy has stable interindustry and regional relationships between basic and applied research, and between applied research and production. A characteristic feature of this sphere of activities is the wide range of application of the scientific and technological results which may be applied beyond the range determined by the production and technological needs of the given branch or individual enterprise. In addition, the development of the socioeconomic system creates new social and production needs, calling for comprehensive interindustry scientific and engineering support and for more complete and flexible use of the existing R&D capacity.

All these factors call for corresponding centralized interindustry R&D management. In the USSR a special system of R&D management has been set up (*Figure 2.3*). Interindustry management functions in this system are performed in the first place by Gosplan, the USSR State Committee for Science and Technology, the USSR State Committee for Standards, the USSR State Committee for Inventions and Discoveries, and the USSR Academy of Sciences. The centralized organization of R&D is implemented in conformity with a unified five-year plan for research, prepared by the State Committee for Science and Technology, the USSR Academy of Sciences, and Gosplan, as a component part of the economic and social development plan. This plan defines major comprehensive problems, research tasks of national economic and interindustry importance, the participants in the activities, and the cooperation required between them, regardless of their normal branch and agency subordination.

The State Committee for Science and Technology, in particular, is assigned the responsibility for organizing the most important interindustry and comprehensive, long-term applied research and design development. The Committee carries out

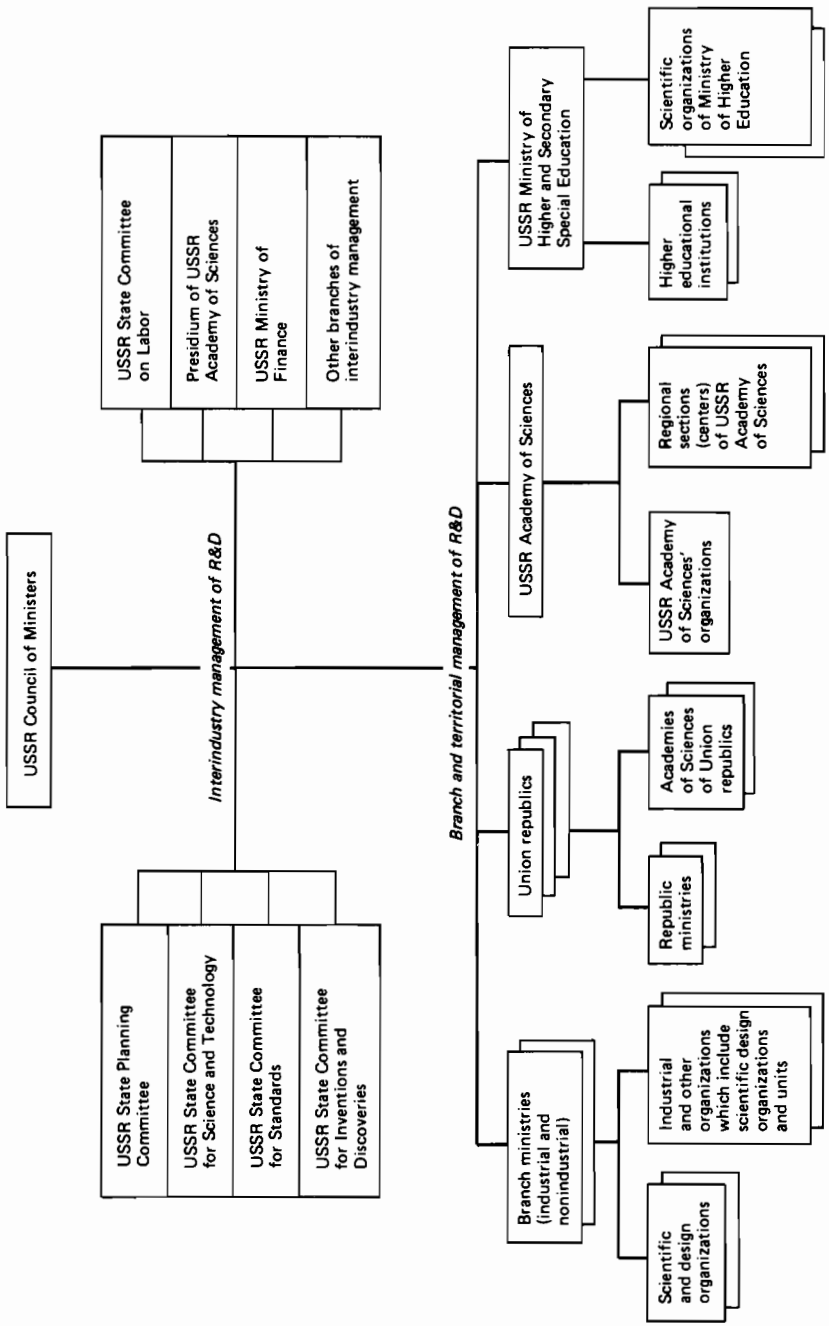


Figure 2.3 R&D management in the USSR.

forecasting, planning, control, and operational management aimed at the formation of a single national policy for science and technology and at the introduction of interindustry and comprehensive research results into practical economic activities. It plans and organizes international scientific and technological relations with other CMEA[1] countries, as well as with capitalist and developing countries.

The Committee provides centralized financial, material, and technical supplies for interindustry and comprehensive R&D, which it formulates in comprehensive R&D programs. The Committee is granted broad authority. In particular, it has the right to assign additional tasks to scientific organizations, regardless of their departmental subordination, and to redistribute financial resources allocated for R&D in Union republics, ministries, and agencies. The Committee has its own centralized funds for the current financing of new projects not included in the five-year plan.

The structure of the USSR State Committee for Science and Technology is shown in *Figure 2.4*. Because of its form and organizational relationships the Committee is a functional body that provides centralized R&D management by functional (not administrative) influence, based on centralized planning, coordination, control, and material and technical supply of the most important projects and their material encouragement. The Committee also provides methodological guidance for R&D organization and planning in branches of industry and Union republics, and issues (within its sphere of responsibility) normative methodological and circular documents that regulate the implementation of R&D in the country. The Committee has the authority to give ministries, agencies, and organizations mandatory directives to discontinue R&D that unnecessarily duplicates research elsewhere or that has neither scientific nor practical significance; it can also stop financing such work.

The USSR national economy has a centralized system of material and technical supply which manages interindustry distribution, supply, and marketing of products, and at the same time

[1]The Council for Mutual Economic Assistance, also known as COMECON.

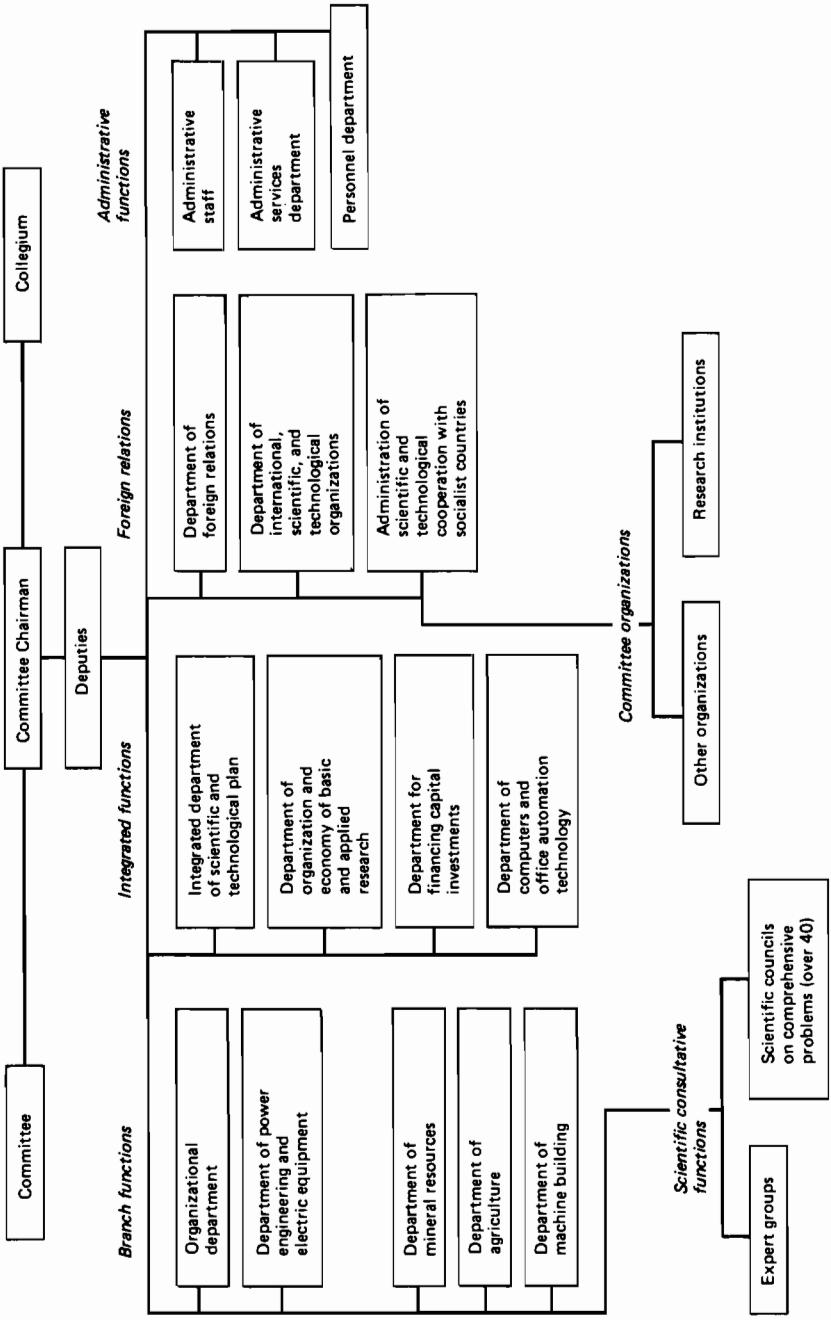


Figure 2.4 Structure of the USSR State Committee for Science and Technology.

conducts economic activities in this field (*Figure 2.5*). The special bodies that manage material and technical supply and market for the entire national economy are the State Committee for Material and Technical Supply (Gossnab) and the State Committee for Production and Technological Supply of Agriculture. In addition, there are special supply and marketing organizations engaged directly in the storage and coordinated supply and delivery of materials and equipment to customers. Management bodies for material and technical supply, and economic organizations subordinate to them, carry out intermediary functions in establishing cooperative relations among production units for the delivery of products according to the centrally approved plans for material and technical supply. Thus, the state committees are organizational centers of special structural networks that directly participate in the planned distribution of material and technical resources and in the management of the material and technical supply of all public production. They also engage in economic activities related to the realization of the material and technical supply plans via procurement, marketing, and trade organizations.

Gossnab is a Union–republic body. Its main tasks are the elaboration, together with Gosplan, of material and technical supply plans for the national economy, the implementation of these plans, the establishment of rational economic relations between producers and consumers of products, the control over the timely implementation of product delivery plans by ministries and agencies, as well as by enterprises and production organizations, and the distribution of products among consumers. Gossnab is also responsible for the soundness of the product delivery plans that it elaborates and adopts, for their harmonization with the plans for production and capital construction, and for the most economic use of material resources.

Together with Gosplan, Gossnab is responsible for methodological guidance in setting the standards for consumption of material resources and control over their effective use and storage. Like Gosplan, Gossnab, within its area of responsibility, directs the functioning of the bodies controlling material and technical supply and marketing that are subordinate to branch ministries and agencies.

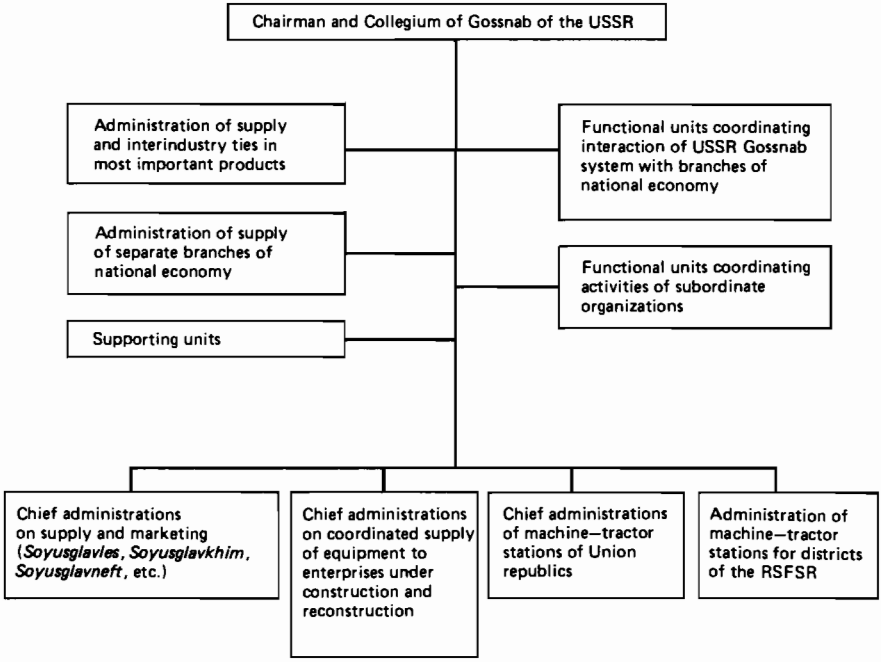


Figure 2.5 The organizational structure of management in the State Committee of the Council of Ministers of the USSR for Material and Technical Supply.

2.2. Branch Management Organization

The management organizational structure of a given branch of industry is determined by the technological and organizational features of that branch of industry, the number and size of its enterprises, their territorial location, and the existence of stable ties between production, scientific, design, and other economic organizations. As a rule, the management organizational structure in branches of industry is based on a three-level (in some cases, a two-level) system. With a three-level system the industrial branch includes industrial associations subordinate to the ministry. Organizations of the main (lower) level are part of industrial associations. Thus, management is exercised according to the following scheme: ministry → industrial association → production amalgamation (enterprise). *Figure 2.6* shows as an example the Ministry for Tractor and Agricultural Machine Building.

In the majority of the All-Union ministries, representing, as a rule, branches of machine building, there are industrial associations that unite the production of separate subbranches specializing in particular kinds of products. In the framework of machine-building ministries there are mostly large-scale production amalgamations and enterprises. These specific features, common to the majority of All-Union ministries, lead to corresponding similarities in the organizational structures of the central apparatus of the ministries, which directly manage the intermediate levels, i.e., the industrial associations. *Figure 2.7* shows the typical structure of management staff within a ministry.

The management organization of a branch is based on the functional principle, according to which all the production–economic units (industrial associations and production amalgamations) are directly subordinate to the minister or his deputies (according to the distribution of authority and responsibility among them). Units of the management apparatus cannot directly interfere in the operational management of production–economic organizations of the ministry, except for in some R&D organizations which are, as a rule, subordinate to the scientific and technological department or the department of capital construction.

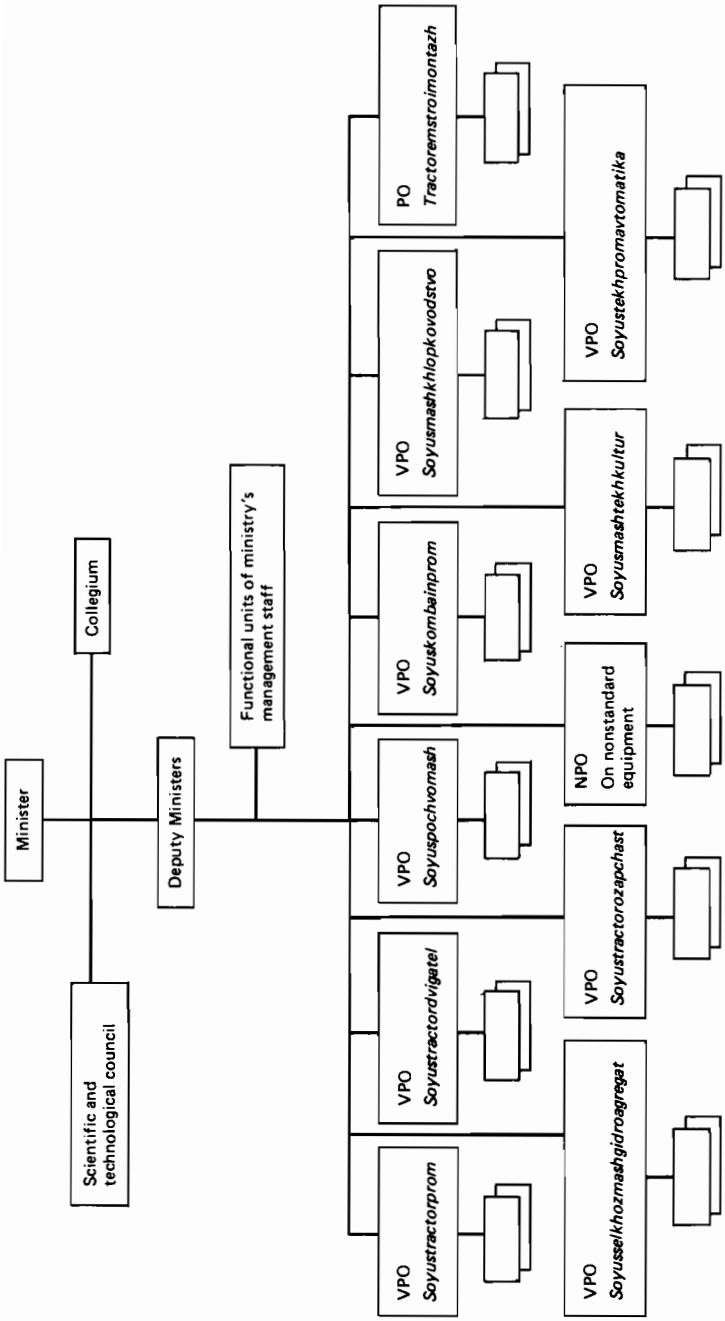


Figure 2.6 The organizational structure of management in the Ministry of Tractor and Agricultural Machine Building.

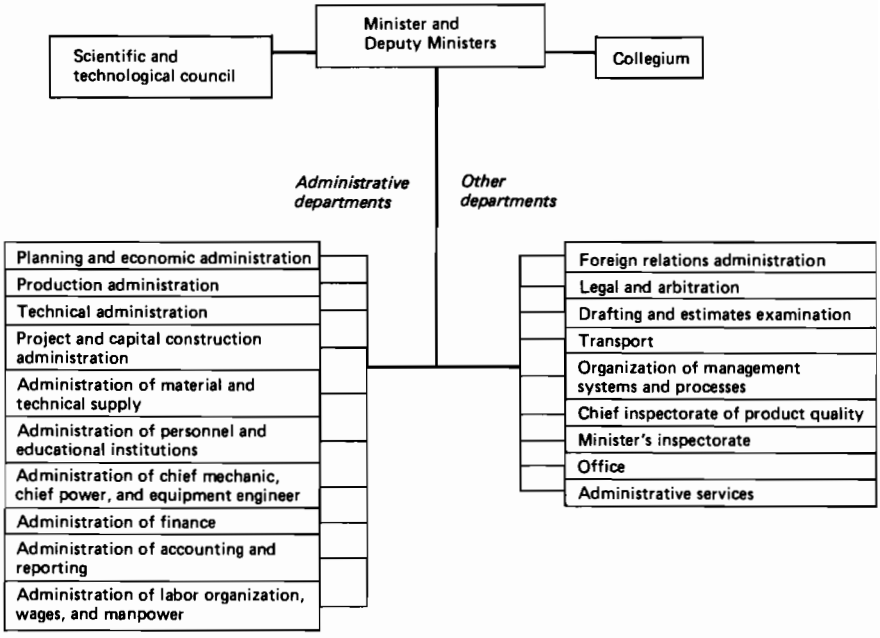


Figure 2.7 The standard organizational structure of management staff in an All-Union ministry.

The distribution of management functions and their assignment to specific units of the management apparatus is realized in the following way.

The minister is personally responsible to the Government of the USSR for the state of affairs in the branch. He is empowered to delegate authority to his deputies to establish the degree of their responsibility and the responsibility of other executives of the ministry for the activities of the enterprises and organizations. He also approves the staff list of the ministry and the status of its structural units.

The Collegium is a consultative body under the minister. It includes, as a rule, the minister, his deputies, and four or five chiefs of ministry departments (not more than 15 persons altogether). The members of the Collegium are endorsed by the USSR Council of Ministers, and they have the right to convey to the Council their opinion if it differs from the opinion of their minister. The Collegium regularly considers reports from executives of the ministry and its subordinate organizations.

The Scientific and Technological Council of the ministry is a consultative body that deals with problems of the scientific and technological development of the branch. Its main tasks are to determine the main directions of the unified R&D policy in the branch, to assess the scientific and engineering level of the branch, and to work out recommendations for improving R&D organization and efficiency.

The main functional departments of the ministry are engaged in planning and coordination. They organize work in the various lines of activity of the economic organizations, and exercise control over the fulfillment of the plans. The planning and economic department, for example, directs the formulation of long-term and current plans pertaining to the volume of production in general and to the most important products and costs of the branch. It ensures the elaboration and harmonization of a single plan for this branch of industry, and is also responsible for the methods and organization of its planning system. The technological department prepares and organizes the implementation of R&D plans and plans for the introduction of new technology and processes.

The production department deals with specializations plans, loading of production facilities, and cooperation in the delivery of raw materials, other supplies, components, or finished products. The department of material and technical supply elaborates plans for material and technical supply, ensures the fulfillment of these plans, and distributes material and technical resources among industrial associations and enterprises directly subordinate to the ministry. The capital construction department elaborates capital construction plans for the entire branch and ensures their implementation. The department of work organization and wages directs the planning of the work force and coordinates the system of wages, the scientific organization of work, and the establishment of norms, standards, and pay rates. The departments of the chief mechanic and the power engineer plan and organize the monitoring and operation of machinery and its maintenance and modernization.

At the same time all the functional units of ministries have analytical and forecasting functions, and perform long-term planning of the branch for 10–15 years. They also organize this work to ensure that the required research is carried out by the scientific and design organizations directly subordinate to the ministry and by the industrial associations and production amalgamations.

Different forms of program- and goal-oriented management are used for the elaboration of integrated long-term plans and for the comprehensive development of a branch.

Union–republic ministries have a somewhat different organizational structure from that of All-Union ministries. (The structure of the Ministry of Timber and the Wood-Processing Industry, shown in *Figure 2.8*, is typical for a Union–republic ministry.) The special feature of the organizational structure of these ministries is that the middle-level management units are organized on the principle of subbranch and territorial units. The ministry also includes republic territorial industrial complexes, i.e., republic ministries that include enterprises of the particular industry in the territory of the republic and that are also middle links in the structure of the ministry.

A special feature of the management structure of a Union–republic ministry is that, besides functional departments similar to those described for the All-Union machine-building

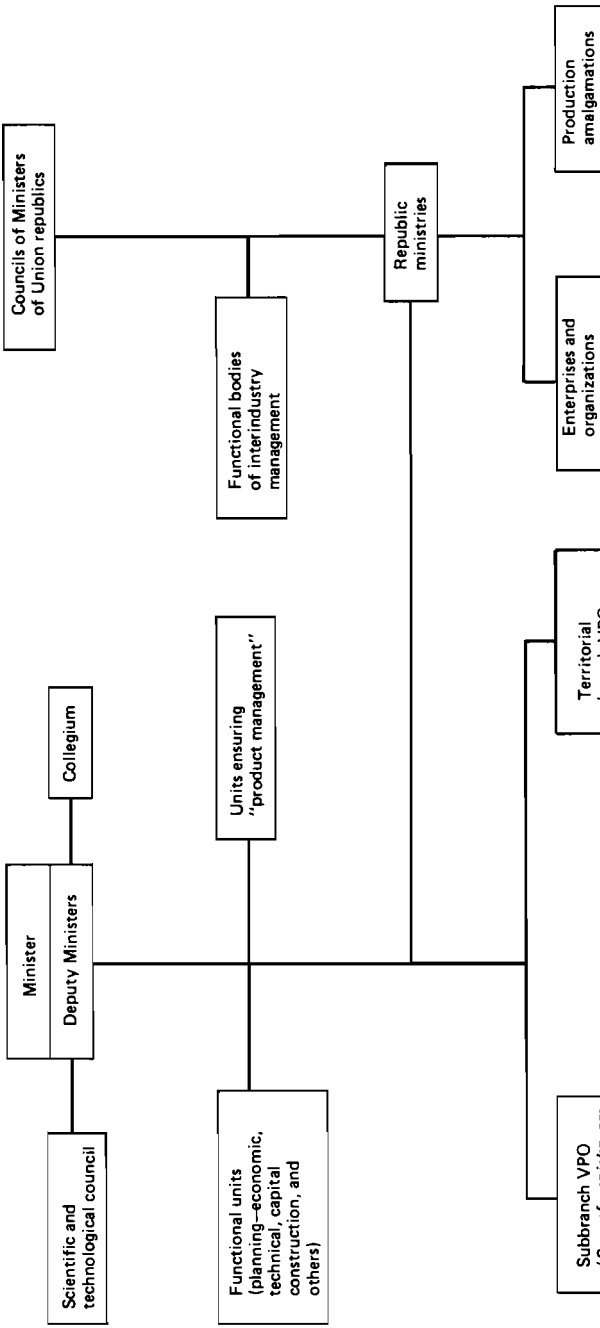


Figure 2.8 The organizational structure of management in the Ministry of Timber and the Wood-Processing Industry.

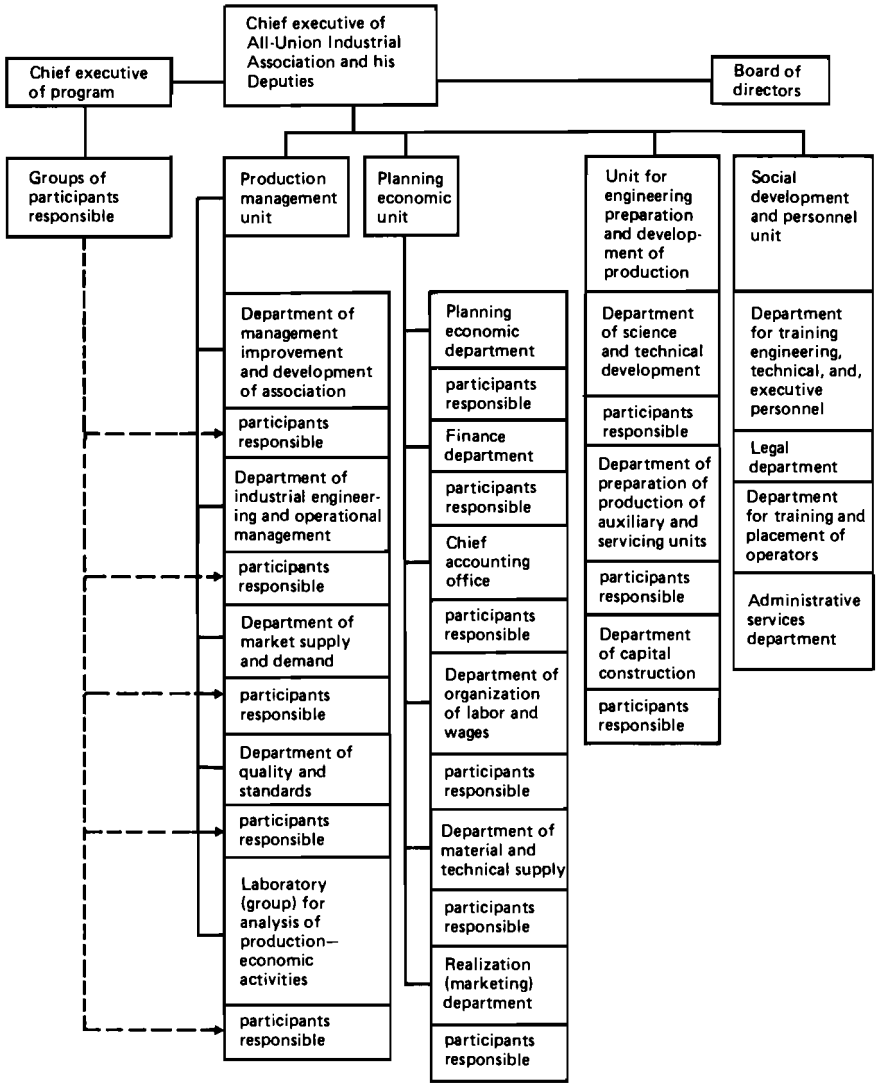


Figure 2.9 The standard organizational structure of an All-Union industrial association.

ministries, there are also functional units ensuring "product management". These units ensure planning and coordination of the activities of economic units in the most important areas of production. They also analyze the level of overall production in the branch of industry and plan and organize measures for the coordinated development of the production of particular products, taking due account of the requirements of the national economy.

The middle links in the structure of the branch ministries (the All-Union or republic industrial associations and also the republic ministries) are, on the one hand, the objects of plans based on the centralized direction on the part of the ministry; and, on the other hand, they are independent production–economic complexes in which the management staff exercises the most important management functions of operation and development for the whole complex and operationally manages the enterprises and organizations incorporated in the associations.

The structure of an All-Union or republic industrial association includes functional units that perform planning, analytical, coordination, organization, and control functions. In the same way as the middle levels are subordinate to the ministry, the enterprises (or lower levels) are directly subordinate to the chief executive of the industrial association or his deputy. The ministry cannot interfere in the activities of the organizations of this basic unit of the industrial association. Thus, both administratively and economically the middle level is for the ministry an individual production–economic organization that performs its economic activities autonomously in accordance with the planned targets set by the ministry. *Figure 2.9* shows the standard structure of an All-Union industrial association.

2.3. Comprehensive Programs in Economic Management

The historically established organizational structure of Soviet national economic management, based on sectoral and territorial principles of organization, has proved helpful for the successful solution of numerous problems in the balanced development of the

national economy. However, the growing scale of the socioeconomic system, the socialization of production, and the closer cooperation of all the economic levels have complicated the problem of interindustrial and interdepartmental coordination. The traditional mechanism of integration, based on the elaboration of a balanced national economic plan and the supervision of its implementation, together with contracts between amalgamations and enterprises from different industries, operates effectively only if the economic activities are fairly routine and do not involve several branches of industry. However, for the solution of new, comprehensive problems of economic development, requiring the joint efforts of industry, construction, and science, and the accelerated creation of basic and secondary infrastructures, it is necessary to frame and implement ***goal-oriented national economic programs***. Socialist management has gained extensive experience during 50 or so years of elaborating and implementing integrated, large-scale programs that have greatly contributed to the national economic development.

It is worth noting that the very first plan for the economic development of the Russian Soviet Federated Republic (GOELRO) was actually drawn up on the program principle. That plan explicitly articulated a general goal which boiled down to higher productivity of public labor based on its intensification, mechanization, and rationalization, while electrification of the national economy was viewed as a principal tool of attaining this goal (Russian Federation's Electrification Plan, 1955, p 43). The goal was to be accomplished through several subprograms developed in two directions, sectoral (five subprograms for electrification and fuel supply, hydraulic power, agriculture, transport, and industry) and territorial (eight regional programs). That long-term integrated program was adopted at the Eighth Congress of Soviets in 1921 and was successfully accomplished in the early 1930s.

In the years that followed, other integrated programs in the areas of large-scale industrial-project construction, of space exploration, of development of the nuclear industry, of promotion of education and health care, of housing construction, of development of large and remote regions, etc., were successfully accomplished in the USSR. A prime example of successful postwar programs is provided by the development of the Bratsk–Ilimsk

territorial production complex. This program was initiated in line with the fifth five-year plan in 1954 and pursued both national goals (promoting the development of the USSR national economy on the basis of the natural riches in the western part of Eastern Siberia and of the development of industries such as the hydraulic power engineering, nonferrous metallurgy, timber, wood-processing, pulp and paper, etc.) and regional goals, such as the construction and development of new cities, of centers of education, culture, and science, of infrastructural branches of industry (construction, transportation, etc.), and of industries of regional significance (manufacture of construction materials, food and light industries, etc.). (This program was studied by an international task force at IIASA in the period 1974–1976.)

In less than 25 years, five of the world's largest hydroelectric power plants were erected on the Angara and Enisei rivers: the Irkutsk (1956), Bratsk[2] (1961), Krasnoyarsk (1967), and Sayansk (1978) stations. The program also envisages the construction of the Boguchansk hydroelectric station (1985–1990). The aggregate capacity of these stations exceeds 25000 MW. Simultaneously, huge industrial enterprises, such as the Krasnoyarsk aluminum production combine (1966) and the Bratsk pulp and paper combine (1965), were built, together with numerous other medium- and small-scale industrial projects. During the same period the regional population grew from 170000 to 297000, and its structure and life style also changed. In particular, the share of city dwellers has increased from 53 to 81%.

In the 1970s great attention was paid in the USSR to the 15-year (1976–1990) integrated program of agricultural development in the non-black-earth zone of the Russian Soviet Federated Republic. Its general objective is to promote intensive agricultural development in an area the size of France. The development is to be based on the overall intensification of agricultural production, on extensive land reclamation, on the integration of mechanization and the use of chemicals, and on the wider application of scientific and technological achievements and progressive techniques. The 35 billion rubles of capital investments should

[2]This station was one of the results of the Bratsk–Ilimsk complex program.

increase agricultural production by a factor of 2–2.5 and transform the working and living conditions in the 29 provinces and Autonomous republics in the European part of Russia.

This program contains three major subprograms (development of animal husbandry and forage, potato and vegetable growing, and production of cereal and industrial crops), as well as nine auxiliary subprograms (land reclamation, cultural and technological projects, the establishment of animal-raising complexes, agricultural product processing factories, production of inorganic fertilizers and agricultural machinery, R&D, rural development, improvement of workers' welfare, etc.). In addition, each of the 29 regions runs an integrated subprogram of its own. Altogether there are 63 large program components to be accomplished by the organizations of 75 All-Union ministries and agencies.

Many other national economic programs, which are similar in scale, complexity of interrelationships, volume of consumed resources, and significance of socioeconomic impact, are to be undertaken in the 10th and 11th five-year periods. These are the development of oil and gas fields in Western Siberia, the construction of the Baikal–Amur railway (BAM), environmental protection, the creation of the Sayansk and Ust–Ilimsk industrial complexes, and the promotion of cooperation with other CMEA member countries.

The direction of the development and implementation of such programs no longer fits into the sphere of control of separate ministries or agencies or regional administrative bodies. The management of large-scale programs requires proper coordination and supervision of the interrelated activities of a variety of production, research, and economic organizations subordinate to different departments, and is possible only through new organizational and managerial mechanisms [9].

Thus, we come to the organizational framing (institutionalization) of yet another component of the USSR national economy, i.e., problem-oriented programs (in addition to the functional, sectoral, and territorial subsystems already considered). This is a significant structural breakthrough in the organization of the Soviet economic system.

It is possible to group programs by several distinguishing characteristics [10]. Our experience in developing organizational

systems for management of the national economic program has enabled us to single out several general classes and the most suitable forms and methods of their management. These are as follows:

(1) *National* programs, pursuing major socioeconomic goals of national significance and simultaneously covering different areas of production and nonproduction activities, and handling public, natural and ecological, and international problems, etc. Examples include programs for developing the world's ocean resources, for environmental protection, for improving the economic management system, and for reducing the differences in working and living conditions between urban and rural areas.

(2) *Functional, multibranch* national economic programs aimed at the solution of large problems connected with the development of a group of industries or with the exercise of an important interindustrial function in the national economy. These programs are distinctly interindustrial or interregional and their ultimate goal is characterized by an aggregate result of activities in a variety of industries. Examples of the problems covered include the establishment and development of an energy base for the 1990 level of production, the attainment of the specified level for the use of chemicals in agriculture, the development of an integrated transportation system capable of handling the specified volume of transportation, and the attainment of the required level of mechanization and automation of the auxiliary and support processes in industrial production.

(3) *Large-scale regional* programs aimed at the transformation of enormous and frequently remote regions through the development and integrated utilization of natural resources, the accelerated development of the predominant branch of industry in the region, and the economic development of the region around its most significant project (e.g., new deposit or power supply station in the West Siberian oil- and gas-bearing region; agricultural development in the non-black-earth zone of Russia; and economic development of the BAM area, are all of this type. Such programs are executed

within strict regional boundaries, but their accomplishment requires joint interdepartmental and interindustrial efforts on a national economic scale.

(4) *Goal-oriented development* programs (interindustrial or interregional), which may be intended to solve a central problem of one of the industries (regions). These aims can be accomplished only through the combination of the large-scale, interrelated activities of many industries, the elimination of imbalances or bottlenecks affecting the national economy as a whole, the acceleration of technological or sociocultural progress in a particular sphere, etc. Related to this type of program are, for instance, programs for the development and assimilation of a new product or process (computer system, synthetic material, discovery-based technology, etc.), the development of certain services on a new organizational and technical base (interindustrial repair and tooling enterprises, tourist and recreation networks, etc.), and the rational reallocation of productive forces. These programs are characterized by the complex and versatile interaction of industries, regions, and spheres of activities, both in the attainment and in the utilization of the planned results.

(5) *Subsystem-oriented* organizational and construction programs aimed at framing the production and economic system around a new construction project, and at the reconstruction, enlargement, and reorganization of operating enterprises and agencies at higher technological and economic levels (the setting up of amalgamations and territorial production complexes, the construction of big enterprises, new cities, etc.). Programs of this type are generally considered as main subprograms in large-scale projects of other classes, but they may often be independent, operating components.

The methods of management organization for the types of programs mentioned have much in common, primarily because of the need to integrate program activities into a unified system in conditions where they are departmentally separated and where their ultimate results depend on the activities of contributors who do not report directly to a single agency. At the same time

there are substantial differences in their approaches to the solution of organizational problems.

2.4. Major Organizational Forms of Program Management

The general and specific features of integrated goal-oriented programs, described in the previous section, presuppose that the corresponding requirements and tasks will be solved by the framing of adequate managerial forms. The types of program-oriented structures, tasks, and functions of separate bodies that must be established for a program may vary markedly, depending on the objective and nature of the program, and on its scope, organizational framework, and time span of execution. However, the distribution of tasks and functions between the levels and major links of management must follow certain, objective organizational principles.

The differences between integrated programs and production hierarchical systems necessitate the establishment of organizational mechanisms capable of handling a host of managerial tasks and functions in a new way. The most common and significant ones are (*Figure 2.10*):

(1) The identification of the program's objective, its structure, and ways of implementing it and utilizing its results.
(2) Elaboration of the program content, selection of program contributors, and distribution of resources between them.
(3) Planned and operational coordination of subprograms and program activities.
(4) Solution or integration of current problems connected with program implementation.
(5) Comprehensive motivation of the program developers and the contributors toward timely, effective, and efficient execution of the program tasks.

Various management organization forms are suitable for solution of these tasks and functions [11]. The most familiar and practiced way is to make all program contributors subordinate to

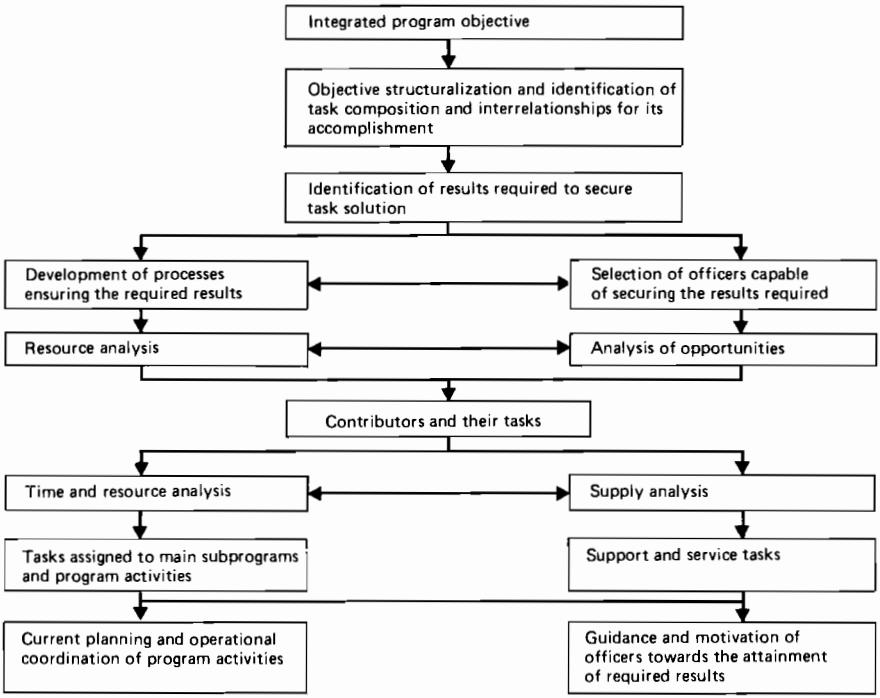


Figure 2.10 Management functions for integrated program development and execution.

one existing or specially established managerial body; this results in the formation of a practically new economic organization of a sectoral or regional system type. Such centralized organizational forms of goal-oriented management may be referred to as *line-program* forms. They are justified when a single, complex, expensive, and long-term program, or a few such programs, have to be realized.

The distinguishing characteristics of the newly established organizational system are its orientation toward a specific objective and its multiindustrial (or multifunctional) internal structure. It cannot, however, be effectively managed and directed from the middle-management level of the system of which it is a part.

Experience in the management of centralized program systems (e.g., the assimilation of aviation and computer technology production, the establishment and running of multiindustrial complexes, and the implementation of a republic environmental protection program) shows that their subordination to a middle-level agency, such as the central sectoral production office of a ministry, an All-Union industrial association, or a functional establishment of the Council of Ministers of a Union republic (provincial or territorial executive committee), is ineffective and does not facilitate coordination, either in the development or in the implementation of the progress.

It is not extraordinary, however, for the centralized systems of sectoral and regional programs to report directly to the highest managerial body, i.e., to the central ministerial office, to the Council of Ministers of a Union republic, or to a territorial (provincial) executive committee. This arrangement may prove effective only if the top program leader is assisted by a collective, interindustrial body intended to consider those problems that require interindustrial and interregional coordination. These organizational forms are most suitable for integrated–discrete programs that are directed through priority ranking and balanced planning of the program activities.

For large-scale national economic programs, the centralized systems with the line-program structure also have to report to the uppermost administration, i.e., to the Council of Ministers of the USSR. The huge number of interindustrial and interregional problems, however, far exceed any reasonable scope of control by

this authority and make it essential that centralized program structures are carefully formed.

So far experience in centralized guidance of uninterrupted programs has been gained only by agencies such as the former State Committee of the USSR for Utilization of Atomic Energy or the State Committee for Standards. For several five-year plan periods the former directed the integrated program to extend the application of nuclear technology to electric power generation, and to other areas, such as chemistry, metallurgy, agriculture, and medicine. It planned and supervised all the associated R&D, the construction of nuclear reactors, the production of the appropriate technological equipment and research instruments, the application of fission materials, etc. The State Committee for Standards directs integrated programs, such as a long-term program for improving the product quality management system, on the basis of standardization. It influences projects related not only to the development and introduction of standards, but also to the development of new organizational forms of management, of metrological support, of product certification, etc. Obviously, both the possibilities and needs for establishing agencies of this kind are limited.

In fact, a similar pattern of relations could well be supplied to the governmental agencies directing a different class of continuous programs: functional multiindustrial programs. For example, today there is an urgent need for specialized agencies or committees of the Council of Ministers of the USSR to engage in the integrated development of groups of energy, machine-building, and transportation industries, and in the development and manufacture of multiindustry products. Analysis indicates that the management of development and functioning in clusters of closely interacting industries requires a different approach from that of traditional interindustrial planning. The focus here is not only on the development of strategies and the general allocation of resources, but also on the day-to-day management of the complex, involving correction of the tasks of individual branches, reallocation of resources, and joint projects and functions. The integration of organizational systems of this kind is based on interrelated activities aimed at a common national economic goal.

There are, however, proven ways of establishing more flexible structures of line-program management, which take into account the specific features of concrete classes of programs. Thus, for instance, the programs belong to the integrated–discrete type, which means that they can be effectively directed through planned coordination arrangements. Accordingly, instead of line management agencies (committees or ministries), the central guidance of the programs may be assigned to the units for aggregate program planning of Gosplan or the planning committees of Union republics. Experience has already been gained in this area and at present the emphasis is on improving the organizational mechanism of program execution [7].

Should the elaboration of the general policy and strategy and the balanced allocation of resources and tasks of a program be accompanied by a great deal of coordination in integrating the current activities of various branches and regions, then temporary line management bodies may be set up at any level corresponding to the scale and significance of the problem. This may be a plenipotentiary committee attached to the USSR Council of Ministers, to the government of a Union republic, or to any of the central offices. The experience of the Interdepartmental Committee of the USSR Gosplan in carrying out the economic reform of several committees of the USSR Council of Ministers confirms the efficiency and feasibility of extensively applying this form of line-program management. It is quite suitable for programs of goal-oriented development and large-scale regional programs, as well as for all other classes of integrated programs.

In the Soviet economic system there are great opportunities for the *coordinative* management of goal-oriented programs, where the top managerial agencies delegate a part of the supervision and coordination functions to one of the leading contributors (either an individual, a whole organization, or one of its units). Very often *ad hoc* collective bodies (coordinating committees, program councils, workers' commissions, etc.) are set up to represent the most important contributors to a program and the users or consumers of its results. The most distinct feature of this form of program management is that the coordinating bodies are alloted only information and advisory powers, while authority rests exclusively with top administration. This approach leaves

the managerial relationships within the established structures practically unchanged and implies merely an insignificant redistribution of functions [12].

Because of their relatively high flexibility and efficiency, coordinative-type structures can be applied successfully to the management of integrated–discrete and loosely related programs of different scales. This organizational mechanism is easy to establish and operate, particularly with local and intraorganizational programs (within a branch of industry, industrial association, or production amalgamation). The limited scale of interaction and the relatively high level of centralized decision-making allow the coordinating bodies to become an effective communication link between the system managers and the program contributors.

Coordinative structures are also used extensively in directing integrated national economic programs. In this case, a directing agency or organization is generally appointed to frame the program, to draw up and integrate a plan of action, and to supervise the program activities. Practice, however, shows that an appointed organization with limited authority is efficient only in directing well-structured programs that have been sufficiently defined and planned while in the development stage.

Poorly structured, long-term programs that require sizable resources or are designed for the attainment of complex intermediate results often suffer serious deviations in their execution, which the directing agency or organization is practically unable to cope with. Thus, according to the State Committee of the USSR for Science and Technology, a number of ministries and agencies engaged in integrated, interindustrial scientific and technological programs do not commit sufficient resources to certain program activities. The development and assimilation of technological processes, machinery, and equipment are often delayed, owing to unbalanced tasks in the construction of pilot and experimental plants or to the violation of construction schedules.

Analysis shows that the potential for improvement and dissemination of the organization of coordinative program management throughout the national economy of the USSR is far from exhausted. For example, the effectiveness and efficiency of national economic program management markedly improve if the

directing body has attached to it a temporary, collective organ composed of contributing organizations, planning bodies, and research and design organizations that jointly analyze program progress and make decisions to eliminate any emerging deviations and to secure the attainment of ultimate targets.

Integrated programs can benefit greatly from expert assessment of the most important technological decisions and from economic substantiations of program activities carried out by independent experts (not reporting to the program contributors) and by representatives of organizations and establishments that will be the end users of the program results. Such expert assessments may be initiated by Gosplan, the State Committee for Science and Technology, the State Committee for Construction, regional authorities, and their agencies [13].

The organization appointed to direct the integrated, related programs has to have the authority to allocate resources, to supervise their consumption, to correct current plans, and to stimulate the timely attainment of adequate intermediate results; hence it must be given additional managerial functions. This approach calls for a drastic redistribution of authorities and functions throughout the entire management system, which leads to the establishment of an organizational and economic managerial mechanism of the matrix type.

Hence, matrix management structures employ a special mechanism of interaction between the functional and program-oriented subsystems of management organization, based on a balanced share of responsibilities, authorities, and functions between the elements of both systems. The coordination and current direction of the interrelated managerial units is vested in the provisional program bodies. The interaction of the program-oriented and functional structures is realized through the combination of functions of the higher- and lower-level management in both systems (*Figure 2.11*).

The distinguishing characteristic of the matrix structure is that the top management delegates the relevant authority to a middle manager or managerial body that is made fully responsible for program accomplishment. Thus, a quite new system of relations arises, where the powers of direction previously concentrated (in accordance with the unity of command principle) in a

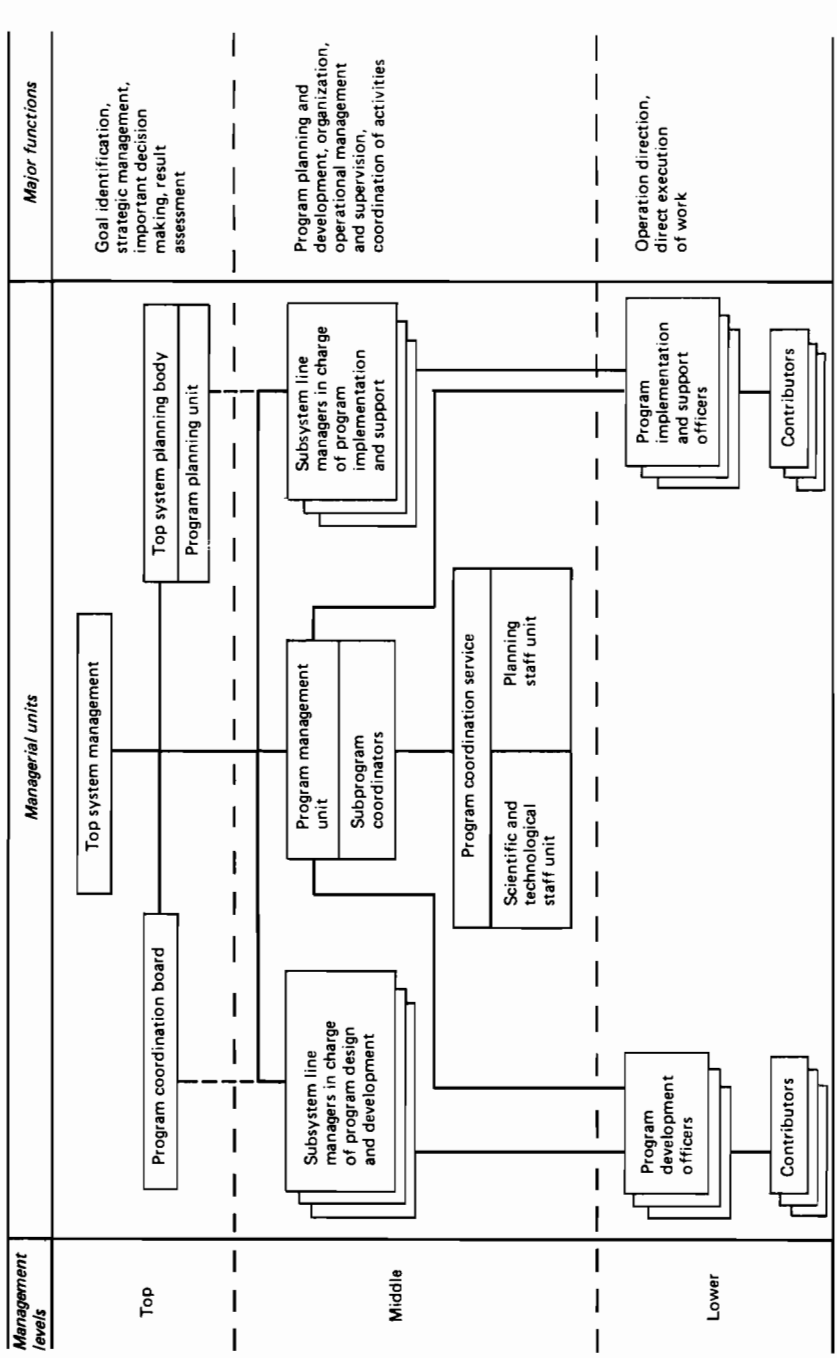


Figure 2.11 Matrix structure of integrated goal-oriented management.

single, top-level body are distributed in strict proportion across the middle level and then are again concentrated at the lower level. In order to make this procedure work, the subsystem managers who implement the program activities are accorded the specific role of responsible officers. They continue to report to their immediate line superiors and functionally start reporting (on program-related issues) to the program leader. Depending on the level and scale of the program, the program-oriented part of the matrix structure may involve various combinations of organs, while similar organs may perform functions that differ in content and magnitude.

As a rule, an interdepartmental (interfunctional board) is attached to the top system-management body to assist in comprehensive reviews and optimal goal setting, in program planning, in analysis of program progress, and in allocation of resources; this procedure improves the efficiency of integrated program management. If, however, a separate board for each program is justified within the framework of a large, national economic program, then at the regional, sectoral, and amalgamation levels it is much more reasonable to set up councils responsible for the development and monitoring of a whole class of technological, social, and other programs. In industrial associations and production amalgamations this role may be assigned to committees of the board of directors.

At the same time, an agency directing a large-scale national economic program is high enough to have attached to it a board of this kind. This pattern is fully justified for programs such as the construction and development of the BAM area and the industrial development of the city of Moscow. Collective bodies attached to the program leader may also be set up for operational management. Naturally, these bodies must have a smaller membership and less authority than the strategic management bodies.

The matrix structure of fairly complex, integrated programs with a sizable volume of functional management provides for a more or less developed coordination service attached to the program leader. This includes units or officers engaged in the coordination and development of technological program, as well as in the organizational and planning decisions.

However, any economic system (enterprise, amalgamation, branch of industry, and even the national economy) runs a variety of integrated programs of different classes. Accordingly, the developed matrix structures must provide for a body, common for the entire system, which is mainly responsible for the integration of all program plans, i.e., responsible for the ranking of priorities, the balancing of resources, results, and schedules, as well as for the striking of an overall balance between program and nonprogram activities [14]. These functions are usually entrusted to one of the units of the main planning agency or service (e.g., the planning committee of the economic planning office or a department).

The reallocation of the major managerial functions between the bodies of the established functional structure and the appointed links of program management allows the following advantages of the matrix management system to be realized:

(1) Decision-making authority is delegated to the middle level of management, while unity of command and supervision of key organizational and technical decisions remains with the top level.
(2) The intermediate structural levels and links attached to day-to-day and operational management are abolished.
(3) The top executives are relieved of operational managerial functions, while major decision making is highly centralized at the top program level.
(4) All established managerial principles are adhered to and the two types of structures closely interact on the basis of the optimal reallocation of functions.
(5) Informal relations assume greater significance in the managerial process and the communications used in the crosscutting supervision of accomplishing the program target become more flexible.

PART II

Organizational System: Principles and Methods of Design

CHAPTER THREE

The Management Staff and Rationalization of an Enterprise

3.1. The Systems Approach to Analysis of Management Staff

The management of an enterprise is divided into two subsystems, the managing and the operating subsystems. The operating subsystem is composed of organizational resources, productive personnel, and their activities, all aimed at the achievement of the final organizational goals (production, provision of social services, scientific and technological innovation, creation of national income, etc.), whilst at the same time ensuring optimal utilization of all resources involved. On the other hand, the managing subsystem is the part of the enterprise that undertakes the tasks of management proper, of using information, of management and administrative personnel, and of special material and financial resources; it also performs all the information activities relating to the operating subsystem.

Many members of an organization (from managers to ordinary workers) perform these tasks in production processes. Management activities may also derive from components of the external environment, either formally through laws, directives, rules, and orders, or informally through societal values, social and group norms, attitudes, etc. The complete management system is

embedded within its parent organization as a functioning part of a living organism.

The management staff of an organization are relatively clearly defined. They are the personnel of the total management system who, in accordance with the division of labor, specialize in the fulfillment, maintenance, and support of managerial functions, and who are assigned the appropriate authority and resources to perform these duties. However, the management staff do not perform the whole range of management activities in an organization, and within management units there may be employees who perform nonmanagerial "logistic" functions (purchasing, transport, engineering, repair, etc.).

The structure and functions of the management staff are the primary subjects of organizational design and development, which should be a rational, scientifically sound process; however, it should be kept in mind that a number of activities at some stages and phases of the total problem-solving process may be fulfilled regularly on a one-time basis by other subsystems in an organization. In addition, the processes of both management system design and of management functioning have informal, self-organizing features that can be explained by the natural social character of the organizational system.

The management system may be characterized by four classes of variables: organizational structure, process of management, leadership, and behavior.

3.1.1. Organizational Structure

The organizational structure of management is one of the main control variables of an organizational system. It can be defined, with the help of systems theory, as "system elements, their interconnection, and properties arising from their totality ... all in some way providing for the stable existence of a system [15]," and as "the principle, manner, or law of interconnections among elements of a whole, the relationship of a system of elements within the framework of a given whole [16, p 4]." These philosophical definitions do not provide a direct basis for understanding management organizational structure, but merely reveal its nature as "the design of the organization through which an enterprise is administered [17, p 14]." Nevertheless,

consideration of management organizational structure from a systems point of view leads to some very important conclusions:

(1) First of all, a management structure is a totality.
(2) To form its elements and subsystems one should formulate features by which they can be identified.
(3) Among the elements of the management structure are important elements and processes that belong to the organization as a whole.

An enterprise may be characterized by different types of structures:

(1) The *production* structure is the set of production facilities, plants, warehouses, etc., together with their territorial location and interconnections in the processes of manufacturing and distribution of different products.
(2) The *technological* structure is defined by the types of technological processes and interconnections among the elements of primary and auxiliary production, by the specialization and loading of production facilities, etc.
(3) The *economic* structure reflects the structure of fixed and turnover-related enterprise funds, the production cost structure, the types of business units (profit centers, cost centers), etc.
(4) The *social* structure is characterized by the differentiation of enterprise employees according to occupation, skills, sex, nationality, level of education, family status, etc.
(5) The *information* structure is characterized by the allocation of data generation sources in the organization, by the direction and configuration of the communications network, etc.

Management organizational structure can be defined most simply as the composition and subordination of organizational units and positions differentiated by a particular feature, and the distribution of responsibilities, authorities, and relationships among them. However, modern organizational theory recognizes the limitation of such a formal interpretation. The stable

organizational elements affecting human behavior can include both the above-mentioned, formal structural elements and elements and relationships of *informal* structure.

> Any organization or collective has formal structure together with informal structure, i.e., the system of interpersonal and intergroup relationships and interconnections, contacts, likes and dislikes that are not specified in documents.... Any one of these groups ... has certain specific features, goals, and interests, unwritten rules and norms, its own ideas about good and bad [18, p 172].

In contrast, Kaidalov and Suimenko [19, p 29] stress:

> ...written orders, instructions, directives, indexes, symbols, signs, which at first sight seem to be devoid of human personal content but which actually, in an overt or hidden form, have not only functional but also personal, psychological, and individual specific content.

The comparison of an organization with an iceberg is well known: the iceberg's visible part corresponds to the organization's formal structure and its submerged part to the informal organizational structure.

In general, the structure of an organization is not its static "skeleton", but the dynamic formal and informal distribution of authorities, responsibilities, tasks, influences, and communications, which are constantly reproduced in human relationships and which evolve to provide changes that, although not always immediately apparent, are sometimes very significant.

Recognition of the complexity and versatility of management organizational structures is important as it helps to define the depth, scientific soundness, and effectiveness of their study and practical improvement. At the very least, attention should be focused on the formal structure of a management organization, as this is the clearest feature of the system that is subject to rational design and control. At the same time, informal aspects of organizational structures should be considered as the factors that maintain the functioning of an organizational toward the achievement of its goals.

3.1.2. Process of Management

Management *structure* and *processes* are two inseparable aspects of an organizational system. The structure reflects the more or less stable statics of a system's elements and their relationships, while processes characterize the dynamics of these elements and their relationships in time. In solving different problems of organizational research and improvement, relatively more or less attention may be given to structural or process features of organizational systems, but in all cases these features should be considered together.

As with the structure of an organization, there are many descriptions of its processes. A number of scholars are trying to classify organizational processes from a general systems point of view. For example, Katz and Kahn [20] have divided organizational processes into production, maintenance, support, adaptive, and control processes, while Miller [21] has differentiated information processing from matter–energy processing. Bakke [22] recognized in a system the processes of identification, resource acquisition and maintenance, output generation, and integration.

Under the most general approach management organizational processes may be divided into:

(1) Processes of functioning, which can be described in terms of management functions, decision making, and organizational communications.
(2) Development processes, which include processes of innovation and organizational growth.

These may characterize both the adaptation of an organization to the external environment and the maintenance of internal equilibrium among its elements.

In reality there is a complex process of activities in an organization as a totality, and the identification of the different kinds of processes depends on the conceptual framework that the researcher chooses for his purposes. However, each class of processes (decision making, communications, innovations, etc.) has not only general, but also specific features. It follows that specific methods and techniques should be applied to their study and improvement.

3.1.3. Leadership

Leadership is an important characteristic of a management system that defines the requirements on managers of different levels and describes their real behavior in decision-making processes. It is important to emphasize that leadership is closely connected with power relationships and therefore cannot be considered outside the particular overall social and economic context in which it is exercised.

In economics, relations between men are always considered as subordinate to relations between things, and a manager, even in his technical decisions, expresses not his own arbitrary intentions, but the interests of a particular social class or group that controls the resources of an organization. Particularly intimate identification of personal values, norms, and convictions with the interests and goals of an "organization" in the above sense is mostly confined to leaders. At the same time, personal qualities, a leader's style of behavior, and his understanding of an organization's objective demands, and of the most effective ways of achieving its goals, are of great importance to management. The systems approach to leadership means that the actions of a leader must be considered as a product of the interaction between the "situation" (i.e., the objective requirements of the content and conditions of performance of the organizational task) and the personal qualities of the leader.

3.1.4. Behavior

Behavior is the second major characteristics of a management organization that reflects the social and psychological aspects of the individual and group actions of organization members. Emelyanov writes, "One of the paramount tasks of the science of developing systems management is modeling the behavior of a man as the main element of such systems [23, p 99]."

Behavior as a variable is important in the examination of managerial problems at the "microlevel", i.e., in primary collectives (small groups characterized by direct contacts between persons, substantial homogeneity compared to higher-level systems, etc.) and in larger collectives (organizational units consisting of several groups, e.g., shops). The "structure" and "management

process" variables play an important role in large-scale organizational systems at microlevels, although behavioral factors may also have substantial influence. Behavioral factors and problems are different in different types of structure. Thus, in highly formalized processes (e.g., in mass and line production) the main task is to reduce the detrimental effect of monotonous and uniform labor on a person's state of mind. In contrast, for creative types of activity (R&D, planning, etc.) it is important to set up conditions for the most productive use of a person's skills, experience, knowledge, and intellectual potential in the solution of complex organizational tasks.

The systems approach to behavior views it as a result of the interaction of many factors: external factors, such as social environment (organizational structure, leadership, system of promotion and motivation, organizational climate, the influence of small groups, etc.), as well as personality factors (personal convictions, needs and interests, attitudes, abilities, the psychological and physiological peculiarities of a person, etc.). It should be stressed that among these factors the most important are the social ones, which stem from the very character of social and economic formation, the income level of people, and the particular social groups to which they belong. The organization as a whole and the primary work collective exert a concrete influence on a person in production and management: they teach him and direct him in the fulfillment of his individually defined tasks. The personal qualities of individuals cause fluctuations in behavior, without being its main determinant.

There are a great variety of behavioral problems in organizational systems; they are connected with motivation, with the material and moral incentives of collectives and individuals, with group and intergroup dynamics, with superior–subordinate relationships, and with the mechanisms for eliminating intraorganizational conflicts. Some behavioral phenomena are typical of an organization as a whole. Regulation of behavior is a special subject of social planning, but essentially the whole management process, to a greater or lesser extent, deals with the behavior of organization members, guiding it toward the achievement of organizational goals.

3.2. Characteristics and Classification of Organizational Structures

The typology and classification of management organizational structures have been treated by the majority of authors attempting a scientific approach to the problems of their design and improvement. Hence, beginning with Taylor, Fayol, Emerson, and others in the West, and Kerzhentsev, Gastev, and others in the USSR, and continuing with contemporary researchers, an extensive literature has developed that covers the various characteristics and classification systems of organizational structures. The purpose of this section in particular is not to undertake a thorough review and analysis of all known points of view, but to identify a method and objective criteria for selecting the major management organizational structures that are fully consistent with current requirements, irrespective of the socioeconomic conditions of their application in a planned or capitalist market economy. Obviously, we try to analyze typologically and systematize only those organizational forms and decisions that are based on scientific principles of management organization and have proved their feasibility through extensive practical application. It should also be kept in mind that the following structures are not complete models of social systems, but serve exclusively for organizational analysis.

Behind our approach to this problem is the premise, resulting from broad and extensive study, that no large modern economic organization employs structures that can be identified by a limited number of characteristics and strictly assigned to a single (albeit the largest) class. The British researchers Burns and Stalker, who were the first to formulate this premise, wrote, "The beginning of administrative wisdom is the awareness that there is no one optimum type of management system [24, p 348]." This does not mean that it is impossible or unnecessary to consider structural classification as a subject of design study, but that more general criteria and a systems approach is required for the description of structures. We try to prove this by analyzing traditional classification characteristics.

These are generally the most essential characteristics of organizational structures, such as the content and pattern of

prevailing relations between the decision-making centers, their functional specialization, and established communications. Just as important for structural analysis, however, is the typification of the management systems proper; where the structures belong is important as well as their characteristics.

The scientific literature usually subdivides management structures into "mechanistic" and "organic" (see, for example, [25]). The major features of these types of structures are listed in *Table 3.1*. It should be pointed out, however, that these two general types are idealized conceptual–theoretical models rather than a direct reflection of concrete management systems. They fix two orientations in management organization: "toward maximum order and organization" (a mechanistic concept) or "toward maximum release of employee labor potential" (the organic concept). Real management systems have predominantly the features of one or other model, but are not fully consistent with either since they are essentially compromises.

The following factors should be considered in the analysis. First, the mentioned conceptual–theoretical models of management organization are not competitive (as some generalists presume them to be). They are objectively determined by the major characteristics of the operating subsystem and the environment in which it functions. The mechanistic model is preferable for stable and deterministic conditions, while the organic model suits an uncertain and dynamic environment. Accordingly, large economic organizations may involve management subsystems based on both the mechanistic concepts (e.g., direction of basic production, maintenance and procurement, accounting) and the organic concept (e.g., the top management system, goal setting and strategic planning, R&D).

Nevertheless, the possibilities for combining the different types of systems are limited, since their individual properties are competitive. Thus, for example, a matrix management structure is inappropriate in conditions of regimented tasks, procedures, and behavior, as it allows only the detailed execution of instructions. In conditions of belt-line production or accounting, a "creative" approach to the execution of prescribed operations is similarly unacceptable because it may result in a mess. The primary

Table 3.1 Specific features of mechanistic and organic types of management systems.

Major characteristics	*Mechanistic system*	*Organic system*
Ways of formulating and structuring objectives	Abstract decomposition of common objective into an impersonal hierarchy of specific tasks	Continuing correction of individual tasks based on interaction during objective accomplishment and alteration of the situation
Principles of responsibility allocation	Formalization of job requirements, authorities, and responsibilities in executing well-defined specific tasks	Flexible allocation of authority and responsibilities as problems arise
Results evaluation criterion	Accuracy in implementing job and other instructions, degree of sophistication of the means and methods used, efficiency and effectiveness of utilization of allocated resources	Contribution to the ultimate goals of organization or unit on the basis of individual effort
Predominant trait and major feature of managerial structure	Functional–product orientation, stability	Matrix structure of relations and communications, adaptability
Prevailing type of relations	Hierarchical structure of authority, supervision, and communications	Horizontal flows dominated by problem-oriented information, council and expert assessment, feedback
Job formalization	Highly recommended	Low, carried out independently on the basis of personal stimuli toward attaining common objectives
Data distribution and prevailing nature of decisions	Concentration of key information in upper levels of management; trends toward centralized decision making	Distribution of information across the stages of problem solution, decentralized and collaborative decision making
Basis of manager's authority	Occupied position	Level of knowledge, experience, personality
Prevalent type of behavior	Punctuality in execution of orders and instructions	Participation in decision making, initiative
Dominant managerial concepts	Technocratic	Behavioristic

condition for success here is the synchronized and adequate interaction of well-organized management.

Although the mechanistic and organic models of management systems are very useful for analysis, it should be pointed out that this dichotomy is far from complete and operational for practical organizational design. It is the intermediate forms of organization (i.e., various modifications of functional or matrix structures that take into account the specific environment of production and management) that are of major importance for the typification of management systems and applied analysis. This is why practical approaches to the typification of management organizational forms have two aspects. The first centers on the type of management structure (functional, line-functional, matrix, etc.), while the other reflects the type of management system as a whole (mechanistic, organic, mixed), which, to a certain degree (but not strictly deterministically), corresponds to the type of structure.

Let us consider the typification of organizational forms based on the unity of the management structure and the organizational mechanism of its functioning. Such typification based on the separation of two major types of structures – line-functional and program – is well adapted to the solution of the problem of organizational framing as a process of rational design, through specific methods and procedures of building a formal structure and an organizational mechanism of management.

There is an objective reason for the appearance of both types of structures and their modifications. The evolution of management organizational forms has followed the major trend in public production development: more extensive division of labor and its cooperation, greater specialization, and closer integration of organizational and economic relational mechanisms striving toward a natural and integral symbiosis. Every step toward qualitative improvement of production has been adequately reflected in new forms of management organizational structures [26].

The simplest type of structure is a pure *line* structure. It is based exclusively on direction–subordination relations and reflects the most general stage of the division of labor, i.e., into supervision and execution. Nowadays, pure line structures exist only in the smallest, autonomous organizations, which perform elementary production functions or services based on simple

technology. In modern enterprises, however, even in the lowest units that might seem to be based on strict line relations (team, work section), the division and cooperation of managerial labor no longer fit into the framework of direct supervision and subordination (*Figure 3.1*).

At the same time, the line form of manager–subordinate relations, as a means of realizing the unity of command principle, is a mandatory element of practically every formal structure. It is mainly the amount and content of the line management authority in resource allocation that determines such an important characteristic of a management system as the extent of its centralization. The latter, in turn, determines, with regard to the span of control, the hierarchical decomposition of the operational subsystem. There may be as many as ten hierarchical levels of direct reporting in a big production amalgamation (for industries employing complex technology): chief executive of the amalgamation, executive manager of the amalgamation, plant manager, deputy plant manager for engineering, production superintendent, shop superintendent, shift superviser, head foreman, foreman (team leader), worker. Naturally, with such a multilevel, hierarchical decomposition of the system, each level may employ quite diverse forms of division and cooperation of management activities, resulting in numerous eclectic organizational forms [27].

The second step in the organizational evolution of formal management structures was the appointment of staff officers attached to a manager, i.e., individuals or units responsible for situational analysis and problem setting, generation and assessment of alternative decisions, and elaboration of criteria for objective attainment and performance standards. The most essential characteristic of structures involving staff links is undoubtedly strict adherence to line relations, as both the production officers and the staff units report only to their immediate superiors. No other relations, formally at least, are allowed. Accordingly, these structures are also referred to as *line staff*.

Modern organizations, particularly large ones, extensively employ diverse types of staff bodies that are attached to the upper echelons and composed of supervisors and experts who are usually not relieved of their primary responsibilities. These bodies include boards of directors, specialized committees, and

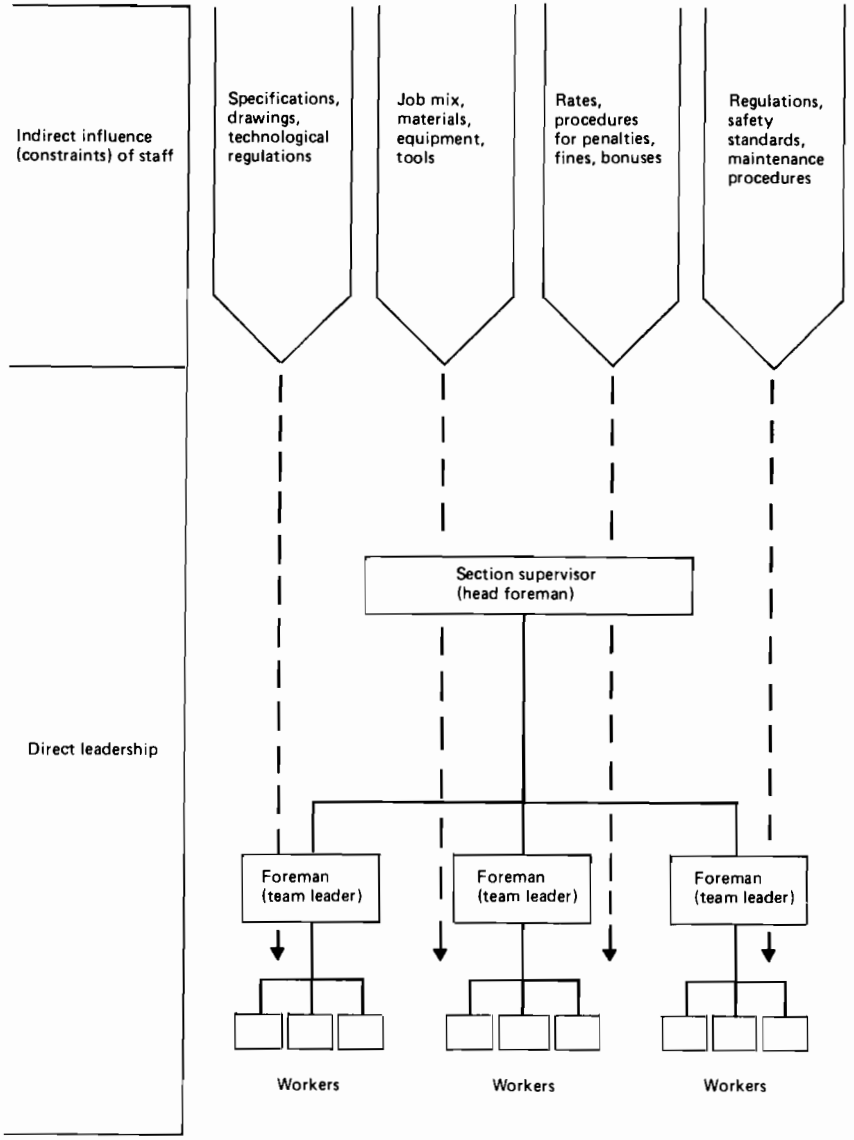


Figure 3.1 The present form of line relations in primary units of large organizations. (Line managers realize the directives and constraints specified by superior managers and functional bodies.)

scientific and technical councils. They are assisted in their activities by specialized staff units appointed from operational units or set up specially for this purpose.

The high level of division and cooperation of labor in the management of large economic systems, which requires a widespread and diversified functional staff, has brought about two, at first glance, conflicting trends. On the one hand, production diversification and functional specialization force the staff bodies attached to the upper management to integrate analytical and evaluation activities, thus extending their role and sphere of influence. On the other hand, the greater complexity of decisions and the resultant amount of work lead to mixed relations between the links of the organizational structure, which are no longer purely line staff. One option for such structures is given in *Figure 3.2* [28].

Analysis of the causes and consequences of both trends indicates that they reflect the objective laws of current organizational evolution and it would be unwise to restrict them artificially. Clearly, the most effective way to ensure their nonantagonistic evolution is to elaborate special mechanisms that formalize the correct management relations, bearing in mind the great variety and instability of the interrelationships between the two trends.

The division of managerial labor through functional specialization is considered to be a breakthrough in management organization. First substantiated and described by Fayol at the turn of the century, it was soon widely applied. In essence, it centers on the allocation of responsibilities to particular management functions, on the organizational separation of management units specializing in each function, and on their more or less deep hierarchical structuring depending on the content, complexity, and amount of work.

The literature also deals with models of purely ***functional*** structures, in which there are no pure line relations between the upper and lower levels of management, but only specialized communications. Even in very small, multiobjective socioeconomic systems, however, this approach leads to an immense amount of coordination at the top executive level, which practically deprives the functional structure of its value. Hence, such

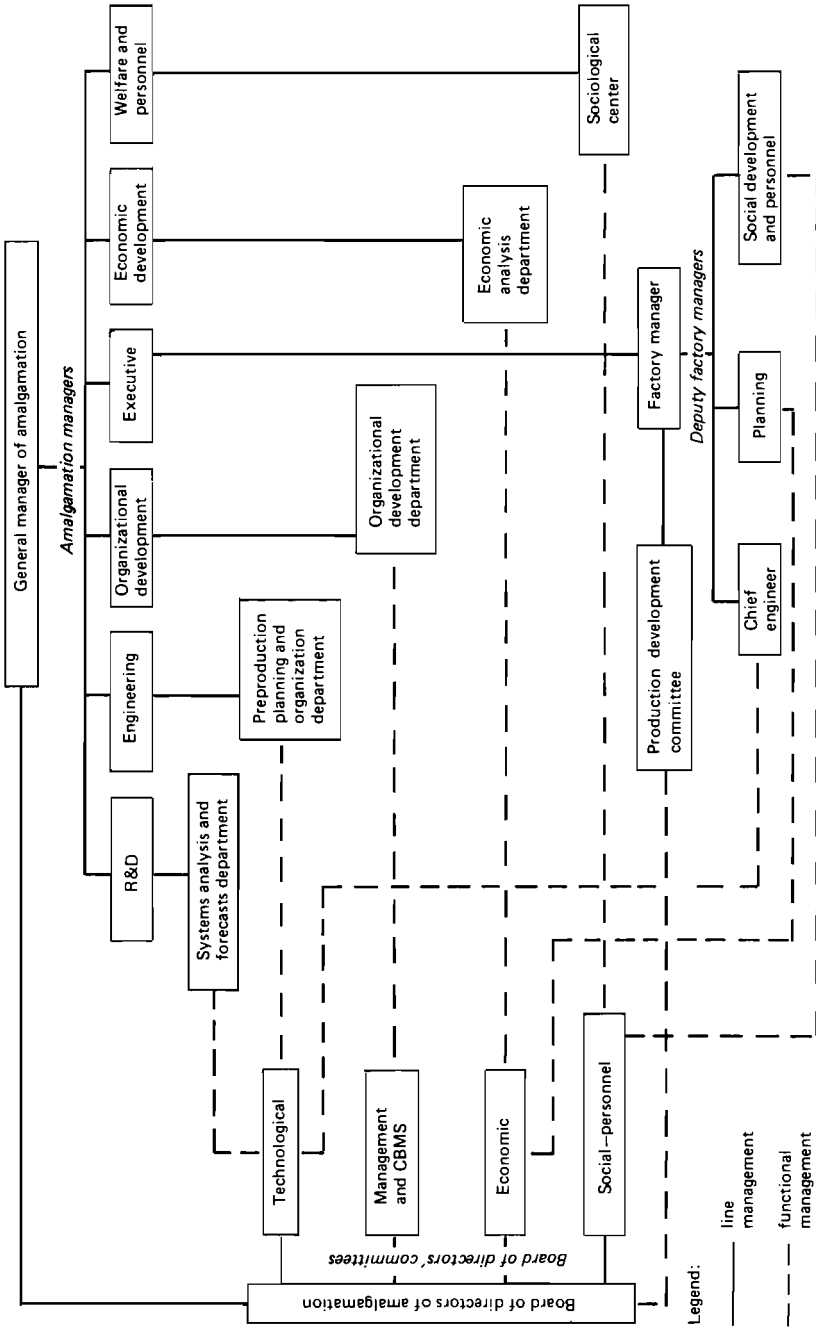


Figure 3.2 A combination of line-staff and line-functional relations showing the new staff bodies – committees and departments – included in the traditional structure.

structures did not find any significant application in their pure form. After numerous unsuccessful attempts to apply them, this approach was discarded in the USSR as early as in the 1930s.

In a truncated form, however, these functional structures are applied even today. It seems reasonable and effective to use them in the top echelons of management, which deal with problems of strategic development and elaboration of a standard methodological basis for functional activities. The scope for the application of functional structures depends primarily on the level of a management system's centralization. In the USSR national economy, for example, the form of functional management presented in *Figure 3.3* is used.

The most versatile form of the functional specialization principle that does not conflict with the unity of command principle is realized in *line-functional* structures. The major characteristic of these structures is that general resource direction and goal setting are the sole prerogative of line managers, while the implementation of objectives with the allocated resources is the responsibility of functional management. The versatility of the approach provides the required diversity of organizational forms for organizations and their subsystems of any scale, complexity, and degree of centralization. The greater scale and diversification of production entities in the 1950s and 1960s brought about specific modifications of the line-functional structures, referred to in the West as "divisional". Their peculiarity lies in the fact that the management structure is consistent not only with its own specialization, but also with that of production.

This modification is characterized by the organizational isolation of autonomous economic units or sectors of an organization (divisions) specializing in certain types of products or services (product orientation) or in the accomplishment of specific objectives (e.g., introduction of a new product line, of a fundamental technological innovation, or of a new service concept – i.e., innovation orientation). Just as widely utilized are divisions set up to act or provide services in a specific area (territorial orientation). Territorial orientation, of course, may be combined with product or goal orientation.

In the Soviet economy there is a great variety of production organizational forms that make up the divisional structure of

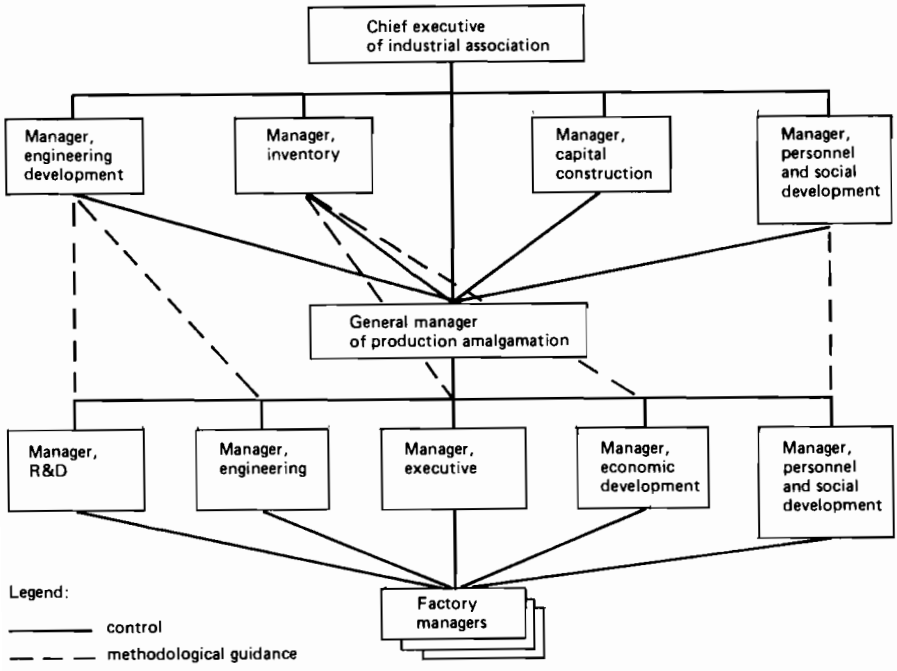


Figure 3.3 Elements of functional structure in the management chart of an industrial amalgamation. (The superior functional bodies supervise the lower-level managers and provide methodological guidance to the respective functional services.)

management systems. Thus, All-Union industrial associations characterized by product orientation and republic industrial associations characterized by both product and territorial orientations may be viewed as divisions of a branch management level (within ministries). Within subbranches the divisions are represented by production amalgamations and big enterprises (product and product–territorial orientations), as well as by R&D and production amalgamations (innovation orientation).

The divisional structure may well be used in production amalgamations. In this case not only the manufacturing units (affiliated factories, closed-cycle operational departments), but also relatively autonomous auxiliary units, such as transportation, repair, preproduction, sales, and design units, are subject to divisional breakdown. The divisions are responsible for the attainment of assigned objectives, are empowered to supervise resources, may establish business relations, both with other divisions and outside organizations, and become not only independent "cost centers", but often "profit centers" too. Such structures are used in amalgamations of the automobile industry, agricultural machine building, and other branches [29].

The most remarkable feature of divisional structures is that each subsystem has its own functional management, which to a certain extent interacts with the central staff and functional management. The complex production cooperation of the subsystem links involved adds to the complexity of management relations and communications in modern, large economic entities. An example of the most important management relationships in a subsystem of a machine-building amalgamation, previously almost unrecognized in the literature, is given in *Figure 3.4*.

The greater amount, mix, and complexity of management relations and communications in modern organizations, which create a great demand for more effective forms of interfunctional coordination, justify the separation of comprehensive, goal-oriented interfunctional programs (projects) and interbranch complexes oriented toward common goals as independent operational subsystems. This brings us to another common feature of organizational structure classification, i.e., classification by operational subsystem. According to this, all structures may be divided into two classes: management of autonomous economic

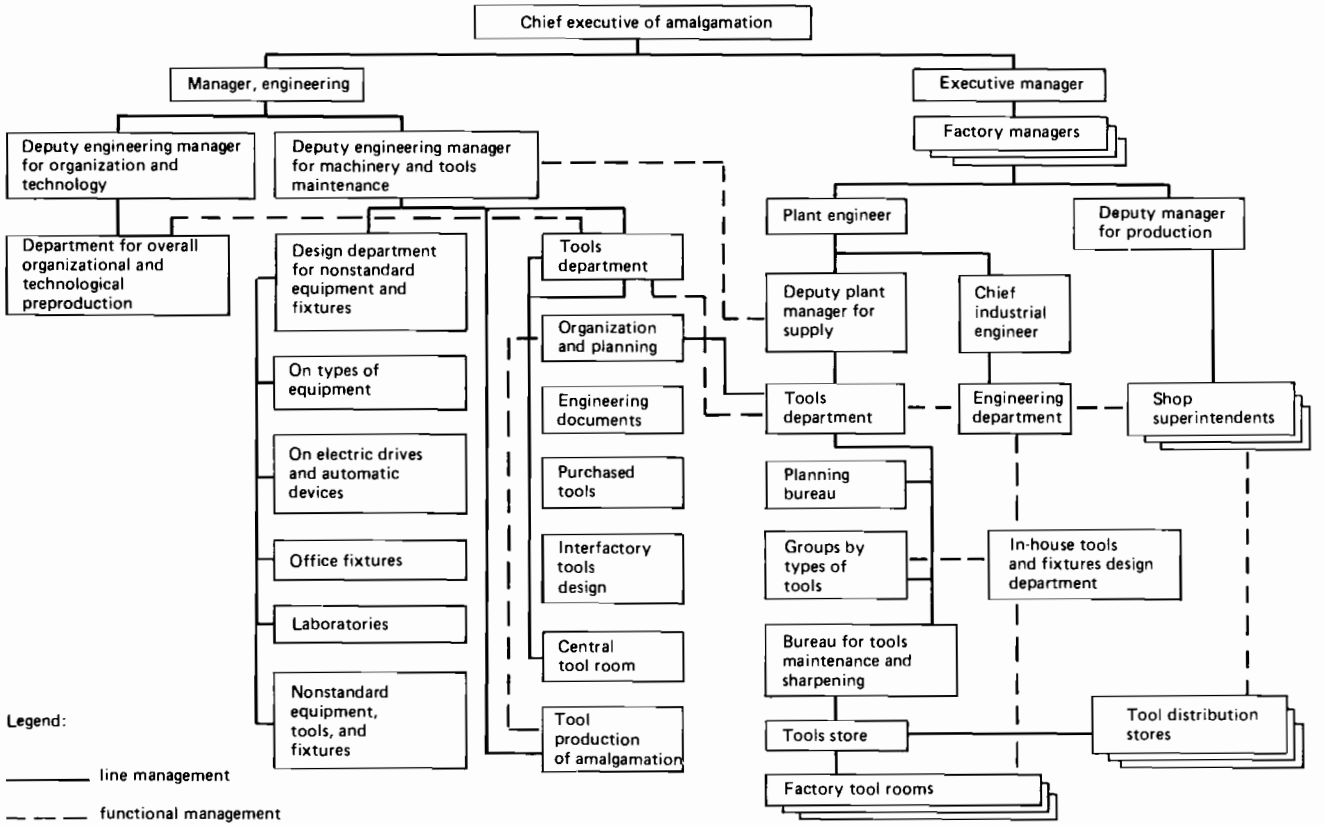


Figure 3.4 A chart of in-bound and out-bound relationships in an amalgamation division of the automobile industry with respect to procurement of equipment, tools, and fixtures.

systems (branches of industry, amalgamations, enterprises, establishments, and organizations) and management of goal-oriented, interfunctional programs and interbranch complexes [10].

The hierarchical structure of the national economic management system does not allow the precise differentiation of the applications of each of the mentioned classes of organizational structures. First, each interfunctional program or interindustrial complex may be initiated only within a definite economic system (or, rarely, within the national economic management system as a whole, which is itself an integrated organizational system). Second, only formal organizational systems of a certain level may contribute to goal-oriented programs or be components of interbranch complexes. Finally, the management of both classes of operational subsystems may employ identical organizational forms from among those mentioned. Let us consider from this point of view the modifications of program management organizational structures.

The traditional forms of interfunctional and interindustrial management involve centralized and coordinating program management.

The ***centralized*** management systems of goal-oriented programs and interbranch complexes are characterized by the organizational separation of major contributors into independent, single-objective systems with their own line management units, which represent separate links of the upper-level economic system. The fact that the program contributors or interindustrial, complex components report to a single body allows us to term this a line-program structure.

It should be kept in mind, however, that a system similar to an ordinary economic organization and differing from the latter only in having a more specific goal orientation and duration may be designed (depending on specific features of the particular program or complex) around all the management organizational forms described above – from purely line to the most complex line-functional structures.

The centralized-type structures are characterized by proper organization, by clear-cut allocation of responsibilities, and by a highly effective management mechanism. Their application, however, results in duplication of all the functional and

auxiliary subsystems, which makes the structure inefficient where multiple programs are involved. In addition, any attempts to restructure due to the changing objectives of organizations or individual programs face great difficulties. Accordingly, the application of centralized structures is justified only for a few complex, costly, and long-term programs (e.g., utilization of nuclear energy, space exploration, and manufacture of new types of complex products, such as aircraft and computers).

The distinguishing feature of coordination-type program structures is that the operational, line-functional structure incorporates special staff units to carry out the lateral coordination of interfunctional (interindustrial) interaction through feedback controls, collaborative making of program decisions, and supervision of their implementation. Such bodies act on behalf of a manager of the system within which the program is executed, but have no authority for direct supervision.

Strictly speaking, reference to such forms of coordination as a separate class of structures is only conventional, as their establishment implies neither new management relationships nor the alteration of existing ones. The differences consist mainly in some redistribution of management functions between the established management links and the corresponding, primarily informal, changes in their roles. In some cases the most specific programs may have special bodies exercising supervision and coordination (committees, coordination departments, etc.), but mostly this function is assigned to one of the existing links or its subunits. Practice shows that the described mechanism is employed not only with distinct programs, but also in other cases where a need arises to exercise large-scale, interfunctional coordination at the middle-management level.

Because of their simplicity and high degree of adaptivity, the coordination forms of program management find a variety of applications. They are not, however, efficient enough, since they do not relieve top executives of program operational management and do not provide for the smooth execution of a program where there is an irrational use of scarce resources allotted to the program. These structures are most suitable for programs featuring poor cooperation between contributors.

A qualitatively new form of interfunctional and interindustrial management coordination is provided by matrix structures. They establish special interactions between line-functional and program management subsystems by balancing the share of responsibilities, authorities, and functions between the elements of both systems. The distinguishing feature of matrix structures is a person (or a body) who is fully responsible for the program and to whom the chief executive of an organization delegates the relevant powers. As for the line subordination, the responsible officers report to their immediate superiors; functionally, they report to the program leader (see the versatile example of an organization chart in *Figure 3.5*). There are various modifications of the matrix management structure.

Thus, very complicated programs that greatly affect the entire economic system usually require an advisory staff body attached to the top system management. This body is a sort of special committee or council engaged in the development and supervision of the program. In the example in *Figure 3.5* this is an interbranch committee for the integrated scientific and technological programs attached to the State Committee of the USSR for Science and Technology. It reviews the decisions related to all the identical programs (technical, economic, social) implemented in an organization.

If a program involves the complex and prolonged interaction of a host of various organizational units facing strained plan targets, then an advisory body is attached to the program leader too. In *Figure 3.5* this is a coordination council, whose prime responsibility is collaborative decision making in relation to current and operational issues of program implementation.

If a system contains several goal-oriented programs implemented concurrently, then its structure usually provides for a planning and organizational body (in the present case this is the Gosplan integration department for comprehensive programs), whose main tasks are to balance the resources consumed for all kinds of activities and to coordinate operational and current changes in the plan involved.

A great amount of functional management of the program may require some specialized functional units attached to the program leader. Mostly, these are the research and design, control and

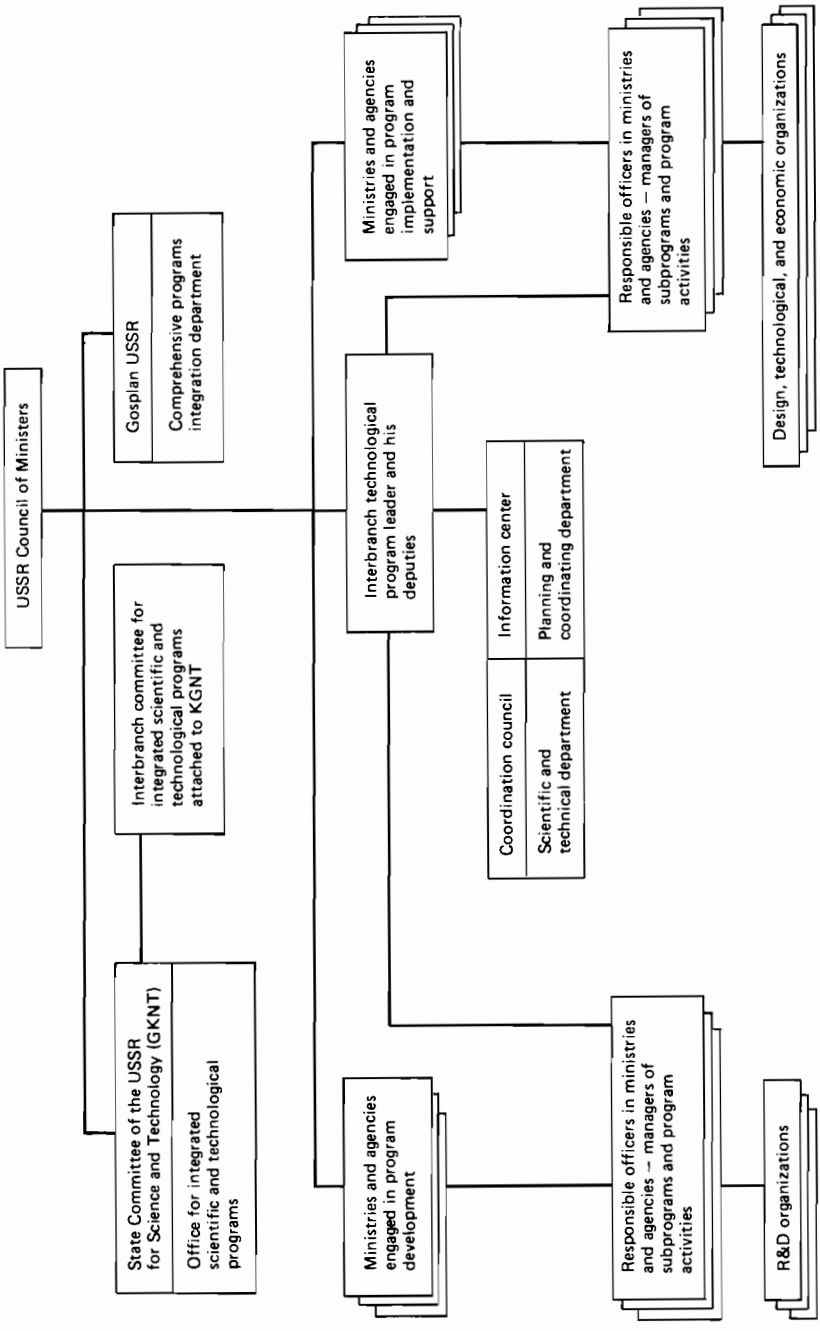


Figure 3.5 One option for a matrix management system for an integrated, interbranch technological program.

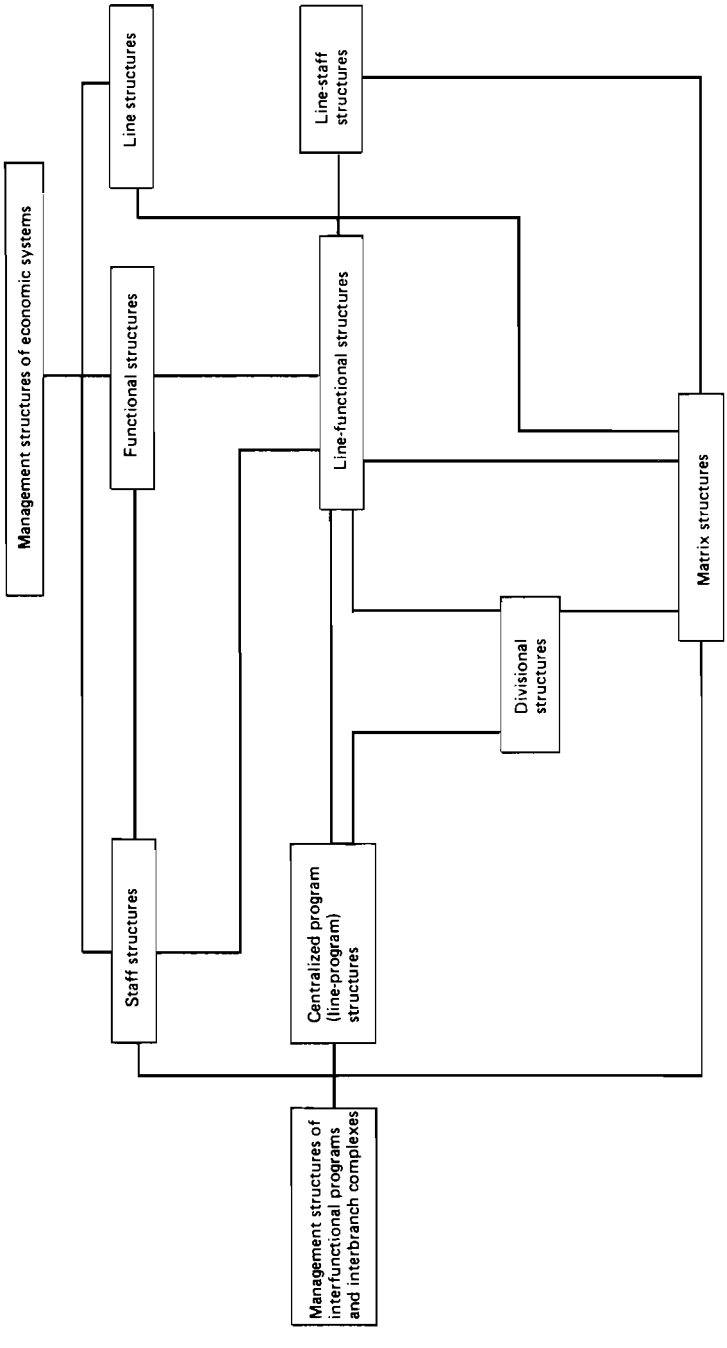


Figure 3.6 A generalized systematization chart of standard management organizational forms.

analytic, and information services. Such bodies are generally established within the management systems of large-scale industrial and interindustrial programs. In *Figure 3.5* these are the technology department, the information center, and the planning and coordination department.

Matrix program management structures are the most versatile and flexible as they do not require much restructuring of line-functional management and may be successfully applied to national economic, industrial, and intraproduction programs.

We have discussed the major types of organizational structures actually employed in modern organizations. Large systems may use various combinations of these organizational structures. Obviously, it is possible to identify and systematize the typology of these combinations too, and this has been attempted by some Soviet and foreign authors. One can easily infer from the foregoing discussion, however, that the organizational structure of a modern, large-scale economic system is a widespread network of management relationships, featuring practically every basic management form (for examples of specific organization and program structures see Part III of this book). The possibility of applying various combinations of elementary forms provides the diversity that is required for a designed, organizational structure to correspond fully to the specific features and objectives of a particular socioeconomic system, as well as to its interaction with the environment.

Figure 3.6 gives a generalized systematization chart of the typical management organizations described. It can be seen that the chart is very poorly structured, which reflects the impossibility of applying a rigid form of organizational relationships in modern systems. It is this circumstance that we use to substantiate the methodology for designing management organizational structures.

3.3. Factors Determining the Requirements of Management Organization and their Impact on the Selection of Organizational Structures

The great variety of potential management organizational forms inevitably poses a problem of choice with respect to each specific

condition of their application. The analysis of case studies of management systems shows that, even for one and the same organization, various types of structures may prove effective, depending on the changing objectives, on available resources, on the environment, on the composition of operational departments, and on many other factors up to and including the personal traits of top executives and leading specialists. Hence, the scientific choice of organizational options must be based on knowledge of the role of structures in the management process, of the objective requirements on it from the point of view of general laws of production and management organization, and of the impacts of certain factors and characteristics of the operational subsystem, the executive component, and the management environment on the ability of a structure to meet specific requirements.

It should be kept in mind that the influence that an organizational structure exerts on management effectiveness is always closely linked and interdependent with the effects of the competence and executive traits of managerial personnel, of the established sociopsychological climate and informal relations, of the applied management techniques and tools, and of other properties of the executive component that may be adjusted in the process of improving the management system. This is very important for a number of reasons.

First, disregard of these characteristics of a management system reduces the benefits of organizational improvements. Second, the diversity of organizational forms is not unlimited and a shift from one form to another is uneven, i.e., there is always a set of requirements that no structural option can meet. It is these discrepancies that may be compensated for by other characteristics and parameters of the executive component. Third, the influence of various objective factors on the requirements on the structure may turn out to be conflicting. Hence, the choice criteria must make provisions for a trade-off and the adopted decisions are compromises. The correct understanding of this state of affairs implies the improvement not of the structure alone, but also of other interrelated characteristics of the management system, in order to achieve an acceptable quality of its functioning.

The analysis of the effect of management laws on the requirements on a management organization is rather complex and lengthy, and is the subject of other scientific papers by us. Here we confine ourselves to some results in terms of the most universal standard requirements on the general properties of management organizational forms. These forms must possess characteristics that will provide for and formalize the following:

(1) Full responsibility of each management authority for the accomplishment of a management task (subobjectives).
(2) Balanced tasks for all management units of a certain level with respect to objectives of a higher management level.
(3) Comprehensive execution (interrelationship) of all the management functions related to each task both in "vertical" and in "horizontal" interrelationships.
(4) The most efficient division and cooperation of labor between the management units and levels with regard to their functions, providing for minimal overlapping in conditions of line-functional and program structure interaction.
(5) Concentration of authority and responsibilities in tackling every specific management task through the rational reallocation of powers at each lateral management level and vertical delegation of authority.
(6) Complete correspondence of the organizational and economic mechanisms of execution control, extending to the responsibilities and decision-making powers related to every management task.

Since, in fact, every modern management system contains the elements of interfunctional and interindustrial interrelationship controls, this list ought to be complemented with the specific requirements on the structures and mechanisms of comprehensive, goal-oriented program management. These can be summarized as follows:

(1) To improve the efficiency and effectiveness of program development and implementation management by bringing the management authorities closer to contributors and by establishing direct communication between them.

(2) To ensure the overall and effective interaction of all the units engaged in the support and accomplishment of the program.
(3) To relieve the system headquarters of the functions of operational management and coordination of the program activities.
(4) To raise the responsibility of the management bodies of each specific program contributor for the results and timing of activities.
(5) To provide effective control of the planned work progress, and to facilitate the efficient administrative adjustment and management incentives for better results with respect to quality, efficiency, and time.

Each of the applied organizational forms is only partially effective in meeting these requirements. To meet all of them a large organization must employ a composite structure that is a combination of various organizational forms, especially suited to a particular operational subsystem in specific conditions. Theoretical studies and practical experience both indicate that the factors most significantly affecting the manner and sequence in which structural elements are combined are the system objectives, the functioning environment, the resources available for attaining the objectives, the organizational and technological parameters of the system, and the process of its functioning (*Table 3.2*).

The changes in these characteristics that stand out as factors affecting the requirements on management organization and, consequently, as criteria for selecting alternative structures, are mostly interdependent and closely correlated. Accordingly, in practice each set of such characteristics is consistent with the most rational form and composition of management organizational structure. Thus, in developing the standards and criteria of organizational design for specific systems (e.g., for production amalgamations of similar industries) it would be reasonable to analyze the aggregate impact of variable factors on the requirements on the structure. However, in our case, which is of a general methodological nature, it is much more fruitful to consider the influence of each factor on the selection of preferred

organizational options. Let us consider briefly the major dependencies.

3.3.1. Management System Objectives

As follows from our preliminary consideration, not only an economic organization, but even a large-scale, comprehensive program may have only a single objective. However, if a system has a set of objectives, one of which has a market priority with regard to the ultimate result and the consequences of its application, to the resources required for its accomplishment, to difficulties of realization, etc., then it is necessary to arrange the organization of a corresponding goal-oriented program. The shares of line-functional and program orientation in management structures depend generally on the following factors.

Where there are several stable and equal objectives the organization is built around a line-functional structure. However, if production objectives are regularly changed and accompanied by a distinct product or process specialization, then the best alternative is the divisional form of line-functional structure or its combination, with some forms of product management. With the interrelated diversity of production and technological objectives and, accordingly, the complex interrelationships of the entire functional and production staff supervising the manufacture of a limited number of new products, the most effective form is found to be centralized project (line-program) management with a line-staff organization in the upper echelons and a line-functional organization at the middle level. Finally, where the dominance of one of the system objectives is prolonged, a multi-objective, line-functional structure may be converted into a centralized program structure in which various forms of line, line-functional, and line-staff organization may be applied.

A no less significant factor is the stability of objectives over time. It is quite reasonable to judge the stability by the life cycle of organizational structures (time period between major restructurings), which generally averages 4–5 years for modern organizations. Should the major objectives of an organization be sufficiently stable within the life cycle of the line-functional structure, the latter must be considered as the most efficient in such an environment. Correspondingly, more dynamic objectives

Table 3.2 Factors determining the requirements on organizational structures and their impact.

Major factors and their characteristics	*Range and direction of change in characteristics*	*Changes in requirements on management organization*
1. SYSTEM OBJECTIVES		
Quantity and integrity	From specific programs to multi-objective economic systems	Transition from line program to divisional structures employing matrix mechanisms
Dynamics	From stable, oriented at steady functioning, to variable	Transition from centralized line-functional to decentralized matrix structure
Certainty	From strictly defined by all the parameters to those defined only qualitatively and poorly structured	Transition from line-staff to line-program structures
Diversity	From homogeneous to diverse production and scientific objectives	Greater specialization of middle-level management, transition to product and project forms of management
2. FUNCTIONING ENVIRONMENT		
Reporting	To central ministerial staff or regional management body, or to an economic authority	Transition from full autonomy and integrity to interaction and allocation of formal functions and responsibilities
Number of partners	From a limited number to scores or hundreds	Greater specialization and centralization of consumer service
Volume of external service	From dominant to insignificant	Establishment of specialized line-functional services and coordination staff units
Stability and rigidity of external relations	From stable, strictly specified relationships to casual, incidental ones	Great centralization and control, creation of additional functional and staff units

cont.

Table 3.2 (cont.).

Major factors and their characteristics	*Range and direction of change in characteristics*	*Changes in requirements on management organization*
3. RESOURCES		
Mix	From a limited number of simple items to a complex variety	Differentiation of organizational structure, specialization of its links, more extensive coordination
Volume	Relative growth from one to several times	Divisionalization, introduction of product management
Supply sources	From predominantly in-house production to broad external cooperation	Transition from divisional to mostly functional structures
Rate of supply	From sufficient to limited	Transition to program forms of management accompanied by centralized supervision
Stability and certainty	From a stable mix of strictly quantified resources to a poorly specified, unstable mix	Transition to decentralized forms of supply, establishment of duplicate functional units
4. ORGANIZATIONAL AND TECHNOLOGICAL PARAMETERS		
Type of production	From one-off to mass production	Centralization of preproduction and development services, transition from product to project form of management
Type of production specialization	From technological to product specialization	Transition to divisionalization, setting up of coordinating staff units at higher management levels

require more flexible and adaptive structures. These are mostly matrix structures made up of line-functional and program (project) components [10].

It very often happens, however, that an organization has both stable and dynamic objectives, in various proportions. This usually occurs together with a significant diversity of production and technological tasks, and is caused by the need to maintain or expand the production of certain goods that are well established in the market and, at the same time, to initiate a new product line or service, which involves R&D, installation of new facilities, and drastic modernization of facilities already running. In such cases, the priority generally is to ensure steady growth while maintaining the profitability of the business. This is achieved through improvements in the line-functional structure, primarily by means of establishing and aggregating staff units in the higher management echelons, such as analytical, forecasting, and planning units. At the same time the middle-level management units are built mostly around matrix structures dominated by program (project) components [28].

3.3.2. System Functioning Environment

The content and nature of open socioeconomic systems (e.g., economic organizations) are largely determined by their relations with the environment. There are three distinct types of environmental elements that determine the requirements on the management organization of any system.

The first type involves the administrative authority of a higher system. The content, structure, and scope of each specific management system depend on the organizational structure of the higher (with respect to the given system) functional management, on the degree of centralization of responsibilities and resource allocation authority, and on the way the management functions of all the external relations are allocated.

In this respect there are a variety of forms of relations between production amalgamations and higher authorities in the USSR. Although they are subordinate to the central production office of an industrial ministry, which exercises mainly administrative, coordinating, and planning functions, amalgamations enjoy an ever-increasing autonomy. They establish an extensive

line-functional network whose units act as major contributors in comprehensive industrial and interbranch programs. The need for autonomy and comprehensiveness is much greater in those production amalgamations that report directly to the central ministerial staff. As a rule such conditions are provided for particularly large and diversified production amalgamations or industrial complexes. In recent years production amalgamations have come to report increasingly to All-Union or republic industrial associations. The latter closely engage in direct economic management; hence, in many cases they centralize a number of functions related to preproduction, supply, and services. This leads to the establishment of an integrated management structure for a whole subbranch of industry where a production amalgamation's management or its units turn into interdependent links of a common system. This increases the need for program management mechanisms developed around matrix structures.

It is also an established practice to set up large-scale production amalgamations and combines within the framework of republic ministries or reporting to a regional administration. This is usually accompanied by the significant diversification of production, and management functions may be allocated in a quite different way. Practice shows that organizations dominated by product program structures are most efficient in such situations. On the whole, however, the impact of various factors on the forms and methods of management organization in such amalgamations has not yet been studied sufficiently thoroughly [30].

The second typical elements of an economic organization's environment are the suppliers of materials, components, equipment, tools, containers, etc. Depending on the scale and variety of cooperation, the tasks of its management may change drastically. Accordingly, management organizational forms may change too: specialized functional services, headed by deputy general managers, may be separated, comprehensive goal-oriented programs for support and cooperation may be established, or supply and sale functions may be decentralized.

Of particular significance are the stability and content of the organization's relationships with the elements of the environment. If the relationships are extremely variable, arbitrary, and poorly formalized, then the priorities in the tasks and functions

of organizational management tend to shift. This leads to degradation of the functional specialization of the top and even middle-level management units; their activities become very diversified and it is necessary to duplicate staff units. Conversely, stable and strictly specified relationships with consumers and suppliers ensure the efficient functioning of the centralized line-functional structure, which employs coordinated forms of program management as the need arises.

The third typical elements of the environment are the components of the production and social infrastructure. Two factors are essential here: forms of infrastructural management and the scope of the external services provided by an organization. The more centralized and specialized the infrastructural branches, the less an economic organization's management centers on them. This allows the abandonment of some functional units in the internal structure, of the centralization and mechanization of planning and inventory procedures, and the cancellation of staff links. The amount of services provided by an organization depends ordinarily on the size of the organization and the availability of special facilities in the region. Giant amalgamations tend to establish in-house specialized transportation, power supply, repair, and similar services. In nonindustrial regions (agrarian, poorly populated, etc.) even medium- and small-size enterprises have to create their own production and social infrastructure. This enlarges and complicates the management and increases the need for special forms of coordination and staff units.

3.3.3. Resources

The characteristics of resources consumed by economic systems to accomplish their assigned objectives significantly affect the management organizational structures and their efficiency. The major effects are as follows.

First, the procurement of each type of resource may be viewed as an independent subobjective of the system. Thus, the mix of resources, their shares and interdependence, and the sources and means of procurement determine to a great extent the structure of the organizational objectives and, consequently, the organizational management structure.

Second, the volume of consumed resources directly depends on the size of an organization. Accordingly, this determines the total amount of management activities, the content and intensity of individual management functions, the specialization of management units, and their interrelationships and internal structures.

Third, the sources of resource procurement and the mechanism of resource circulation greatly influence the composition, content, and procedures of organization–supplier relations. It is worth pointing out that semifinished products, power, tools, information, and services must also be considered as specific resources; hence, their characteristics largely determine both the manufacturing structure of the system and its external cooperation.

Finally, the degree to which consumed resources have to be supplied determines the requirements on management organizational forms to a large extent, albeit indirectly [31]. Thus, scarce resources, lack of current assets, and poorly organized deliveries call for highly coordinated day-to-day operational activities in all the functions, for the strict and frequent control of costs and progress by upper management, and for highly centralized authority and responsibility for resource allocation.

The uncertainty and variations of resource composition that occur during the development of new products and services, or during interaction with an unstable environment, require decentralization of authority for resource procurement and utilization, the establishment of interfunctional (lateral) interrelationships, and increased stocks and rates of resource consumption.

3.3.4. Organizational and Technological System Parameters

Although to a certain extent subordinate to the objectives, resources, and environment, these parameters, on account of their variability, exert their own influence on the requirements on a management organization. We can single out the following factors, whose influence is important regardless of the specific features of particular systems.

The internal structure of management tasks and the content of the functions are mostly affected by the type of production organization. Thus, mass production enhances the role of forecasting and long-range planning, of organizational and

technological preproduction programs, and of consumer service organization. The most suitable organizational forms under these circumstances prove to be those that ensure the separation of strategic and operational management functions and the economic self-adjustment of organizationally independent subsystems. Conversely, in small-batch or one-off production the emphasis is placed on relationships with specific consumers and suppliers, on the instantaneous adjustment of technology and material flows, and on the continuous coordination of the utilization of various resources. The maximum benefit in this case is achieved through the application of flexible organizational forms that allow horizontal relationships to be established and adjusted quickly.

The type of production specialization and the degree of its cooperation essentially affect the requirements for the centralization of authority and responsibility, for the differentiation of the middle-level units, and for the composition of their communications. Thus, product specialization allows a deeper separation of management units engaged in operational control of manufacture and sales, while technological specialization places the primary emphasis on the preparation and support of production. Greater cooperation in production requires extensive coordination of current activities, while lower cooperation promotes those units dealing with economic analysis and resource allocation.

The complexity of the output and the technology employed affect mainly the content and volume of management functions. For example, the manufacture of particularly complex products often goes side by side with excessively large and complex design and quality control management units. Various forms of design management are available here. The application of diverse and highly mechanized technology increases the scope of technological preproduction and technical services, and enhances the role of scheduling and the control of the rates of plant operations.

An essential factor of management organization for the majority of large-scale amalgamations is the geographical spread of production units and the availability of communication facilities. For example, if the divisions and subsidiaries of an amalgamation are a great distance from each other, they have to perform many middle-level management functions on their own. This results in additional staff and integration units at the top

management level. Conversely, when the entire production is concentrated in a single (albeit large) area there is an opportunity for significant centralization of a host of management functions on the basis of integrated, deeply structured services.

The description of some common laws characterizing the influence of the major properties of an operational subsystem on the requirements of its organization indicates that, apart from a close interrelationship of the organizational factors proper, there is also a joint influence on the requirements of the organizational structure. These requirements may be reconciled and met only through deep studies and the setting of standards with regard to the specific features of particular branches of industry. The methodological basis for applying the identified factors in the process of organizational structure development are described in Section 3.4 and Chapter 4.

3.4. Rationalization of Organizational Structures as a Scientific Problem

One of the most essential achievements of the modern methodology of management organizational development is, in our opinion, the consideration of this problem as the task of *organizational design*. This problem should be solved rationally on the basis of the use of principles of systems science, behavioral sciences, and other fields of science.

The dual character of the organizational structure of an economic enterprise as a unit of design should be taken into account. On the one hand, the structure of an organization reflects technological, informational, administrative, and economic relationships that can be analyzed directly and rationally designed. On the other hand, in its functioning an organization is also characterized by social and sociopsychological relationships and interactions that depend on the differentiation of skills of the employees, their attitudes to work, management styles, etc. These relationships are subject to indirect influence through the appropriate selection, staffing, and training of personnel, through the choice of a particular system of payment,

through material and moral incentives, and through the creation of an appropriate psychological climate.

Thus, the task of organizational structure design cannot be formulated as a pure engineering or mathematical problem, though modern methods of formal analysis and modeling are going to play an increasingly important role. In large systems the number of elements and the complexity of their relations increase so much that the necessity for a statistically sound and proper correlation between the parameters of an organization becomes quite apparent. For instance, a high diversification and geographical spreading of production in a large enterprise requires the decentralization of management, regardless of the views of the chief manager. In contrast, in the reorganization of the internal structure of a small department the personal likes and dislikes of employees are one of the decisive factors that influence their ability to cooperate.

However, an organizational structure, figuratively speaking, should be not only designed, but also "grown". Its formation is a dynamic process, resulting in the improvement of the effectiveness and quality of management activities.

Organizational structure design is thus a peculiar problem. It is a qualitative, quantitative, and multicriteria task that must be solved on the basis of the integration of scientific (including formalized) techniques of analysis, evaluation, and organizational system modeling with the subjective judgments of manager–users, specialists, and experts. Moreover, this integration must be secured at a fairly early stage in the evaluation and selection of the most appropriate alternatives for organizational design, long before the implementation stage.

The role of subjective factors is larger in the solution of the particular problems of organizational subunit formation than in the reorganization of the configuration of larger systems. Subjective factors are also particularly important in the design of flexible, adaptive program structures that require new patterns of organizational behavior (in contrast to the design of line–staff structures, which are more formalized and based on the detailed description of and strict adherence to formal organizational charts).

Scientific and methodological principles of organizational design began to emerge as a separate sphere of knowledge in the 1970s. There are several approaches, each singling out one (usually) of the major dimensions of an organizational system and applying particular techniques for its improvement. However, their integration into a unified methodology of organizational design has yet to be achieved.

In our view, modern approaches to organizational design may be classified along four lines:

(1) "Synthesis of structure" from some initial elements.
(2) Rationalization of organizational systems and procedures.
(3) Organizational change.
(4) "Situational" choice of the organizational system characteristics.

The systems–goal approach is based on a methodology aimed at the solution of practical tasks of organizational design. Thus theoretical principles and techniques developed by each of the mentioned approaches are integrated into our approach to a greater or lesser extent. However, the overall framework of their application is the systems–goal approach to the design and improvement of management organizational structures.

Soviet management science and management practice have, during the course of their development, worked out general principles of management organizational design that are adequate for socialist production. In the 1960s the applied techniques of management organizational design were developed. They are based on the ideas of cybernetics, the techniques of statistical analysis of the relationships between organizational structure parameters, and the design of certain organizational models. During the 1950s and 1960s, however, in the concrete methodology of management organizational design an approach that might be termed as "function-oriented" prevailed. Its essence was as follows.

The process of management organizational design was based on the singling out of a standard set of "management functions" (more exactly, functions of business activities), whose performance was considered as necessary for the normal functioning of

every industrial enterprise. These functions include operational production management, purchasing, industrial engineering, organization of work, wages and salaries, and operational planning.

In this approach the major characteristic of an organizational structure was considered to be the size of the administrative staff, which was determined by management functions depending on the scale of production, the type of industry, and other factors. Any definite organizational decision corresponded to a particular size of the administrative staff: the formation of a bureau, department, or administration to perform the given function, the introduction of deputy head of department positions, etc. The main way of searching for a rational organizational structure was considered to be the generalization of the practices of advanced enterprises (including statistical, interorganization surveys), while the main means of realizing advanced organizational forms was the elaboration (based on experience and evaluation of future trends) of standard management structures, of staff schedules, and of standards of personnel size that were prescribed for use in corresponding branches and at enterprises in the same category.

The function-oriented approach to organizational design played a positive role during a certain stage of development. It facilitated greatly the rationalization of the management of industrial enterprises on the bases of the proper arrangement and balance of all its elements, the development of management standards, the eradication of poor performance in the activities of some organizational subsystems, the more accurate distribution of authority and responsibility among units and positions, and the saving of administrative expenses.

Nevertheless, this approach is limited in two main ways. First, it is used only in the design of line-functional structures that are mainly adjusted to the performance of well-defined, repetitive management tasks under conditions of stable products and services, of stable technology, and of a highly certain, external organizational environment. The approach did not work for the design of program or matrix management structures or for systems integrating R&D and production and aimed at the generation and rapid implementation of various kinds of innovations, etc. Second, this approach is hardly suitable for large reorganizations

or for fundamental management changes in links where quite new tasks arise. A thorough study and generalization of advanced management experience at existing enterprises gave little direction for the organizational design of newly formed industrial or R&D and production amalgamations. It made no recommendations about rational forms of organization for the development of management information systems, management improvement, etc.

It was the large-scale and new practical task to reform the management system in the USSR that stimulated the dissemination of new ideas in the methodology of management organizational design. According to these ideas questions of the structuring of functions, the definition of the size of the management administrative staff, and the choice of organizational structure should be viewed from a broader perspective. The whole set of recent theoretical and practical developments that are based on such ideas of organizational design may be called the systems–goal approach. This approach provides the framework for a new consideration of the essentials and procedures of management organizational design and the methodology for searching for, elaborating, and selecting organizational designs. The main principles of this approach to organizational design are the following:

(1) *Formulation of the final objectives* as the basis of organizational design. Here, large industrial complexes are considered as multiobjective systems having production, economic, technological, and social objectives. However, this does not mean a simplified, straightforward correspondence between the elements of the goals and the composition of the structural units, since the objectives are only some of the factors relevant to the design of an organization, together with its size, technology, external environment, etc.

(2) *The systems view of the organizational structure* consists of the determination of "the total organizational task", which is a differentiated and interrelated combination of actions necessary to achieve every major final objective, and of the determination of which part of these actions should be performed inside the organization and which part outside (i.e., outside the boundaries of the organization as an open system). The systems approach to the organizational

structure itself means the definition of contextual variables (objectives, environment, technology) and management variables (structure, processes, leadership, behavior), and an analysis of the quantitative and qualitative relationships between them. A properly based choice of forms for management bodies requires that the characteristics of targets (uniform and multiform), organizational structures (mechanistic and organic), and behavior (executive and initiative) should be coordinated and linked together, as a result of analyses of the whole complex of factors that influence the organizational system.

(3) *Typological systematization* of the principal characteristics of the organizational structure, determined not only by the subordination and composition of subunits, but also by the mechanism of functioning of the whole organization. These characteristics include the types of structures (line-staff, matrix, project, etc.), the degree of centralization and decentralization in decision making, the degree of formalization and automization of management processes, the character of the applied means of control, and the requirements on personnel (i.e., as to skills, behavioral patterns, etc.). Each distinct combination of characteristics can be singled out as a model (type) of organizational structure: organic, mechanistic, or intermediate.

(4) *Multifactoral assessment* of the requirements on the management system from the operational system. This envisages the complex assessment of the conditions under which the system operates. The more significance that scientific and technological goals have compared with production goals, then the closer the type of technology is to small-batch production; the more complicated technological processes and work relationships are, the more interconnected the organizational units are; the more diverse the sources of external influences and information inputs are, the more applicable are program and matrix organizational forms in comparison to the line-functional forms.

(5) *Elaboration of the organizational mechanism* of systems management functioning. This envisages the determination not only of the composition, subordination, and size of

administrative units, but also of the relationships between them and the processes by which these relationships are realized. The problem of management structure design is closely connected with the formation of an intrafirm economic mechanism, a planning system, a material incentives system, and an information network. This elaboration is performed after the principal type of management structure has been chosen.

Organizational and economic mechanisms are formalized in management for those functions where a high formalization of jobs (accounting, quality control, etc.) is necessary. In addition, there are some complicated cases of the distribution of responsibilities and authority (e.g., where purchasing is either centralized or decentralized) in various units of an economic enterprise, and in the design of program management systems. Here too it is necessary to formalize the organizational mechanism of management.

This approach to the design of a management organizational structure requires the development of an adequate methodology. Three points are of major significance here. First, the design of a management structure as a specific kind of object should be considered partly, but not completely, as a rational process involving the application of scientific techniques of organizational design. Second, a management structure should be designed on the basis of a whole set of techniques applied in various combinations. These techniques include the technique of structuring, the organizational modeling method, and the analogy method. Third, the process of management organizational design requires efficient forms of involvement by managers and other members of the client organization at every stage of organizational design. It also dictates the application of program and "action research" approaches to the organization of the design process itself. But what are the essential characteristics of organizational design techniques?

The technique of goal structuring envisages the elaboration of a system of organizational goals, including their quantitative and qualitative definitions, and a subsequent analysis of the organizational structures with regard to their correspondence to the system of goals. This technique is of special significance in the

systems–goal approach to organizational design. The various goals at the high, middle, and low levels of this structuring cannot usually be assessed according to a single criterion.

It should be stressed that the goal formulation should not be abstract. First, the definition of every goal should be clearly stated in such a way that the following characteristics are presented: subject area, i.e., it should be clear as to what real objects the goal is related (new technology, production output, personnel, financial funds, etc.); time horizon, i.e., whether the goal is permanent or *ad hoc*, long-range, short-range, or operational, etc.; spatial, i.e., the boundaries of the sphere of activities to which the goal is related should be clearly defined (consumer of products, enterprise as a whole, functional service, department, plant, shop, etc.). Second, the system of goals must be quite clear and simple. In designing the system of goals and its representation (graphic, in the form of a goal "tree"; matrix, in the form of a table; and, in the form of a list, enumeration and coding of goals) it is impossible to cover all the various relationships between the different goals (equity, mutual support, competition, etc.). Nonetheless, the consistency, comprehensiveness, and compatibility of goals of different levels must be secured.

It is impossible to develop algorithmic procedures for the transition from the goal system to a management organizational structure, because the goals are only one factor in organizational design, together with the organization's size, technology, internal and external relations, etc. The determination of goals is used in organizational design along the following major lines:

(1) Differentiation of the major units (subsystems) in an organizational system, where each unit should accomplish a particular organizational goal and the structure as a whole should provide the conditions for achievement of the total set of organizational goals.
(2) A check on the homogeneity of the goals for each unit to protect against dispersal of responsibilities for a particular goal among various units, as well as against duplication of the goals.

(3) The setting out of rational organizational relationships and the formulation of the requirements on coordination mechanisms according to the structure of the organizational goals.
(4) The elaboration of intraorganizational economic indexes, as well as work measurement and work stimulation systems in separate units, on the basis of the tasks assigned to them.

The expert–analytical method involves examination and analytical study of an organization to reveal its specific peculiarities, problems, and bottlenecks in the activities of the management staff, and to work out rational recommendations concerning its design or alteration on the basis of quantitative measurements of the effectiveness of the organizational structure, of the principles of rational management and expert judgments, as well as of the summing up and analysis of the most advanced practices in the field of organizational management.

The main forms of application of this method are as follows:

(1) Examination and analysis of the goals, functions, and organizational relationships of management system elements.
(2) Diagnostic analysis of peculiarities, problems, and bottlenecks in the management system of an operating economic organization or in an organization similar to the newly created organization.
(3) Expert interviews with managers and organization members to indicate and analyze separate features in the formation and functioning of management staff.
(4) Development and application of the scientific principles of management structure design, which are the guiding rules for the rational design and improvement of organizational management systems that have been derived from advanced management experience and scientific generalizations.
(5) Elaboration of graphic and tabular descriptions of the organizational structures and management processes that reflect recommendations on the best organizational design from among various possible alternatives.

It is important not only to attract qualified experts to organizational structure design, but also to find a proper

systematization method, records form, and a clear representation method for expert opinions and conclusions that can be used effectively in design work. Expert interviews of managers and organization members play a particularly important role, since they are not only a valuable source of information, but also a method of checking the feasibility of possible organizational designs and of overcoming psychological barriers to the implementation of an organizational structure. In addition, large-sample statistical surveys (based as a rule on questionnaires) have become more important recently. On the basis of mathematical statistical methods (e.g., range correlation factor analysis, list treatment) these surveys reveal stable correlations between organization size, production technology, and type of organizational environment, on the one hand, and the effectiveness of organizational structures, control mechanisms, coordination forms, etc., on the other.

Organizational modeling is the elaboration of formalized mathematical, graphic, computerized, and other descriptions of the distribution of authority and responsibilities in an organization, as a basis for the design, analysis, and evaluation of different versions of organizational structures, depending on changes in the most important factors.

Various approaches to organizational modeling have been developed with both scientific and applied orientations. The known models ultimately reflect only separate features of management structures and do not cover all dimensions of the organizational design problem (i.e., the administrative, information, and behavioral dimensions). Organizational modeling is therefore considered to be a supporting analytical tool in the search for an elaboration and choice of rational decisions in the design of organizational management structures.

The most important question is whether the description of organizational communications and management relations in the model under consideration is direct or represented indirectly through the modeling of information or production–economic relations. The direct modeling of organizational relations has so far been a very complicated task, owing to their variety and their dependence on human behavior, which restricts the sphere in which organizational modeling can be applied.

The analogy method consists in the implementation of organizational forms and management mechanisms that have proved their effectiveness in organizations whose characteristics (goals, types of technology, size, organizational environment, etc.) are similar to those of the organization being designed. It is important here to choose organizations that are reasonably similar to the system being designed and to carry out a detailed analysis of the principles and regularities of management structure design in such organizations.

The most popular form of the analogy method is the elaboration of typified management structures for economic enterprises and the determination of the limits and conditions of their applicability. Here the typified organizational decisions should be:

(1) Multivariant decisions.
(2) Those decisions that are reconsidered and adjusted regularly.
(3) Those decisions that are flexible and allow divergence when the organizational context differs from those conditions for which the appropriate standard form of management structure is recommended.

The most effective method of applying typified decisions for the design of a management organization is the "building-block" method of standardizing its subsystems, i.e., line-staff and program structures. More specific characteristics of the organizational structure are regulated by progressive standards, which are elaborated on the basis of both calculation methods and the distillation of advanced management practice.

Thus, the analogy method can be effectively used only by highly qualified experts, experienced managers, and others with extensive practical experience. They have played the decisive role up to now in the design of management structures that correspond to objective requirements. However, the systems–goal approach, which is the logical organization of thinking in the design and improvement of organizational structures, together with the reasonable use of available methods, should allow us to make advances in the scientific solution of the organizational design problem.

An action research approach assumes:

(1) That the organizational design is the result of the joint efforts of organization designers, executives, ordinary members of the organization, and sometimes the representatives of superior bodies.
(2) That there is a permanent feedback from the personnel of the new or modified organization to the organization designers.

After each stage (problem diagnosis, elaboration of alternatives, etc.) data are collected concerning the reaction of the existing organization to the implemented action. The organizational design is based on the revealed opinions, the experimental implementation of new organizational forms, etc. This not only increases the soundness of the change action, but also helps to restructure the attitudes, opinions, and values of individuals affected by the change in organizational form. This process integrates the rational methodology of systems design with the sociopsychological methods of organizational change.

It is important to stress that this synthesis requires an appropriate organization of the design process itself. In the development of the structures of internal organizational units this is mainly a question of the interaction between organizational design specialists (change agents) and organization members, and their training and development (with methods of sensitivity training, the Blake–Mouton grid, etc.). However, the design of large organizations often requires program-oriented organizational forms for both the design and implementation stages.

The specific features of the content of a design for a management system are determined by the relative importance of the system's variables. Organizational design may therefore be described as a three-stage process with feedbacks, including the following stages:

(1) Development of the overall organizational chart and its major parameters (composition stage).

(2) Structuring of the organization into separate units and definition of their main relationships (structuralization stage).

(3) Definition of the quantitative parameters of the management organization and formalization of the procedures of its functioning (formalization stage).

CHAPTER FOUR

Design of Management Organizational Structure: Processes and Techniques

4.1. The Process of the Development of Management Organizational Structure

A central problem in the design of a management organizational structure is the definition of its formal structure and its parameters (including its composition, hierarchy of subordination, functions, communications, and relationships), and an estimation of the appropriate number of managerial staff. Management organizational systems design is an ill-structured problem; its solution therefore starts with a diagnosis of the problem and the search for and analysis of alternatives, and finishes with the choice of the most suitable alternative and an evaluation of the efficiency of the organizational structure.

This process has features characteristic of both engineering systems design and the "action research" process, typical of changes in social organizations made by influencing their members [32, 33, and others]. On the one hand, it permits the design process to be rationalized and, on the other, it permits account to be taken of the ill-structured nature of the problem and of the

necessity to motivate the commitment of interested individuals in changing their organizational relationships.

The rational process of systems design consists of the following stages:

(1) Study and design.
(2) Development and implementation.
(3) Utilization and efficiency evaluation.
(4) Improvement.

It is possible to consider the design of organizational structure as a process incorporating three stages with feedback:

(1) The formation of a general structural scheme and its major characteristics (the *composition* stage).
(2) Specification of a list of management divisions and the basic relationships among them (the *structuralization* stage).
(3) Definition of the quantitative characteristics of the management staff and regulation of its activity (the *formalization* stage).

The composition stage is the principle part of the design process. It permits the clarification of an image of the organization, the main features of the organizational structure, and all the directions of its study and analysis. The content and sequence of steps included in this stage are shown in *Figure 4.1*.

The most important methodological tools at this stage are the following: an overall analysis of the organizational problems and a broad search for ways to solve them; various kinds of surveys to reveal the main trends in management practices in different functional spheres of the organizational system; use of the analogy method and definition of the ways in which organizational changes are subordinated to the master strategies for the economic, technological, and social development of the organization.

Certain common problems are solved both at the composition stage and at the structuralization stage; however, the specific task of the second stage is to make organizational decisions, not only for large line-staff and program-oriented units, but also for autonomous (main) management organizational units to allocate

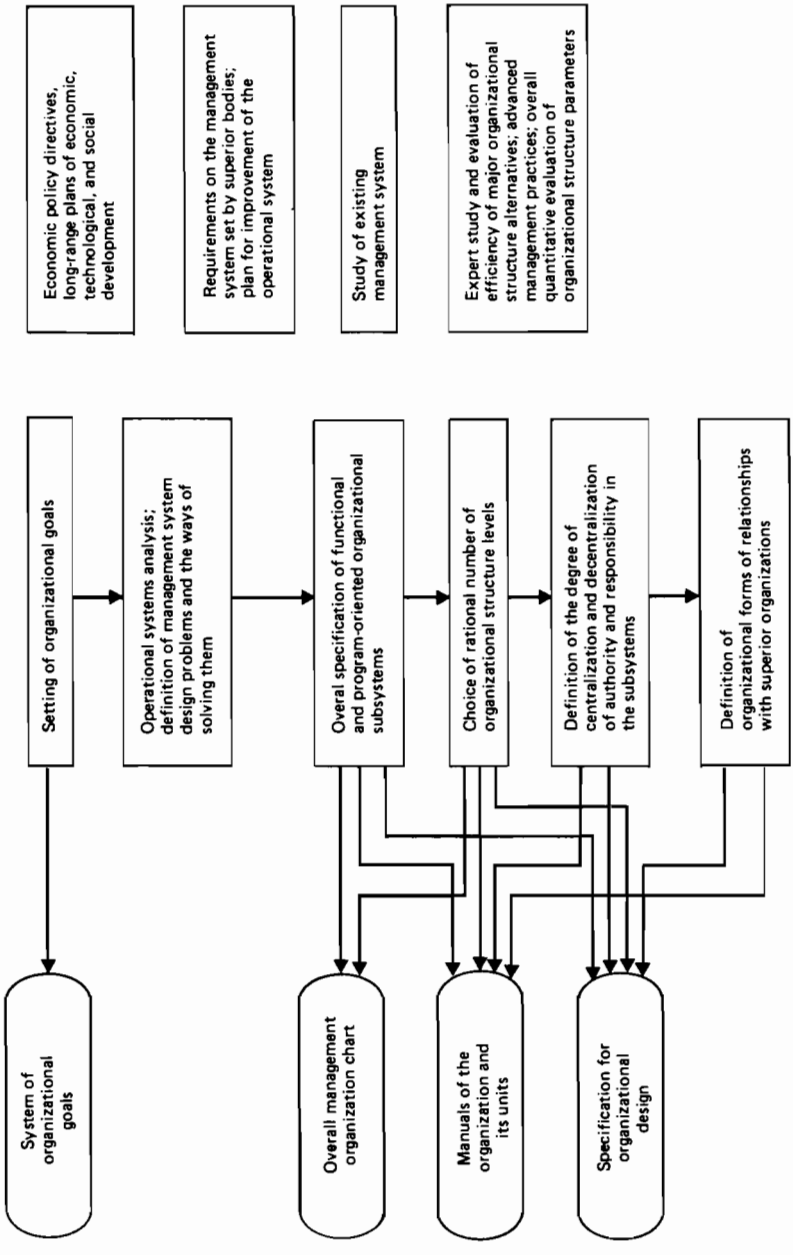


Figure 4.1 The composition stage of organizational design: content and sequence of steps.

specific tasks, and to elaborate intraorganizational communications among these units (*Figure 4.2*).

The term "main units" in this context means the autonomous organizational units (departments, offices, sections, laboratories, etc.) that are the elements of the line-staff and program-oriented subsystems. At the structuralization stage a comprehensive chart of the management organization should be elaborated, and manuals for the main units and goal-oriented program units and position descriptions for line-staff and program managers (deputy directors, chief specialists, deputy chief engineers, program managers, etc.) should be developed.

At this stage specific organizational and administrative decisions are made about the structure and mechanisms of activity, and planning indexes and criteria for motivation are defined. Various research techniques are used during this stage, but the experience and judgment of specialists and members of the organization assume the critical role.

The third stage – formalization of the organizational structure – deals with the definition of quantitative parameters of the management organization and the elaboration of management procedures. It involves the definition of the composition of main units (bureaus, groups, and positions), the allocation of tasks and activities among particular units and individuals, the delineation of responsibilities, the estimation of the size of staff, the definition of the time to be taken for main activities, the formulation of the skills required by personnel, the elaboration of management procedures (including the procedures that are carried out through the computer-based management information system), the estimation of administrative expenses, and the setting of indexes for the measurement of managerial effectiveness and efficiency in the designed organizational structure (*Figure 4.3*).

At the formalization stage, the comprehensive organizational design project is elaborated. First of all, the following main regulation documents are elaborated and improved:

(1) The personnel schedule (and size of the staff) of the units.
(2) Organizational charts of the main units according to these schedules.

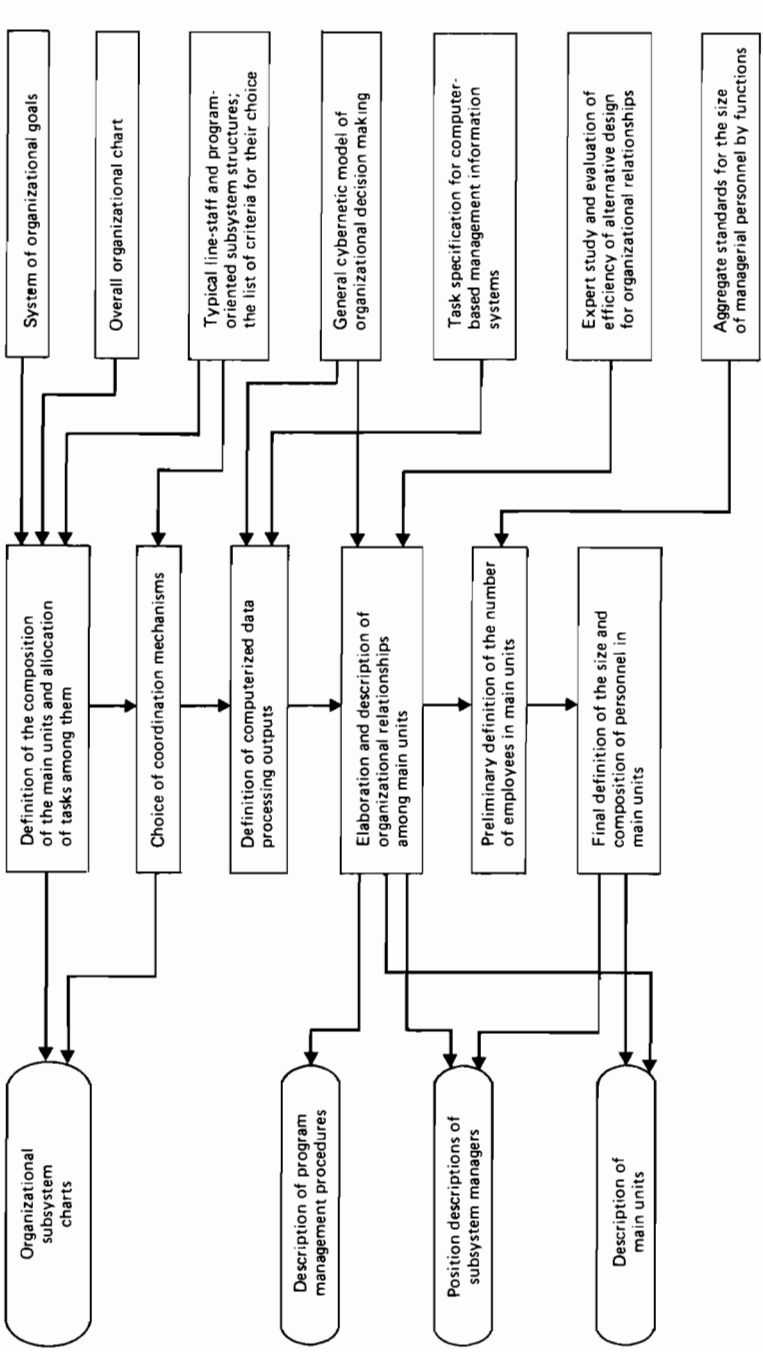


Figure 4.2 The structuralization stage of organizational design: content and sequence of steps.

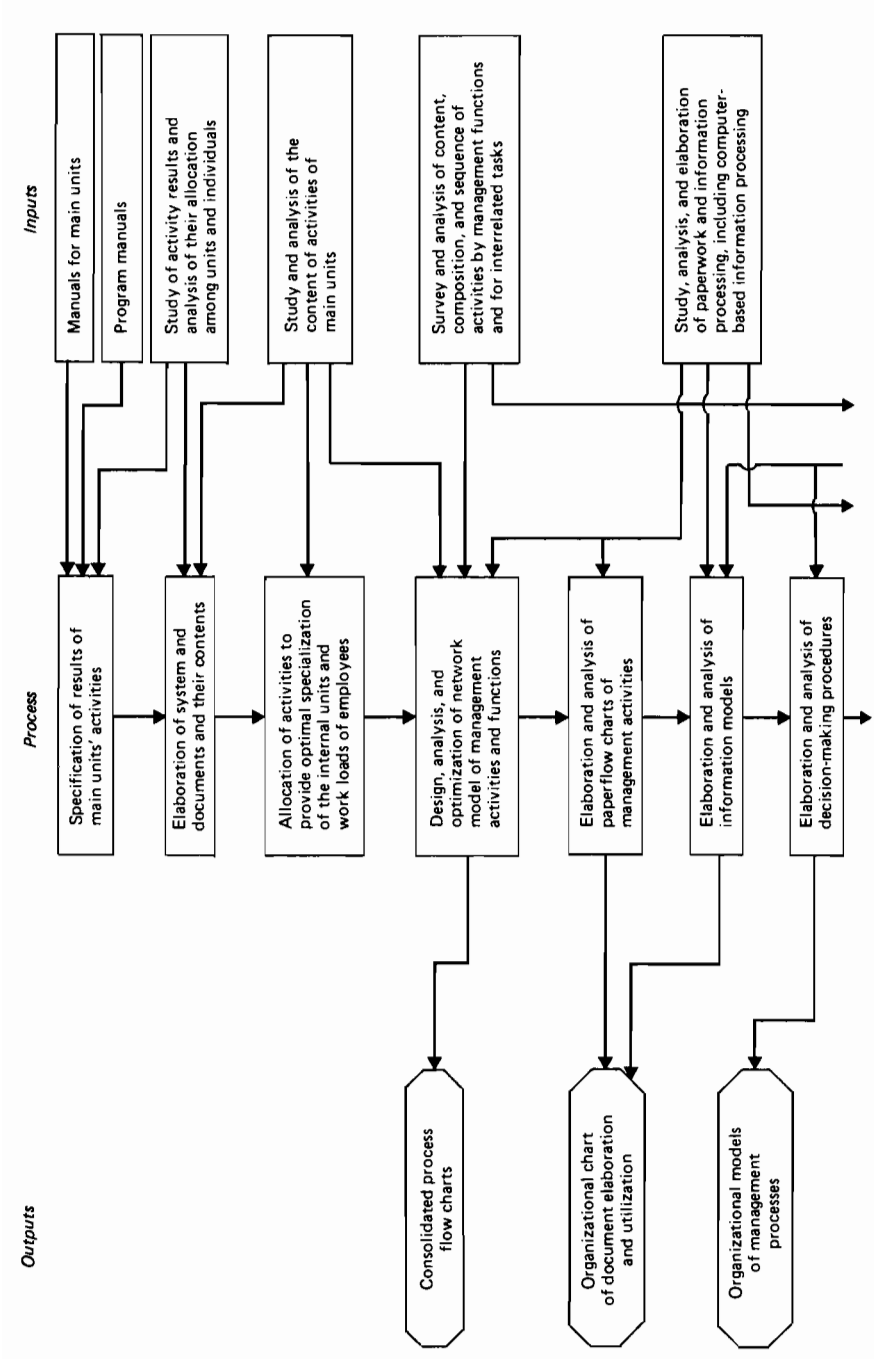
These documents are the basis for the work load and for payroll planning and financial control. They are elaborated and submitted for approval at the initial stages of management structure design.

Standard work loads and staff sizes for the main units of the management organization are defined on the basis of branch instructions approved by the State Committee for Labor and Social Affairs of the Council of Ministers of the USSR, of branch norms, and of interbranch standards.

The documents regulating the management process are also important. They include flowcharts and organizational models of management processes, position descriptions, operational charts for the elaboration and utilization of documents, and information models realized by the computer-based management information system. These documents and the methods of their elaboration may play an important role in the earlier, more generalized stages of the organizational design process. For instance, the elaboration of job descriptions for new (especially administrative) positions, which define the limits of their authority and responsibility, the design of organizational models, and the elaboration of flowcharts for complex interfunctional activities may be important auxiliary tools in the supplementary analysis of major organizational decisions.

The development of a comprehensive system of documents regulating the management process is gradual, and usually requires a long period of time. It is a resource-intensive process, but it unifies the design of the management organizational structure. Finally, the detailed codification of management processes can have a significant effect only when it is based on advanced management information-processing technology. It is in this stage that various formal techniques of organizational modeling and computer-based estimation play the most essential role.

The structure, content, volume, and sequence of steps in each of the three design stages depend on the particular features of the operating system, on the specific requirements on the organizational structure, and on the practical possibilities for its realization. These features include the following: the degree of formalization of the organization and the final organizational forms by directives and regulative documents; the type of design


Inputs
Process
Outputs
Manuals for main units
Program manuals
Study of activity results and analysis of their allocation among units and individuals
Study and analysis of the content of activities of main units
Survey and analysis of content, composition, and sequence of activities by management functions and for interrelated tasks
Study, analysis, and elaboration of paperwork and information processing, including computer-based information processing
Specification of results of main units' activities
Elaboration of system and documents and their contents
Allocation of activities to provide optimal specialization of the internal units and work loads of employees
Design, analysis, and optimization of network model of management activities and functions
Elaboration and analysis of paperflow charts of management activities
Elaboration and analysis of information models
Elaboration and analysis of decision-making procedures
Consolidated process flow charts
Organizational chart of document elaboration and utilization
Organizational models of management processes

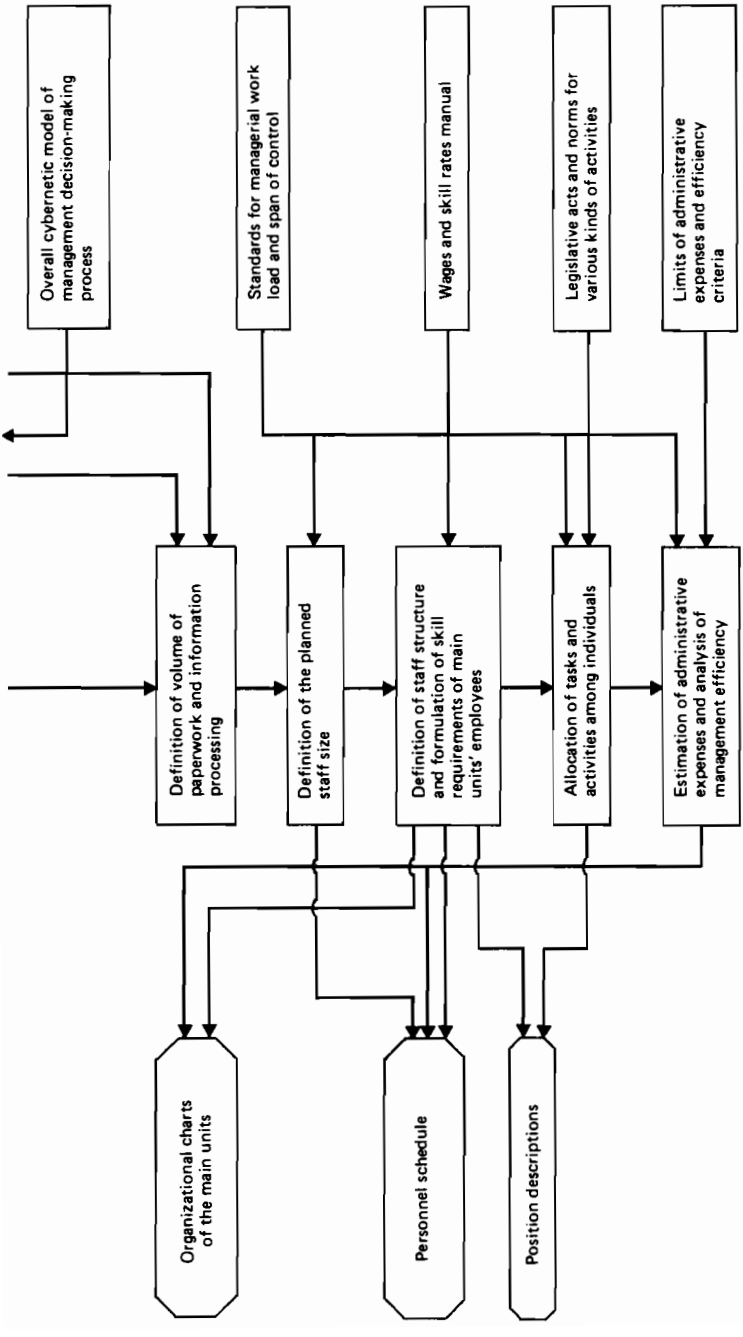


Figure 4.3 The formalization stage of organizational design: content and sequence of steps.

structure (rigid, adaptive, etc.); the time limits set for overall preparation of recommendations and elaboration of the project documentation; the availability of skilled personnel for investigative, analytical, and design activity; the existence of branch instructions and methodology for the design of management structures; the level of organization of the system; the complexity of the organizational problems; etc.

The definition of the problem of organizational structure design depends on whether an entirely new production complex is being designed or whether the structure of an existing enterprise is being improved. In the latter case it is necessary to pay special attention to the existing forms and techniques of performance. This prevents the loss of positive elements in the existing management structure, while helping to bring it into line with the new objectives and requirements.

The importance of activities at each stage of organizational design may differ, depending on the above-listed requirements. As a result there are three main approaches to the design of a management organizational structure.

(1) The deductive approach concentrates mainly on the composition stage, in which a generalized system evaluation and a formulation of the general principles of organizational design are especially significant and define the whole complex of subsequent organizational decisions. This approach is used for the design of new organizations on the basis of existing units (which are to be consolidated, enlarged, reformed, etc.) when the time available is fairly limited and when analytical and information resources are insufficient for elaborate and comprehensive research.

(2) The inductive approach focuses on the third, formalization, stage in which the maximum volume of design work is done and which consists of detailed descriptions of the organizational (unit) functioning, of information communications, and of organizational relationships, and the construction of organizational models, as well as comprehensive estimations and the evaluation of different alternatives for the management structure design. This elaborate, detailed, and comprehensive organizational system research serves as a basis for

making essential decisions about the overall management structure of the designed organization. This approach is most appropriate for the development of a new enterprise project or for organizational research aimed at the elaboration of standard decisions to be utilized in several organizational units.

(3) The combined approach assumes a more or less even distribution of design work among the three stages. It is used when the main essential decisions about the organizational structure are made in a relatively short time on the basis of the definition of the principal organizational parameters, of the general structuring of the composition of the most important units and communications between them, and of the detailed development of the most complex or new subsystems, which require special justification. After these steps the whole complex of the organizational system is gradually structured and formalized; this process may have a certain influence on organizational decisions made at the initial stage of organizational design. This approach is the most flexible and universal one, and it is recommended as a basis for the development of the design projects for most management organizational structures in production organizations.

4.2. Definition and Structuring of Goals for an Economic Organization

Among the key features of the systems–goal approach to organizational design is the formalization of management relationships on the assumption that a system's active components will be responsible for the accomplishment of the defined goals rather than the performance of particular functions. The active components of a socioeconomic system are those that have their own interests and exert considerable influence on the definition of the goals of an organization or its subsystems. They can also change their functional orientation independently. In the most general terms, from this viewpoint *all* the social components of an economic organization – both individual employees and groups – are active. In analyzing organizational relationships, it is more

convenient to narrow the focus to structural units only, i.e., to independent departments or executives responsible for making and implementing decisions.

The advantages of the result or project orientation of the active components of a management system stem from the variety of patterns utilized to achieve the specific goals of the economic organization. Given the complex and multifaceted interaction of the elements of a large system in accomplishing their objectives in a dynamic and uncertain environment, it is impossible to determine *a priori* the optimal pace of operation that will ensure maximum effectiveness of an organization. Therefore, any attempt to formalize rigorously the functions of a management system reduces its flexibility, adaptability, and capacity for self-development. Conversely, the use of well-defined objectives as a stimulus and guide guarantees that a complex system will exhibit an appropriate degree of flexibility, a balanced set of formal and informal relationships, and a greater economic independence of units at all levels of the management system.

The project or goal orientation of an organizational structure consists of the definition for each independent organizational unit of its own objectives, while their structured totality provides for the attainment of the system's goals. Consequently, the design of a management system and its operational mechanism should be based on the objectively necessary and scientifically justified structure of the organization's goals.

Before going into the methodology of structuring the goals of a socioeconomic system, let us assume, for convenience, that the goal is defined as the necessary end result of an activity, which is recognized by both superiors and subordinates. This end result possesses quantitative and qualitative parameters based on the long-term and current needs of society, on objective socioeconomic laws, and on the needs arising from within the organization itself.An objective (or a subgoal) is understood to be a certain decomposition of a goal and a particular result whose accomplishment is a prerequisite for the attainment of that goal.

From this definition stems the first rule of goal decomposition: the totality of objectives (subgoals) should be necessary and sufficient to guarantee the complete attainment of the given goal, and the requirements for the identification and formulation

of an objective are the same as those for an overall goal. This means that each objective should be formulated in terms of a certain, necessary composite result that possesses quantitative and qualitative parameters and that can be achieved by an organizationally independent management unit.

The last part of the definition is particularly important to secure compatibility of the goal structure and the organizational structure to be designed. The fact is that any goal of a socioeconomic system – a large-scale economic organization – is itself a complex state or totality of multiform characteristics of the output that is achieved owing to a multitude (requiring a formal description) of various results. Therefore, in order to obtain a logical and integrated concept of a goal, it is necessary to describe it as a hierarchical structure reflecting the dependence of each specific result on another result or on the common goal. In practice, this means that each objective, in its turn, can be described in terms of a multitude of other objectives subordinate to it. The information available indicates that the number of hierarchical levels in this sort of structure can exceed ten, i.e., it can be extremely numerous in operational use (*Figure 4.4*).

In addition, the approaches to decomposing or structuring a complex goal in conformity with both its organization and the specific technological and organizational features of its attainment are quite varied; in other words, any goal structure can be described in several alternative ways. The goals can be decomposed by product or process specialization criteria or according to where and when they are achieved. Thus, the components can be arranged in different sequences (*Figure 4.5*).

The variety of patterns employed in structuring the goals is necessary and useful for the functional analysis and optimization of economic activity, but it complicates the procedures and makes less explicit the criteria for allocating responsibilities for the performance of specific management tasks. Comprehensive analysis and substantial expertise indicate that it is essential in goal decomposition to relate each definable result to the organizationally independent, active component: department, service, group of interrelated units, or even an independent decision maker. If this rule is applied, the goal structuring is effected with respect to one or more alternatives of management

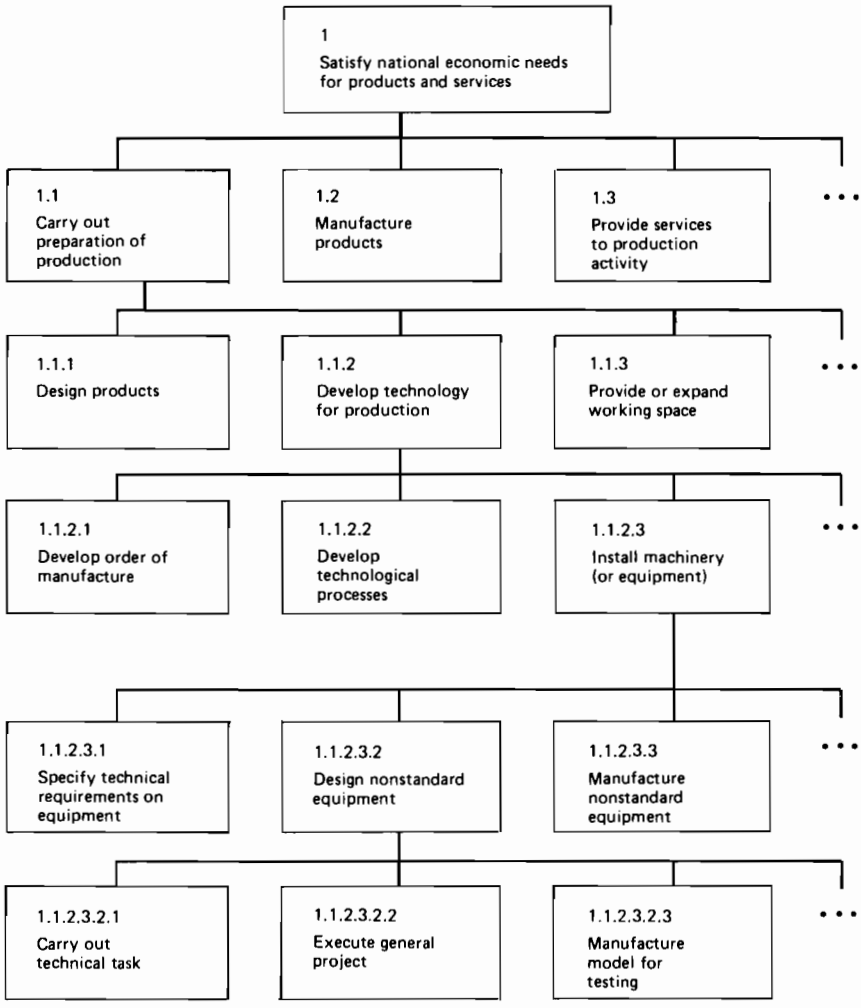


Figure 4.4 Part of the production goal structure for a machine-building amalgamation.

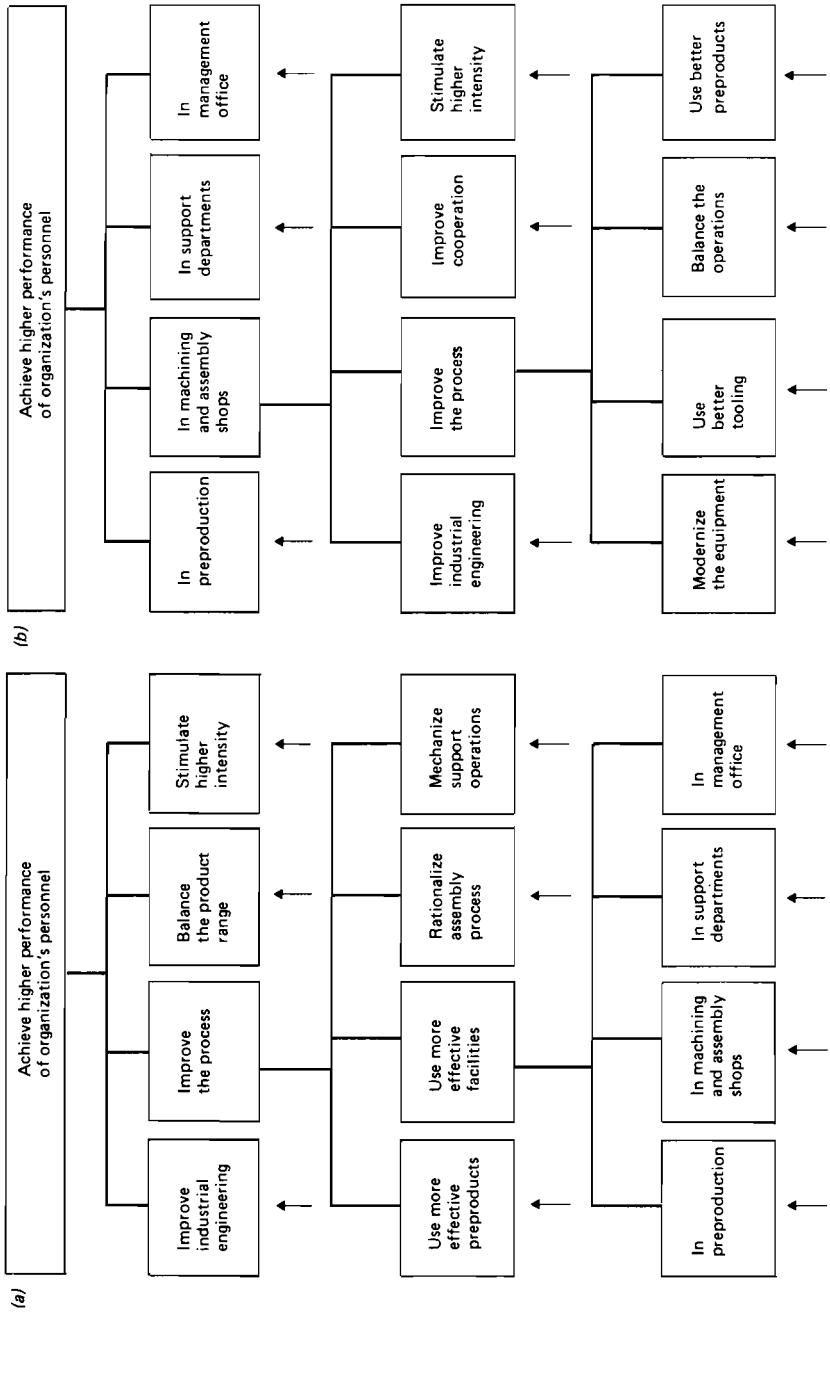


Figure 4.5 Two ways of decomposing and structuring a complex goal.

organization, which largely accounts for the composition and sequence of stages in designing organizational structures.

A common approach to the structuring of complex hierarchical goals is to represent them as a "tree of objectives", i.e., an interconnected open graph without cycles. This form of representation corresponds best of all with the management relationships that occur commonly in purely line structures and partly in functional (divisional) structures that also have the form of a tree. Under certain conditions this approach is employed in structuring the goals for other classes of systems.

However, the contemporary organization of production and business is a multigoal system; it possesses several independent, hierarchical goals that are attained by one composite whole through the integrated interaction of all its elements. If each independent goal can be formally expressed as a tree of objectives, the graphic representation of the system of interrelated goals inevitably leads to the emergence of cycles, i.e., to the closing in of different top-level branches on one of the lower-level objectives (*Figure 4.6*). This pattern does not allow for the distinct hierarchical division of responsibility.

Largely as a result of this, purely functional structures were preferred at the earlier stages in the development of organizational forms. However, as functional structures do not completely meet modern requirements for management organization, there is an urgent need for new patterns of goal structuring that can meet the complexity of the operational system adequately. The most rigorous formal way of solving this problem is the matrix organization of a system of goals (*Figure 4.7*).

In this approach it is assumed that each organizational unit of the management system possesses a multitude of goals. For example, on one of the levels in a hierarchy of goals, each unit providing tools for the production process might have the following objectives defined in general (nonquantitative) terms: to provide the production process with the required amount of tools; to cut the costs of producing and utilizing the tools to the level fixed; to guarantee the preset technical parameters of the tools; to accomplish the established objectives; and to meet the social development needs of unit employees.

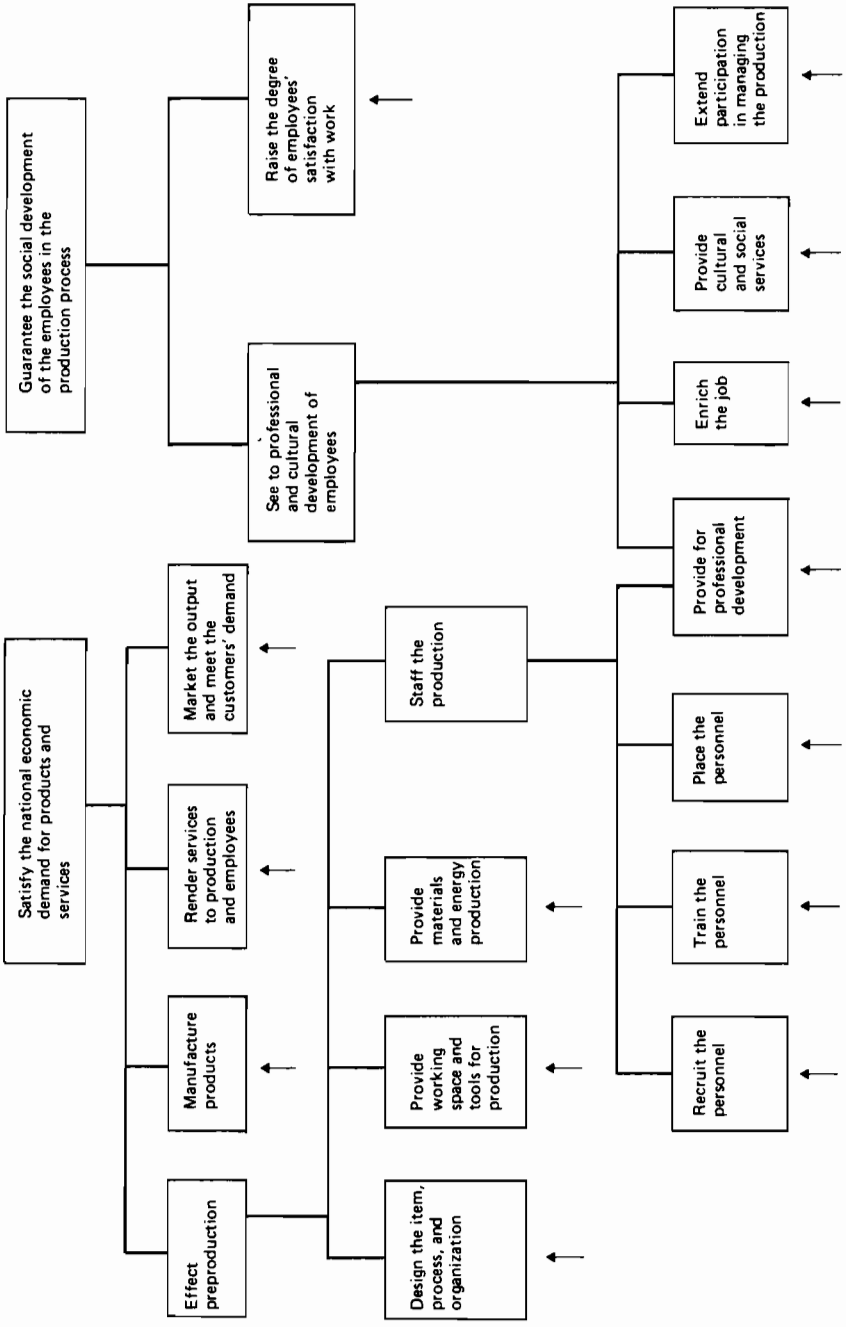


Figure 4.6 Overlapping of the hierarchical structures of interrelated goals.

Structural components of nonhierarchical goals				Production goal								
				Subgoal A			Subgoal B			Subgoal C		
				Objectives								
				A1	A2	A3	B1	B2	B3	C1	C2	C3
Engineering goal	Subgoal a	Objectives	a1		A2 a1		B1 a1		B3 a1		C2 a1	
			a2	A1 a2			B1 a2			C1 a2		
			a3			A3 a3						
	Subgoal b		b1		A2 b1			B2 b1	B3 b1			
			b2			A3 b2					C2 b2	
			b3	A1 b3			B1 b3			C1 b3		
	Subgoal c		c1			A3 c1			B3 c1			
			c2		A2 c2		B1 c2	B2 c2				C3 c2
			c3	A1 c2				B2 c3			C2 c3	

Figure 4.7 A matrix representation of a goal system.

The description of each unit's objectives with regard to the goal decomposition of all the organizations' goals is extremely useful for the development of integrated programs, on the one hand, and for the elaboration of interfunctional, interaction procedures, on the other. However, since economic organizations have at least four top-level goals, this sort of approach requires a matrix of at least four dimensions, and maybe even more. Though it takes a lot of effort, this is possible, but only for an already existing organizational structure of management. If a totally new functional model of the division of labor in the management organization is to be established, the multidimensional matrix representation is not constructive. Or, to be more precise, we do not yet have the formal tools to solve this problem.

In the process of structuring a full system of an economic organization's goals, which could also be used for the allocation of authority and responsibility, it is possible and, as shown by experience, useful to apply a combination of two approaches. Technically, this can be done along the following lines.

First, each independent top-level goal is decomposed and structured as a tree of objectives. The following rules (in addition to the commonly used ones) are observed:

(1) Each objective is defined quantitatively and qualitatively, with consideration of three factors (operational component, time frame within which the desired result should be obtained, and the boundaries of the environment where the management component functions and for which it is responsible).
(2) Goal structure levels are formed after the end result is decomposed according to the mode of its attainment or according to one of the factors indicated in the previous rule (however, each level should be formed according to only one principle of decomposition).

Second, the trees of objectives for all independent goals are integrated into a single system, with a horizontal correspondence of the top levels of each tree and the levels formed by the same principle of decomposition (phases of process, time, etc.).

If these rules are observed, it becomes very simple to identify the places where the goals become interlocked, i.e., those objectives whose accomplishment provides directly for the attainment of two or more goals (as indicated in *Figure 4.6*). It should be pointed out, however, that the leveling of the structural tiers of different goals according to their having the same principle of decomposition is frequently difficult and sometimes practically impossible. In order to make the procedure easier, it is advisable to use the same sequence of decomposition when structuring each goal. The information available indicates that the most commonly accepted sequence is: by operational components, by time frame, by technological phase, and by operational environment.

Third, the objectives that interlock are represented in the matrix form at a corresponding level in the structure of each of the interrelated goals. There are two ways to achieve this.

For upper-level objectives that allow further multilevel or multilink decomposition of the relevant goals, the most effective method is multigoal disaggregation, i.e., the development of a new definition in terms of the totality of the objectives of various classes. As a rule, such complex objectives are implemented through interfunctional programs.

For lower-level objectives, where the interlocking of different goals is mainly expressed by the emergence of rigid, specific constraints on various criteria, it is permissible to break the interlock artificially. This means that the objective is left in the tree where it has the strongest dynamic ties. The interdependences of an objective with other goals are reflected by introducing most of the explicit constraints imposed by those interdependences into the formulation of the objective. For example, the influence of the production objective is dealt with by the introduction of the output or performance indicator into the formulation; the influence of the economic objective, by the introduction of the marginal costs; the influence of the engineering objective, by the introduction of the fixed technical requirements; the influence of the social objective, by the introduction of the standard set for working conditions or service. Thus, the universal formulation of the objective of the tooling department, discussed earlier, could be as follows: to improve the forms of moral and material incentives to minimize the consumption of steel

alloy in supplying item A manufactured with hard-faced alloy tools. It can be easily seen that objectives with similar formulations are quite compatible with units of functional structure.

Within the framework of the described techniques a series of complementary methods for the identification and formulation of goals and their components can be applied; these are developed from the systems analysis of the organizational and cybernetic decision models, from the accepted models and indicators of economic planning and incentives, and from the judgments of the managers of different units as to how they understand their own objectives.

A full description of a structured system of goals is the point of departure for designing a management organizational structure and the first of the general documents on an organization's management system. However, there is no simple relationship between the defined goals and the organizational forms for their attainment, as the goals, though a very important characteristic, are not the only factor that determines the organizational structure. Of equal importance are the nature of the organization, its size, the volume of the work to be done, the technology to be used, the engineering and managerial personnel requirements, the relationship of the organization with the external environment, and the national economic requirements for the systems of management and accounting. The system of goals is therefore used in designing the organizational structures for:

(1) Identification of the management system's organizationally independent units (services), oriented toward providing for the attainment of a certain class of ultimate goals.
(2) Logical allocation of authority and responsibility for the attainment of goals between levels and units of the management system, to prevent duplication of effort and to guarantee the accomplishment of all the desired intermediate results.
(3) Determination of the sequence and nature of the activities aimed at the attainment of ultimate goals, and identification of the requisite relationships and requirements for the coordinating organizational mechanisms to be designed.

(4) Comparison of the effectiveness of various organizational designs, and elaboration by individual units of a system of evaluation criteria and incentives to determine to what extent goals are attained.

4.3. Approaches to Organizational Structure Research and Analysis

The justified and logical allocation among the management units of the responsibility and appropriate authority for the attainment of defined objectives must be based on the analysis and improvement of the functional interaction and communication in decision making, i.e., on the most effective of the feasible management processes. Therefore, the study, analysis, and adjustment of the functional and process relationships of the management system with respect to the organizational requirements are objectively necessary, regardless of whether or not organizational change is accompanied by the introduction of a new pattern of management. By applying a systems approach to the design of organizational structures and by taking due consideration of the available experience in this field, one can develop universal techniques of research and analysis (*Figure 4.8*).

The sample under review is an operating management system or, in the design of a new structure, a new model developed as a result of studying the available management systems. In the former case, the descriptions are based on observation, study, and assessment of employees in the operating management unit; in the latter, the descriptions stem from the needs of the enterprise. This provides a sufficient basis to analyze the reasons for each result. At the same time the results of management activity are reflected either in documents or in the changed composition of the production system.

The next step in the design stage is the identification and analysis of the mix of activities that must be performed in order to obtain the desired results. To this end, the available set of documents can be effectively used since most of the results of management or production activity are recorded in these documents. If each document is regarded as the input or output of a

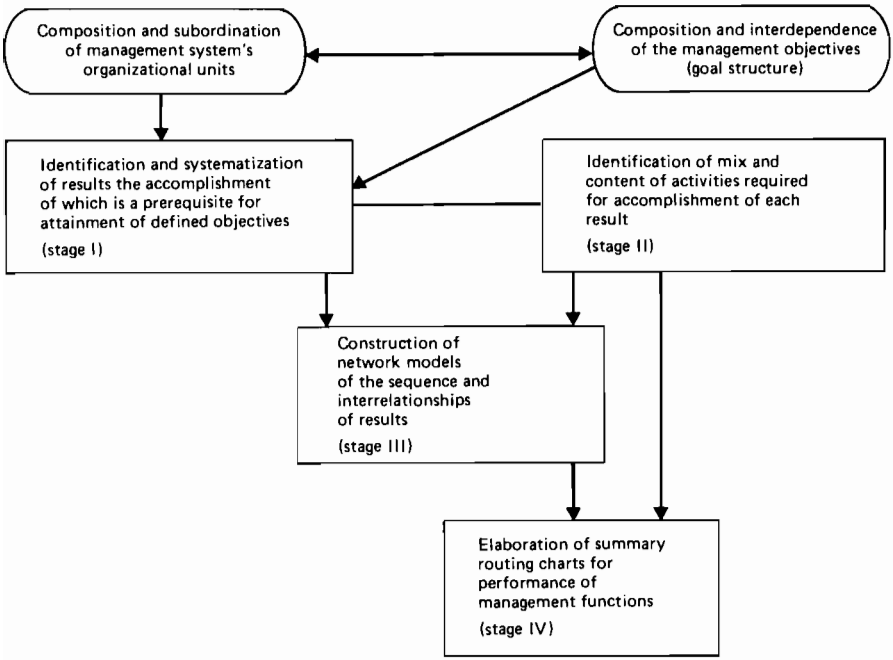


Figure 4.8 Schematic diagram of preproject research and analysis.

management process, it is possible to delineate almost all the basic management activities.

Depending on the degree of sophistication of a given document or a production result reflected in it, the process of its elaboration can also be more or less complicated and can include technically heterogeneous jobs. Such processes are analyzed and described with the help of "document charts", which give a graphic interpretation of document-making procedures centered around both the formation of the data contained in them and the processing of the information carrier. The chart reflects the content and sequence of all the stages in the making and utilization of the documents concerning a specific managerial job or function. With its help one can systematize the content, adjust the structure, and rationalize the paper routes.

There are various approaches to the composition of document charts, and they depend largely on the specific goals and feasibility of analysis. In order to make them reflect the flow of a whole set of documents, a coding system is used. This system is based on the classification of all the documented jobs by their content, and of all the documents by the information they contain. In conformity with the commonly accepted classification, symbols (usually various geometrical figures) are used to indicate the type of document on the basis of the numerical or geometrical indexing of job content. The subject of such document charts is a list of documents, and the predicate contains the coded features of the jobs performed. A sample of this sort of chart is given in *Figure 4.9.* The document chart can fully reflect the technological content and structure of information-processing procedures; therefore, it is also a reliable source for the quantitative assessment of document-making tasks.

However, where there is a sophisticated division of managerial labor, particularly when varied information-processing technologies are used, elaboration of a document chart turns out to be insufficient. In such cases the content and amount of jobs connected with data transformation are analyzed using another device, namely the construction of information models. The transition from document charts to information models is effected on the basis of the analysis of operating information design. To

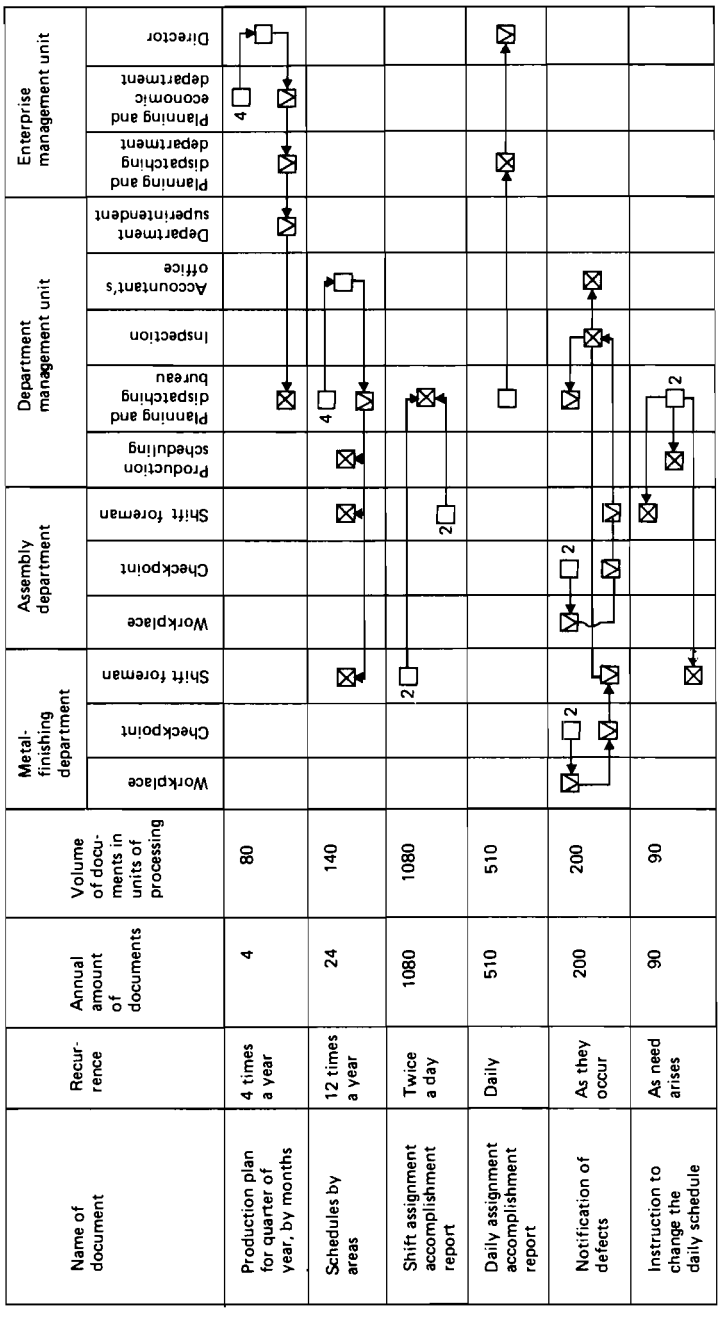


Figure 4.9 Part of the document chart for a production shop.

impart some quantitative certainty to the information model, it is provided with space, time, and volume parameters (*Figure 4.10*).

The space parameter of the information process is derived by summing all the coordinates of the points where information is gathered, processed, transmitted, and stored in the organizational structure of the management unit. The time parameters of the information procedures are the period for which the information stays in each place where it is processed, the recurrence of each operation, the speed of information travel through the communication channels, and the structure of the processing cycle (active part, expectation, etc.). The volume parameter implies a corresponding mass measured in the appropriate units. The measurement of volumes is as difficult as the measurement of material products that differ in purpose and quality.

Identification and systematization of the entire range of activities performed in the management system do not provide a sufficiently complete and rigorous description of the management process. To organize and accomplish all the management functions efficiently it is necessary to calculate the loads at all the information-processing points and to define the optimal sequence of jobs, with due regard to the time in which it is possible to obtain each result.

The balance of management functions that include a small number of sequential activities can be analyzed with the help of a Gantt chart. However, many management functions, and even their component elements, include a large number of activities performed in parallel or both in parallel and sequentially. If it is very important to balance the activities, this may lead to a review of the logical sequence of activities determined by their content, to a redistribution of the activities between interrelated executives, and to an alteration of the paperwork flow routes. Naturally, all these changes should be reflected in the description of the actual management process.

Complex functions are balanced through network model analysis, which, in contrast to the Gantt chart, reflects not only the substantive structure of the management functions, but also the sequence of all the activities carried out in parallel. The third stage of research and analysis therefore consists in constructing network models of the sequence and interactions of the

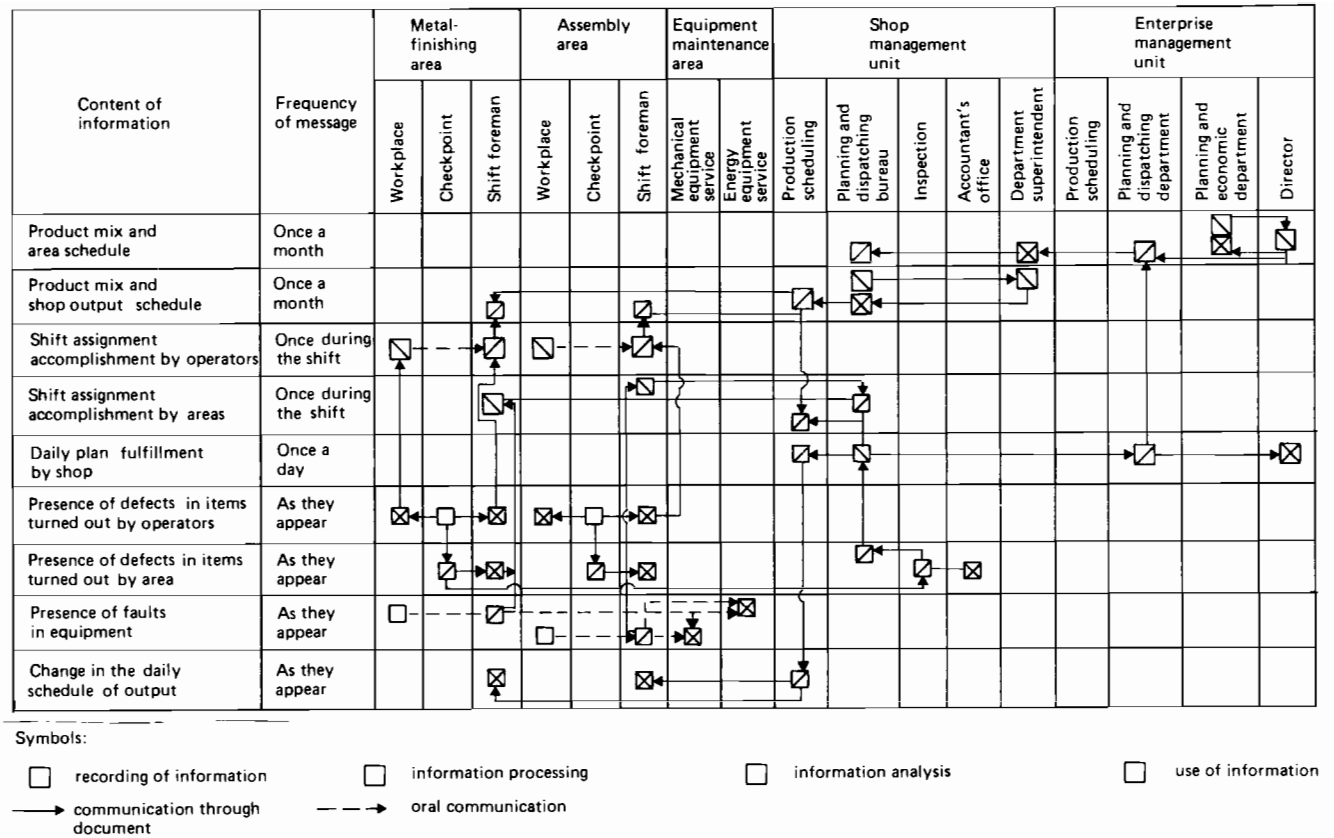


Figure 4.10 Part of the information model for a production engineering shop.

results. There is an abundant literature on the techniques of elaborating charts and models.

The closing step in the predesign stage of shaping an organizational structure is to devise all kinds of summaries containing the requisite characteristics of the process of performing each management function. For this purpose Soviet practitioners often use the so-called summary routing charts. The make-up and structure of these charts can differ depending on the specific objectives and the factor analyzed. A common type of summary routing chart is shown in *Figure 4.11*.

The routing chart is intended to provide a basis for the identification and analysis of the interrelationships between individual executives and units in their performance of management functions. The information contained in the chart allows the inputs and outputs of jobs to be balanced by the physical carriers of information, i.e., documents. In *Figure 4.11*, if the names of the documents at the input of one job (column 4) and at the output of another (column 9) coincide, the names of the corresponding executives and addresses should coincide too (columns 3 and 10), as well as the names of the sender and the executive of the document (columns 5 and 3). The names of the documents in columns 4 and 9 under items 16 and 17 coincide. Consequently the addressee under item 16 (column 10) and the executive under item 17 (column 3) should coincide too (in this particular case, they are both a unit for standards in the Process Engineering Office). Likewise, the executive under item 16 (column 3) and the source of the document under item 17 (column 5) should also coincide (they are both the chief inspection unit). The analysis of the summary routing chart in this way lays the foundation for designing a system for the interaction of units in the management process.

4.4. Organizational Modeling

Organizational models are supplementary scientific and analytical tools for the study, justification, and choice of rational decisions in the design of management organizational structures. These models can be valuable at all stages of organizational design, but

their role increases at the stage of defining quantitative organizational variables and in the development of management procedures.

Organizational modeling is closely connected with the investigation, analysis, and improvement of information flows. The use of organizational modeling in the development of a management organizational structure depends on the particular needs of the organizational design problems in question.

At present we have quite a large arsenal of diverse models for organizational analysis and improvement. However, these models lack any methodological unity and reflect only separate aspects and parameters of organizational systems, so they can be used only for specific purposes.

It is possible to single out three main perspectives in organizational systems modeling:

(1) Cybernetic modeling, which encompasses a great variety of approaches from the mathematical modeling of multilevel decision-making systems to the simulation of organizational management processes and the formalized descriptions of information and administrative communications (the approaches include: activity analysis models [34, 35], decomposition models [36, 37, 38], systems dynamics models [39], decision-room models [40], and others).
(2) "One-to-one" modeling of organizational behavior, both at the actual enterprises and in the laboratory (e.g., managerial specialization research, analysis of differences in managerial styles, pilot implementation of vertical or more horizontal organizational structures, and management games).
(3) Application of statistical methods to empirical analysis of organizational parameters on the basis of sample surveys of real organizations [41, 42, and many others].

Each of these perspectives, which have essential differences in their main assumptions, problem formulations, and techniques, is focused at one particular structural dimension of the organizations. A number of organizational dimensions can be identified.

Summary routing chart of management function

Name of function: engineering preparation of production

Jobs providing for function performance	Code	Production center	Input: Document information or production results	Code	Input: Information generating unit	Job content
1	2	3	4	4k	5	6
1. Coordination of technical requirements		Design office	Client's request		Client	Clarification of item's operating conditions and manufacturing capabilities
2. Elaboration of technical order for designing the item		Design office	Technical requirements		Client	Identification of item's basic operating characteristics
15. Multiplication of specifications		Drafting office	Designer's specification		Computer center	Multiplication of blueprints for the users
16. Development of technology (process)		Inspection	Drawings, specifications		Drafting office	1. Development of technological processes 2. Coordination and approval
17. Job standardization		Subdivision of standards, process engineering office	Flow process charts		Inspection	1. Development of standard time by operation 2. Labor consumption in jobs performed
18. Material standardization		Computing center	Drawings, specifications, flow process charts		Design engineering office, process engineering office	Development of material consumption standards

Figure 4.11 A sample of a summary routing chart.

Summary routing chart of management function

Name of function: engineering preparation of production

Responsible executive	Code	Output: Document, information or production result	Code	Output: Recipient units
7	8	9	9k	10
Chief product design engineer		Coordinated technical requirements		Design office
Head of design office				Design offices of project contributors
Head of drafting office		Specification blueprints		Material standards department, material bureau, stores, production departments
Industrial engineering office, plant engineering office		Flow process charts		Subdivision of standards, computing center
Head of standards subdivision		1. Time standards by operation 2. Summary rating of labor consumption by piece work		Production department, wages and salary department
Head of standardization office		1. Elemental material standards 2. Specified material standards		Production departments, prices department
		3. Three-month standards		Procurement department, production department

Figure 4.11 (cont.).

(1) *The production and technological dimension.* The elements of the system are the production processes and the relationships between them.
(2) *The information (communication) dimension.* This reflects communications between information sources and receivers. The elements of the system are the information sources and users and the communications between them.
(3) *The information technology dimension.* This reflects processes of information generation and processing and management decision making. The elements of the system are the information processing processes and communications between them.
(4) *The functional dimension.* This reflects the specialization of management organizational units. The system elements are the management functions, activities, and operations.
(5) *The sociopsychological dimension.* This encompasses relationships between individuals and groups. The elements of the system are particular individuals and groups and their relationships.
(6) *The administrative dimension.* This characterizes the composition of organizational units and their administrative subordination. The system elements are the departments and positions, and their hierarchical location.

These aspects of the description of a management system are not isolated, but interrelated. A certain structure in a real organization corresponds to each of them. Therefore, the choice of a particular model or combination of models to describe a management system depends on the objective of the organizational research or design.

Models of organizational structure can be divided into two groups. The first includes the formal OR/MS modeling of separate dimensions of a management system, without the explicit consideration of organizational structural characteristics, i.e., the system of departments and positions (formal structures) or interpersonal relations (informal structure). The results of such modeling are used by experts to rationalize and design organizational structures. The second group of models encompasses more or less formalized models of organizational structure and more

complete models of a management system, which include structural parameters. The results of such modeling are used as direct recommendations for the improvement of an organizational structure.

Let us describe briefly the existing types of models in relation to the particular organizational dimensions (1)–(6) mentioned in the above list. For example, the reference M(1,2,6) means a model of the production technology, information (communication), and administrative aspects of the management system. Decision-making models and information-flow models comprise the first group.

(1) *Decision-making models*, M(2,3), are developed for individual management tasks as a one-level or multilevel system of models for interrelated tasks. The mathematical techniques used in these models are mathematical programming methods, composition and decomposition algorithms of planning and control, network models, game theory, etc. – in other words, the comprehensive arsenal of operations research and management science techniques. Such models are used to rationalize management processes and production technology and, less frequently, to improve organizational structure. Recommendations made with the help of these models are usually confined to the rigid centralization of decision making, whereas management practice shows the effectiveness of the less centralized and more flexible management organizational forms. The most essential problems of transforming the network of decision units into an improved structure of managerial positions and units, and of distributing authority and responsibility for decision making among particular individuals and units, however, remains unsolved.

(2) *Information models of a communication network*, M(1,5), are used to minimize the total cost of information transmission on the condition that all the receivers obtain the necessary information. In this case the organizational structure is identified with the communication structure, which is justified as a rule only for routine functions in a management system (accounting, scheduling, production control, etc.),

where the effectiveness of management depends largely on the costs of information transmission.

(3) *Compact information models*, M(1,3,6), are used to shorten the communication links in the process of management decision-making. They are based on the assumption that the best conditions for management decision-making are provided by the closest proximity of elements from the standpoint of some "proximity criterion", which measures the volume of information exchange during the solution of certain management problems. The elements (activities, positions, decision centers) are integrated into groups both by experts and by algorithmic methods. This approach permits the analysis and design of information structures for management at the middle and lower organizational levels, but its realization involves difficulties in identifying and describing the contents of communications and the exponential growth of communication links as the number of organizational elements increases.

(4) *The paper flow chart*, M(1,3,5), is a graphical representation of the processes for elaborating and distributing documents. It describes routine administrative activities and provides supplementary information for the design of management organizational structures (see Section 4.3).

(5) *The integrated information model*, M(1,4,5), is used in the development and implementation of an integrated data processing system (IDPS), in parallel with the rationalization of the organizational structure on the basis of the separation of creative decision-making procedures from routine ones (which are assigned to the central data-processing office). In their turn, experts make suggestions regarding the creation of new units and the elimination of some existing units, and they develop organizational manuals and position descriptions based on an analysis of the algorithmic network of document (index) formation in the IDPS.

Models of the second group, M(1,5), directly but incompletely describe communications and relationships between organizational elements. The following models can be assigned to this group.

(1) *The model of organizational–technological relationships*, M(1,2,3,5), is based on the assumption that at lower management levels the character of the production technology is the major determinant of the organizational structure. Relationships between technological processes and employees engaged in them are differentiated by their type (general, sequential, multilateral) and degree of intensity (strong, moderate, weak). The most closely connected elements are integrated in one group with the subsequent appointment of managers/foremen and shop supervisors. The model is applicable to the lowest organizational level.

(2) *The model of organizational management relationships*, M(1,4,3,6), is used by experts to assess the intensity of administrative relationships between management functions, with the help of a scale from "very strong links" to "communication between functions is undesirable". The factors that cause particular communication links are identified. Alternative ways of allocating functions among units are analyzed through the formal procedure and the most closely connected functions are combined under one superior. This model can be used to analyze complex management relationships and to rationalize the middle-level structure.

(3) *The model of statistical factor analysis of administrative relationships*, M(1,3,4,6), is based on the analysis of organizational goals, and, in its turn, is the basis for defining a list of functions and tasks for the whole or part of a management system. An expert survey is made of the relative significance of particular tasks and their relationships, and both activities and individual members of the organization are placed in preferable groupings; the data are processed by factor analysis methods. This model can be used to reallocate functions and tasks among existing organizational units.

(4) *The deterministic functional model*, M(1,4,6), consists of the decomposition of management functions into elementary functions (activities, operations) that could be performed by one person, whose work load would be close to the normal labor intensity of each elementary function, defined as rate times hours-per-working-day as an average annual index. The personnel work load is balanced by regulating the span

of control of one superior (five to seven subordinates), delegating part of the work load from one person to another, appointing leaders for groups of individuals, assigning technical personnel to support the groups, etc. The authority and responsibilities of each manager are defined and department manuals are elaborated. The model can be recommended for conditions in which the functioning of the management body is stable over a prolonged period, and mainly for the middle-level management.

(5) *The queuing theory organizational model*, M(1,5,6), is based on a mathematical description of the functioning of a management system, which considers two components of the process: regular and stochastic (caused by stochastic influences on the functioning of the management system due to deviations in the implementation of decisions previously made). The operating management subsystem is described by a linear, stochastic, queuing-theory network, with heterogeneous flows of requests for redistribution of resources. The model is optimized by minimizing the discounted cumulative costs for the design and operation of the management system and the losses from time lags in the elaboration of management decisions (regular component) and from time lags in decision making and the approval of decisions (stochastic component). This model should help to develop appropriate organizational structures and information links among interconnected units.

(6) *The organizational–information model*, M(1,4,5,6), is a responsibility chart of decision-making procedures and document flows. The subject of the responsibility chart is a list of steps in operating processes (e.g., design engineering, quality improvement, and order handling); its object is a list of structural units of the management organization. At the intersections, symbols are placed that indicate the functions of the respective units at each stage of the organizational process. Each management procedure is coded and is represented graphically, and the sequence of procedures is shown by arrows.

A fragment of a responsibility chart describing the design and implementation of a technological project is shown in *Figure 4.12*. The responsibility chart is based on a classification of the organizational procedures subject to modeling.

The procedures of elaboration, making, and implementation of decisions can be divided into the following groups.

(1) *Management procedures.*

- (i) Goal setting and formulation of tasks for specialists and technical personnel (task assignment).
- (ii) Development of the search for alternative management decisions (working out of alternatives).
- (iii) Selection of the alternative management decisions and choosing between them (decision approval).
- (iv) Administrative direction of subordinates to ensure fulfillment of tasks (orders, directives, instructions).
- (v) Encouragement and motivation of task fulfillment (measurement of quantity and quality of performance, rewards, punishments).

(2) *Control of performance.* Procedures of staff activities in management decision making:

- (i) Study and evaluation of the state of the operating system, and generation and assessment of its desired state (elaboration of task specifications).
- (ii) Generation and selection of alternative management decisions subject to further analysis and elaboration by specialists and operating personnel (functional direction).
- (iii) Formulation and choice of methods for the elaboration of alternatives, the design of a model of the expected state of the operating system, and the analysis of relevant information (methodological guidance).
- (iv) Evaluation of decision alternatives from the point of view of the stated goal, and the submission of alternatives for approval (decision making).

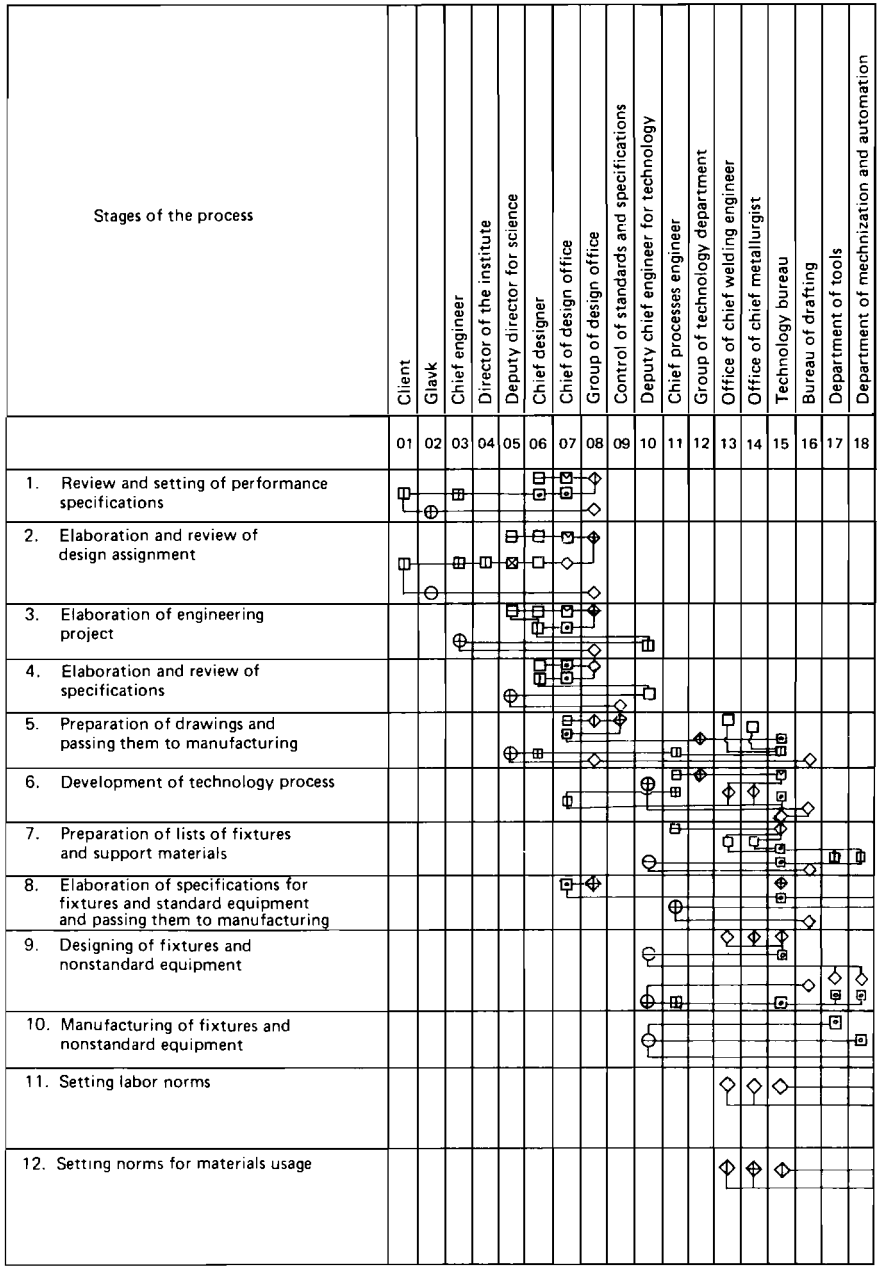


Figure 4.12 Part of the responsibility chart for the design and

Information processing center	Department of labor norms	Department of material norms	Planning department	Department of wages and production engineering	Department of purchasing	Production	Notes
19	20	21	22	23	24	25	
							Input: project of performance specifications Output: 1-1 performance specifications
							Input: 1-1 Output: 2-1 design assignment 2-2 preliminary design
							Input: 2-1; 2-1 Output: 3-1 intermediate design
							Input: 1-1; 3-1 Output: 4-1 specifications
							Input: 1-1; 3-1 Output: 5-1 final drawings
							Input: 5-1 Output: 6-1 technological flowcharts
							Input: 3-1; 5-1 Output: 7-1 lists of fixtures 7-2 lists of supporting materials
◇							Input: 6-1; 7-2 Output: 8-1 specification for fixtures
							Input: 6-1; 7-1 Output: 9-1 drawings of fixtures 9-2 drawings of equipment
					⊕		Input: 9-1; 9-2 acceptance list Output: 10-1; 10-2
⊕ ⊞	⊕ ⊞			⊕ ◇			Input: 5-1; 6-1; 8-1 Output: 11-1 time standard for operations 11-2 labor capacity for separate operation
⊕		⊕ ⊞	⊕		⊖ ◇		Input: 5-1; 6-1; 7-2; 8-1 Output: 12-1 norms per 12-2 norms per product 12-3 norms per kinds of materials 12-4 norms for a quarter-year

Legend:

- ⊖ task setting
- ⊕ task approval
- ⊽ administative direction of subordinates
- ⊘ stimulation and motivation
- ⊙ performance control
- ⊡ elaboration of task project
- ⊟ functional leadership
- ⊠ methodological guidance
- ⊞ decision making
- ⊠ approval of alternatives
- ⊠ coordination
- ⊡ coordination of decisions
- □ consulting
- ◇ document processing
- ◈ information recording
- ◈ information processing
- ◈ reporting

implementation of a new product.

(v) Evaluation of decision alternatives derived from the models of the expected future state of the operating system and submission of these alternatives for selection (approval of alternatives).

(vi) Adjustment of decisions from the standpoint of the total set of goals of the operating system (coordination of decisions).

(vii) Adjustment of the models of the expected state of the operating system and evaluation of the suggested decisions (adjustment of decisions).

(viii) Assistance in the functional direction and methodological guidance, in the evaluation of alternatives, and in the assessment of the correctness of their elaboration (consultation and expert advice).

(3) *Information-processing procedures.*

(i) Document handling, reception, delivery, copying, search, storage, etc.

(ii) Information recording (records, drafting, listening, reading, etc.).

(iii) Technical information processing according to the prescribed algorithms (synthesis of alternatives, calculations, modeling, graphical representation, checking of the correctness of calculations, etc.).

(iv) Submission of reports about the volume and content of activities performed in accordance with the assigned task.

Most management processes are performed in such a way that a single body or individual can carry out a whole range of procedures connected with various kinds of activities. As a result there are many alternative ways of assigning the procedures among individuals. To analyze and evaluate possible alternatives, the flowchart is presented as a graphic simulation model; managers, specialists, and other individuals can "play" various alternative allocations of authority and responsibility by moving symbols (which indicate management procedures) on the chart, and afterwards they can make their judgments. Thus, the flowchart can be classified as a way of modeling, by laboratory

experiments, that is visual, simple, and yet approximates to practical needs in the design and improvement of organizational structures.

4.5. Regulatory Documents and Standards

The operation of a formal management organization and its success depend on a series of documents that regulate the relationships, communications, and procedures of management that underly the organizational machinery. Two types of similar documents can be distinguished:

(1) Legal-normative acts and manuals establishing the relationships between the management unit employees.
(2) Process-normative regulations establishing procedures for carrying out individual management jobs and operations.

The first type of document also includes the charters of organizations and their legally independent economic units, descriptions of standard and specific units in production and management systems (departments, divisions, programs), and position descriptions. The second type covers special instructions, standards and regulations, flow-process and plant-flow diagrams, document charts, information processing charts, flowcharts for management functions, etc. Depending on the specific features of the subsystem and on the degree of application of the technical means of processing information and documents, various forms of process norm can be employed.

Position descriptions play the most important role in clarifying the distribution of authority and responsibility in the system, providing a basis for management organization. They are the basic and universal documents that underly the entire system of relationships between managers, professional experts, and executives. The structure of the position descriptions depends on the approach to organizational design. Let us analyze an approach that is consistent with the systems and goal-oriented principles of designing an organizational structure.

First of all, the positions are categorized by their place and role in the management process: managers of the organization and of its subsystems, production and functional units, and internal subunits; functional experts; subordinates (staff). Evidently, for each position category there are certain common authorities and responsibilities defined by labor legislation, business law, the organization's objectives, production and process regulations, and the specific setup of the organization's operation. This general part of the position description is mandatory throughout the system and does not allow for individual deviations.

At the same time the accomplishment of the purely management goals requires the delineation of the specific authority and responsibility of each executive. In this connection, four regulatory and controlling parameters have been introduced that provide for the goal orientation of every employee and the conditions for his effective activity: span of responsibility, objectives, criteria of goal attainment, and authority. The basic principles that underlie the position description are:

(1) Concreteness, i.e., elimination of possible ambiguity in the understanding of each regulatory parameter by the appropriate executive and by external inspectors.
(2) Personal specification of all the management tasks, i.e., complete elimination of duplication of responsibility for their accomplishment.
(3) Adequacy of the authority granted for the attainment of the defined objectives, and the practicality of this authority, i.e., the degree of independence of an executive from external influences and conditions.

It is also understood that, though the technology for the performance of the management functions is of secondary importance with respect to the goals, the allocation of authority and responsibility among executives should fully correspond with the established and observed procedures and organization of the management processes.

The span of responsibility implies identification of the operating subsystem whose functioning state or use is under the jurisdiction of the relevant executive. To ensure that all the

spans of responsibility covered by the position descriptions are balanced, the definitions of the operating subsystems are standardized in their multilevel classification. The general criterion for delineating the span of responsibility is the relation of the operating subsystem to one of the basic elements of the production process: the finished product or service; the resources (material, power, financial, labor); the means of production (equipment, tools, installations, information). The specific criterion for delineation is the relationship of the operating subsystem with one of the standard processes in the economic organization: main activity; support and service; management. The divisional criteria are the boundaries (scope) of the operating subsystem determined by its position in the organizational chart: the entire organization; its subsystem; the specific unit. In certain cases the time frame of influence can also be considered.

The objectives (tasks) for each executive are defined on the basis of the goal structure developed for the structural level that corresponds to the span of responsibility assumed. However, it should be remembered that for the functional experts and actual executives of the task the objectives are somewhat narrower than those in the structural system of goals. This is due to the operational division of labor in decision making and information support. For these categories of employees, task distribution is based on the organizational models and flow-process charts. Since the actual executive officer receives his task from the manager responsible for the attainment of the final and intermediate goals, he (the executive officer) naturally bears responsibility only for the fulfillment of this very task according to the criteria of timeliness and quality.

The methods for measuring the performance of an officer in goal attainment are developed on the basis of how the results achieved by him or his office influence the attainment of goals by a higher-level system in the hierarchy (see *Table 4.1*). This is essential as not all the operational tasks can be adequately and correctly defined. Moreover, under conditions of uncertainty they are usually dynamic. Therefore, the formalized harmonization of each executive's objectives with the objectives of the departments and services in which he works is of particular importance.

Table 4.1 Part of a "specific authority and responsibility chart" for a program manager in a machine-building amalgamation.

(1) *Scope of responsibility*	(2) *Objectives*	(3) *Measures of goal attainment*	(4) *Authority*
Finished product (name of specific machine or aggregate whose development is the goal of the program	To ensure scheduled manufacture and conformity to specified requirements	(Some or other parameters of the comprehensive program goals requiring maximization/minimization: a machine's efficiency, functional purpose, power consumption, reliability, etc.)	*Approve* (*a*) Technical requirements for units and parts to complete items (*b*) Engineering and process documentation for units and parts to complete items (*c*) Test reports on the finished items and its system's operation *Participate* (*a*) In elaboration of technical requirements for item and its systems (*b*) In elaboration of basic engineering and process decisions

cont.

Table 4.1 (cont.).

(1) *Scope of responsibility*	(2) *Objectives*	(3) *Measures of goal attainment*	(4) *Authority*
Executive of program activities	To ensure implementation of program-activities according to output and schedule, and conformity of decisions to program goals	Minimum deviations from scheduled time and standards, strict observance of technical requirements	*Coordinate* (*a*) Candidates of executives (*b*) Penalty and reward measures *Confirm* (*a*) Reports on fulfillment of annual and quarterly plans
Financial resources (centralized part)	To secure financing of the planned output and compention of program contributors' expenses on provision of requisite quality and pace	Minimization of cost with complete attainment of program goals	*Approve* (*a*) Current allocation of reserve funds for contingencies (*b*) Financial reports on spending of centrally allocated resources on program activities *Control* (*a*) Spending of financial resources for direct purposes, justification of expenses (*b*) Observance of norms and tariffs in payments

An executive's authority can be practically derived from the extent of his participation in the decision making that influences the accomplishment of the formulated objectives or the environment of their implementation. This participation can be rigorously classified in conformity with the universal structure of decision making and the basic management relationships. As the majority of decisions are recorded in documents, authority is defined in terms of certain operations with these documents.

For instance, authority *to approve* a document means authority to make a decision connected with the administration of resources available within the scope of responsibility. The authority *to endorse* a document corresponds to the authority to resist or not to resist certain actions or the making of certain decisions. The authority *to participate* in the elaboration of a document means the authority to suggest one's own alternative decisions and to assess others; this authority cannot be rejected without formal consideration. The authority *to control* implies authority to obtain full information on the state of the subsystem included in the executive's scope of responsibility, etc. The main documents that provide a foundation for the authorities and responsibilities of executives are the flowcharts for management objectives and functions.

The regulation of all four parameters is defined in the so-called "nonstandard authority and responsibility chart", which is included as one of the key sections in the position description (*Table 4.1*).

A special form of regulation of management activity is represented by the operational norms and standards used in organizing the current operation of departments. These norms can sometimes be applied directly to the elaboration of organizational design documents (internal structures of the basic departments, manpower and organizational plans, general position regulations and standards, flow-process charts), i.e., as norms of engineering. They can also be used in the implementation of specific managerial tasks, with due regard to contingencies, i.e., as constraints and criteria of performance.

It is commonly observed that in an uncertain environment the dynamic nature of a task, the variety of organizational and

managerial problems and patterns of their solution, the mix of formal and informal relationships, and the making and implementing of managerial decisions all involve a considerable degree of creative activity. This implies that often nonstandard ways of thinking and the intuition and abilities of individual managers and experts can exert as great an influence on the level of effectiveness of an activity as the rigid observance of procedures and normative instructions. Therefore, the goal orientation and incentives aimed at improving managers' creative activity should require only the minimum standardization and regulation of their activity.

At the same time, however, the large scale of managerial activity, the increasing tendencies toward specialization and cooperation, the mechanization and automation of the majority of information-gathering and information-processing operations, the mass nature of many professions, and other factors strongly suggest the need for unification and standardization of a range of management system parameters.

Hence, in a socialist economy there is a centralized and planned effort to develop substantive norms for organization of management processes. Among the key directions of this effort are the following:

(1) Elaboration of national regulations for industrial (branch) and regional (territorial) management organs (ministries, functional departments, etc.) that allocate authority and responsibility for the attainment of national economic goals and regulate the relationship between the organs of state and those of economic administration.
(2) Elaboration of regulations and standards for the performance of the basic management functions (strategic and current planning of production, material resources, R&D, incentives, product quality-control, etc.) that provide for the unification of indicators and documents in planning and accounting, and for the techniques to calculate and analyze them, and thus to create preconditions for nationwide information systems and networks.

(3) Elaboration of general regulations for economic organizations (industrial associations, production and research–production amalgamations, combines, trusts, enterprises) that allow the development of balanced and noncontradictory charters and structures for such organizations, based on scientific principles and methods of management.

(4) Development of master plans for industrial and regional management that ensure that the goals of all the management systems are balanced and that all advanced organizational forms are introduced and improved according to plan.

(5) Elaboration of interbranch methodological recommendations for the design of the organizational structures of the management units in amalgamations and enterprises, as well as intrabranch directive documents on management system designs (this increases the methodological level and normative support of engineering).

(6) Development of unified job specifications for managerial and professional positions that will pave the way for effective unified systems to train and place managers and professionals.

(7) Development of unified labor standards and basic pay rates for the noncreative jobs common to all branches (drafting, accounting, typewriting, etc.) that will help to standardize the utilization of employees in the mass professions.

(8) Development of interbranch and intrabranch recommendations and standards on the organization of employees' work, workplace equipment, and the use of unified forms of documentation and information processing that will contribute to the introduction of advanced forms of management organization at all levels of the national economy.

The national system of interrelated standards, combined with the centralized planning and control of administrative expenses and material and technical supplies, makes it possible to improve management organization at all levels and encourages planned activity toward the improvement of organizational structures in all bodies. In addition, it facilitates the training and development of managerial personnel and helps to regulate their

pay. At the same time, the wise and justified combination of directive and recommended norms stimulates rather than constrains the search for new and more effective organizational forms and methods of management.

4.6. The Application of Standard Organizational Designs

In the systems methodology of designing organizational structures a special role is played by standard organizational designs that are conceived as generalized patterns for the structuring of an organization as a whole or as its individual subsystems. These patterns are objectively invariant with respect to a certain range of differences in the basic structural elements. In other words, standard organizational designs are equally applicable (according to universal criteria) to a set of economic systems classified by sufficiently formal characteristics.

The objective premises for the development and application of standard organizational designs include:

(1) Unity of the principles underlying a public production organization within the framework of the established production relations.
(2) Universality of decision-making processes and a limited number of formal expressions of management relationships, which results in only a fairly small variety of fundamentally different forms of management.
(3) Discreteness of the transition from one form to another, which sets certain bounds on the applicability of each form.
(4) Sufficient qualitative uniformity in the objective characteristics of economic organizations (organizational factors), which determine organizational structure requirements.

Until recently standard organizational designs in management were very common in the USSR [43]. Enterprises in each branch of industry were grouped using a limited number of essential factors that dictated the choice of a certain structure (number of employees, sales volume, process diversification, etc.), and for each group a preferred organizational chart of the

management system was recommended. In standard organizational designs approved by ministers, such structural parameters as the number of hierarchical levels, basic services, and departments, the ratio of line and functional staff, and the degree of authority centralization were strictly regulated. This approach was explained and justified by the high degree of centralization of industrial branch management, the unification of production structures, the common environment in which socialist economic organizations functioned in all regions of the country, and the close supervision by the state over the effective utilization of resources.

Naturally, the standard organizational designs reflected the most advanced effort in management organization that could be followed by most enterprises. With the rapid growth of industry and the lack of skill in organizational design, a normative approach was sure to yield positive results. It served to optimize the structure of the management system in many enterprises, to harmonize and balance authorities at different hierarchical levels in management systems, to disseminate quickly and widely advanced organizational experience, and to make the training and utilization of managerial personnel and professional experts more effective.

In the design of organizational structures, however, any standards employed on a large scale necessarily limit the choice of organizational design and hamper consideration of the individual features of a subsystem. Therefore, as the goals and environment of production became more dynamic, and as economic organizations and the sphere of their activity diversified, the application of standard organizational design in its traditional form (where the formal structure of the management system for every type of economic organization is regulated by means of norms) ceased to satisfy the requirements for management systems.

The systems approach described here opens up new avenues for pilot schemes and introduces a number of subjective considerations that justify the application of standard organizational designs and restore their usefulness. For a number of reasons it has become practically impossible to choose the proper prototype for the general pattern of a structure and to carry out a full

preproject study and analysis. In contrast, the application of standard organizational designs helps to minimize the time and effort involved in designing an organization and makes it more economical and acceptable for even comparatively small design groups. Finally, standard organizational designs allow for the incorporation of all the modern achievements in management organization and of scientifically justified norms, which substantially raises the quality of design, while minimizing the requirements on the skill of the management-system developers.

The foregoing does not involve rejection of any of our basic concepts, i.e., of the need for individual approaches to the structuring of the management system of each specific economic organization. It is worth reemphasizing here that standard designs are merely generalized structural patterns whose actual implementation depends on the organizational mechanism suggested, the totality of formal and informal relationships, and the administrative regulations. It is these aspects that add "personality" to organizational designs and thus make them more specific.

In the structuring of individual management subsystems, the application of standard organizational designs has another specific feature: there is a wider variety of organizational factors that are essential to the choice of a specific type of structure. It therefore helps to create real conditions so that the specific requirements of subsystems can be reflected in the organizational design.

The essential characteristics of the standard classification of organizational design can differ depending on the goal orientation and functional specialization of the management system. For example, the structures of subsystems for R&D, engineering support, management of basic production and marketing, material resources, product quality, and guaranteed maintenance service, are designed, as a rule, on the basis of the characteristics of branches of industry. The organizational forms for the management of personnel recruitment and social development, of capital construction, of economic development, and of general services, are worked out in accordance with the basic principle of a given branch of industry, and an appropriate form is selected with regard to the scope of activity and the degree of the subsystem's cooperation with the external environment.

The organization of the management system at each level depends to a great extent on the structure of the superior-level management units, as well as on the distribution of tasks among them. Therefore, the standardization of organizational designs for integrated hierarchical subsystems (including all levels: ministry, industrial association, production amalgamation, enterprise, shop) are becoming widespread and increasingly justified. This sort of approach is very fruitful as it *a priori* provides for coordinated, vertical organizational designs, although it does cause greater difficulties than the horizontal interfacing of organizational charts. However, the large-scale character of these structural blocks requires that they have a high level of universality, which means, in turn, a limited number of organizational factors to be considered in the selection of an appropriate organizational design.

Methodologically this problem can be solved in the following way. Standard organizational designs for each level of management are elaborated in all the various forms, i.e., reflecting all the basic aspects of the requirements. The vertical compatibility of the standard designs is then analyzed and recommendations for the design of compatible hierarchical sets of structures are elaborated. If necessary, these designs are corrected with respect to the compatibility factor. The analysis and choice of alternatives are based on the hierarchical structure of the goals of the industrial branch; the mode of decision making in the functional process should also be considered. This activity obviously requires more effort, both at the stage of elaboration of standard designs and at the selection stage. Moreover, it requires a deeper study of the management system *per se* and of its external environment. In return, though, the effectiveness of the organizational structures thus developed and their potential introduction are optimized.

In the elaboration and selection of standard organizational designs, two basic approaches can be employed. The first consists of an analysis of all the existing and functioning organizational structures, identification of the most effective ones, and design on this basis of certain generalized versions including, as far as possible, all the identified, existing positive elements. The

second approach is based on the selection from among the available subsystems of the one that is most representative from the viewpoint of the essential organizational factors; a nonstandard organizational design based completely on the scientific principles of management organization is then elaborated for this representative subsystem. After practical verification and adjustment, this nonstandard design is adopted as a standard design for the given class of subsystems.

There are various groups of organizational factors by which subsystems are classified when standard organizational designs are elaborated and selected:

(1) For subsystems of R&D and the engineering support of production, these factors are the sophistication of the products and the diversification of the processes employed, the rate at which the technology is updated, and the R&D concentration.
(2) For systems of management for basic production and marketing the classification factors include the mix of basic types of products, the quantity and location of consumers, and the level of cooperation in production.
(3) Systems of management of material resources are classified by the main categories of materials consumed, by purchasing and material storage volumes, and by the level of centralized control for the utilization of material resources.
(4) For management systems for personnel recruitment and social development the organizational factors are the manpower available and the level of concentration of training and support effort.
(5) For systems of economic development management the factors are the organization's degree of economic independence, the volume of economic relations, and the level of development of internal economic relations.
(6) For the management systems of economic services the factors are the volume of work performed, the level of management centralization, and the extent to which external services are utilized.

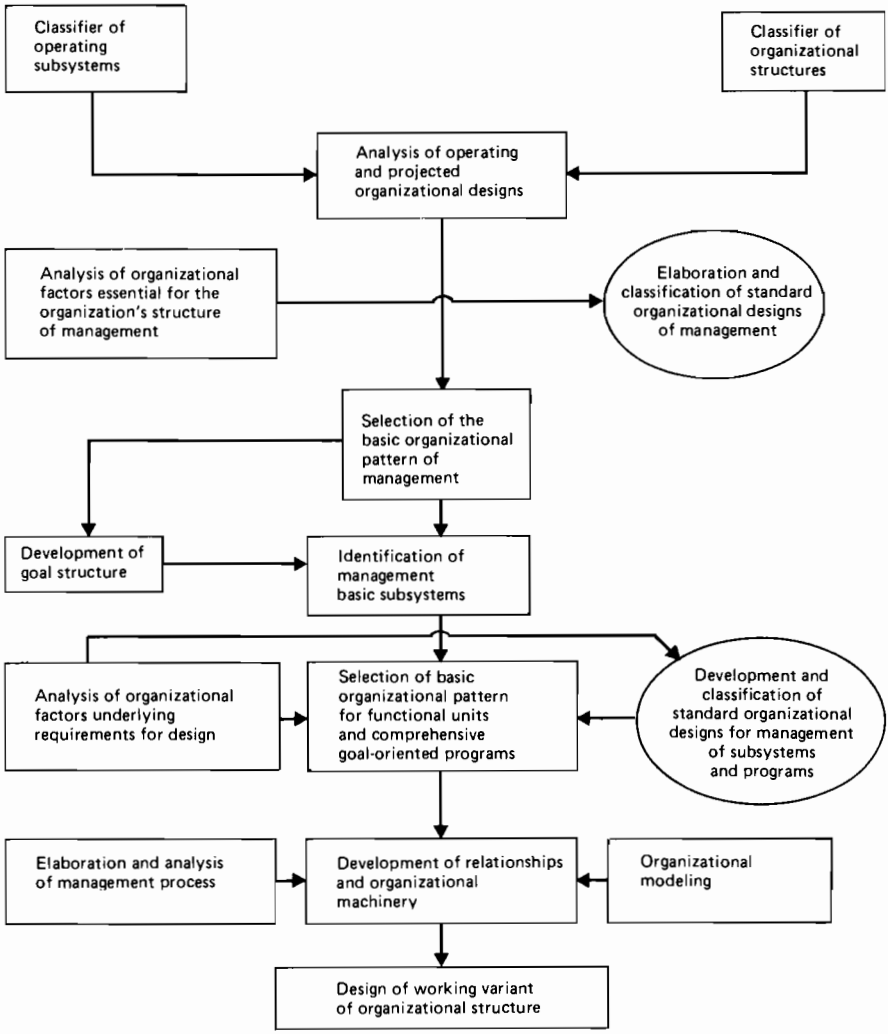


Figure 4.13 The role of standard organizational design in the development of an organizational structure.

(7) For systems of capital construction management the factors are the volume of construction, the scale of subcontracting, and the diversity of the projects to be constructed.

This fairly universal classification of standard organizational designs permits the elaboration not only of generalized organizational patterns, but also of standard descriptions of individual services and even of basic units. Thus, in the USSR there exist commonly adopted inter- and intra-branch descriptions of management units for economic development, standardization, metrological support, etc. In this way the elaboration and application of standard organizational designs becomes an essential component of a systems approach to the design of organizational structures. The general procedure for incorporating this step in the design process is shown in *Figure 4.13*.

PART III

The Development of Management Organization Structure

CHAPTER FIVE

The Management Organizational Structure of a Large-Scale Industrial Complex: The KAMAZ Case

5.1. Specific Features of the KAMAZ Complex

The Kama complex of plants for the manufacture of heavy trucks (KAMAZ) was built during the ninth five-year plan period (1971–1975) and started turning out trucks as early as 1976. The complex is situated on the Kama river, a large tributary of the Volga, in the environs of Naberezhnyje Chelny, once a small town of about 17000 inhabitants. Following the construction of KAMAZ the population increased by nearly 20 times and the town became one of the industrial centers of Tataria – an Autonomous republic of the Russian Federation. KAMAZ is one of the largest production complexes in the Soviet automobile industry. Its designed capacity is 150000 trucks per year, each with a hauling power of up to 20 tons in the trailer version. For its own consumption and for contractual deliveries KAMAZ must produce 250000 powerful diesel engines per year, complete with gearboxes, and a huge amount of subunits, spare parts, and cast and formed blanks. In order to comprehend better the concentration of production facilities, suffice it to say that KAMAZ would have been capable of producing 2–3 million cars.

The KAMAZ preproduction facilities include the largest foundry, forge, and frame-pressing factories in Europe. The machine-tool and assembly facilities consist of similarly large wheel, diesel-engine, and assembly plants. The amalgamation's support facilities are made up of a tool-repair plant, a spare-parts plant, and an engine-repair plant.

KAMAZ is equipped with the most advanced and efficient machinery, including nearly 400 complex automatic transfer lines. Interoperation conveyers are extensively employed, while two thirds of the machine tools are connected through flexible transfer lines. KAMAZ products, represented by 14 modifications of the three-axle diesel-powered trucks, are assembled concurrently on two conveyers, each 670 m long.

The design estimates indicate that, on attaining its full planned capacity, KAMAZ will have the highest labor productivity in the USSR automobile industry. The production per worker at the amalgamation is to be over 1.5 times higher than that at the VAZ amalgamation and more than twice that at the GAZ complex.

The legal and economic status of the Kama complex of plants is also special. Like some of the other larger amalgamations in the automobile industry, it reports directly to the central ministry staff (unlike smaller amalgamations and enterprises, which report to the central production office or to an All-Union industrial association). This kind of subordination makes the KAMAZ management system more autonomous and independent. Apart from flexibility in maneuvering the productive assets (both fixed and current) to attain its objectives, the amalgamation has affiliated large-scale R&D services, as well as production infrastructures such as transportation, repair, power supply, welfare, and other services.

The position and role of KAMAZ in the USSR automobile industry account for the major goals of its economic activities. They make up a system of four goals of equal priority, which may be briefly described as follows.

5.1.1. The Production Goal

This boils down to meeting the country's requirements for 8–10-ton trucks and for truck tractors for 20-ton trailer trains capable of running over any type of road. However, the production

goal is far from straightforward: to produce trucks of specific load-carrying capacity for the entire range of standard classes of cargo (container, bulk, large-sized, light, etc.) and for different climatic and territorial operating conditions (for the arctic, south, mountain regions, etc.); to arrange the efficient service and repair of the produced fleet of trucks; and to provide the motor transportation enterprises and repair plants with spare parts for the entire service life of the truck models produced.

The fact that the amalgamation by itself faces the task of completely satisfying national economic needs in a specific kind of product is the result of the planned way in which the mix and volume of production are assigned, and it has its advantages.

The customers of KAMAZ are not the individual motor transportation enterprises, but the motor transport ministries of the Union republics acting in the name of the state. They estimate their current and future needs for trucks with regard to the development of particular industries, construction, and agriculture and, through the agencies of the USSR Council of Ministers (Gosplan, the State Committee of the USSR for Science and Technology, and the State Committee of the USSR for Material Supplies), set tasks for the amalgamation in terms of volume, mix, and time of delivery. All the financial, material, and labor resources alloted to KAMAZ must be used exclusively for the accomplishment of the production objective.

The prices of the trucks are also fixed by a governmental agency, in this case the State Committee of the USSR for Prices. They take into account both the socially necessary expenses of truck production and the benefit gained by the consumer (reduction in maintenance costs, increased labor productivity, acceleration of haulage, etc.). A part of the benefit of consumption is charged, through the price mechanism, to the manufacturer's income.

The arrangements described provide for the maximum national economic benefit of production concentration to be obtained from KAMAZ. This means economies of scale, the optimum unification of all the parts and subunits for the various models facilitating their maintenance and repair, no need for premature renewal of the consumer stock due to competition, and

lower distribution costs as a result of abundant inventories and advertisement.

Because demand for the amalgamation's products is steady, strictly determined, and regularly increasing, the production objective described is a reliable basis for the development of the capacities of KAMAZ and for a high profitability on investment.

5.1.2. The Scientific and Technological Goal

This is essentially to develop a material base for the most complete satisfaction of national economic needs in the area of highly efficient transportation facilities and to secure the maximum aggregate growth of labor productivity in the production and maintenance of amalgamation products. The accomplishment of this goal requires constant improvement of the implements, production processes, and products on the basis of science and advanced technology. Hence, KAMAZ boasts powerful R&D services, pilot production facilities, testing units, and a scientific and technical information service.

The attainment of this goal is promoted not only by the business relations between the amalgamation and its customers, but also by an uninterrupted control on the part of the state and public over the technological level of production. The concrete supervision is carried out by the State Committee for Science and Technology, by the State Committee for Standards, by the State Committee for Inventions and Discoveries, and by the Technical Office of the Ministry of the Automobile Industry of the USSR. Recently, special emphasis has been placed on the production processes and production parameters that affect working conditions and environmental quality.

5.1.3. The Economic Goal

This was a result of the need to ensure the maximum growth of the national income from the production and labor resources concentrated at the amalgamation. This goal can be achieved only through the higher efficiency secured at KAMAZ by the required quality of work, by economy of resources, and by improved industrial engineering and management organization. The degree of economic goal accomplishment is evaluated by a set of indicators,

such as total profit, profitability of the productive assets, labor productivity, and investment payback. Variations in the indicators also affect the bonuses of the managerial personnel.

It is worth pointing out that the permanent system of state assessment and control at KAMAZ is arranged so that the purely commercial goal should not become a predominant goal for the employees. As a result, in-house planning must secure mandatory contractual deliveries and specified qualitative parameters regarding the output.

5.1.4. The Social Goal

This may be defined as a struggle for the steady social development of the employees to improve production and psychological relations, to raise the professional and cultural level of workers, and to increase satisfaction with the process and conditions of work. In the USSR this goal of industrial organizations is closely scrutinized by the Communist Party and the state.

It is not only the production and economic factors of social development that are considered. In fact, the higher professional and cultural level of the workers and the favorable working conditions and psychological climate promote higher productivity, improved quality, initiative, etc. Besides, one of the most important goals of Soviet society is the satisfaction of both the material and intellectual needs of its members. The process of labor, which still takes over one half of the active time of employees, is one of the major spheres in which intellectual needs can be satisfied. That is why making the work easier and more fulfilling, as well as more attractive and creative, constitutes a separate major goal of any industrial organization [44].

The described system of goals, as well as the high level of concentration, specialization, and technology, the close interrelationship between production facilities and management techniques through computer-based systems, the servicing of production on an up-to-date industrial base, the integrated solution of technological and welfare problems in the conditions of a rapidly developed industrial region – all these specific features of KAMAZ necessitated a search for new managerial forms and called for a creative approach to the development of the organizational mechanism.

The design of the KAMAZ management organizational structure required broad application of the systems approach methodology, described in the opening chapters of this book. Here we present some of the most interesting solutions obtained in the design.

5.2. The General Scheme of the KAMAZ Management Structure

The KAMAZ management organization is a complex and dynamic system. The development of the amalgamation is to be accompanied by the stage-wise introduction of new structural solutions. In addition, a number of existing organizational forms may have to be adjusted. Experience in the development of several Soviet amalgamations (e.g., LOMO, VAZ, and Electrosila) convincingly shows that this is a natural process brought about by the gradual expansion in the activities and complexity of an organizational structure that is considered as a design project which incorporates both the formal properties of large data-processing systems and the informal features inherent in social organizations. The latter are related to the staffing of the managerial system, the establishment of a managerial style, the familiarization with new organizational forms and management techniques, the accumulation of operational experience in the new environment, the conformity of the formally delegated authority and responsibility to the established system of material and moral incentives, etc. It should be pointed out, however, that the key principles of structural formation still remain intact.

The design of the KAMAZ organizational structure relied heavily on the methodology of the systems approach described in Part II. Because KAMAZ constituted a newly created amalgamation, the organizational problems were identified by analyzing Soviet and world experience in organizing the management of the automotive industry. The development and structuring of the KAMAZ system of goals were based on the analogy method, the model subsystems being those of advanced automobile amalgamations (ZIL, VAZ, GAZ, etc.) that, by their performance and according to expert judgment, best met modern requirements. The

developed system of goals covered over 3000 objectives in various spheres of production and economic activity.

The objectives were distributed between the structural levels and links of the KAMAZ management on the basis of scientific principles of management organization and expert analysis. The design of the internal structure of subsystems and the individual line-functional blocks, with regard to the optimum relationship between the links, involved the iteration of task allocations. Account was taken of both formal factors and informal factors (the personal traits of individual managers, their compatibility, etc.).

The development of the detailed organizational design and guidance documents was based on the methodology of organization modeling explicitly described in Sections 4.4 and 4.5, and included organizational charts, analytic diagrams and tables, and network models, as well as the approved norms and standards. Thus, the development of the KAMAZ management system covered all of the design stages described in Chapter 4.

The job of design was carried out by a team of highly skilled researchers and specialists from the USSR Academy of Sciences (12 people), a group of experts representing the customer (top managers and chief specialists of KAMAZ – altogether 40 people), and a design team consisting of over 30 professionals designers who spent nearly two years preparing documents. In addition, at various stages of the design, assistance was provided by experts and consultants from the Ministry of the Automobile Industry and other governmental agencies, as well as from different plants in the industry. A description of the outcome of their efforts follows.

The chart of the organizational structure of the top-level management of KAMAZ is given in *Figure 5.1*. The initial, general premise for specifying the rational number of levels in the managerial system and the composition of functional blocks and goal-oriented programs was the need to relieve the strategic and coordinating functions of day-to-day management activities.

The rational correlation between centralization and decentralization of various managerial functions was established, bearing in mind the experience of ministries, enterprises, and other economic entities, which indicates that top executives are often

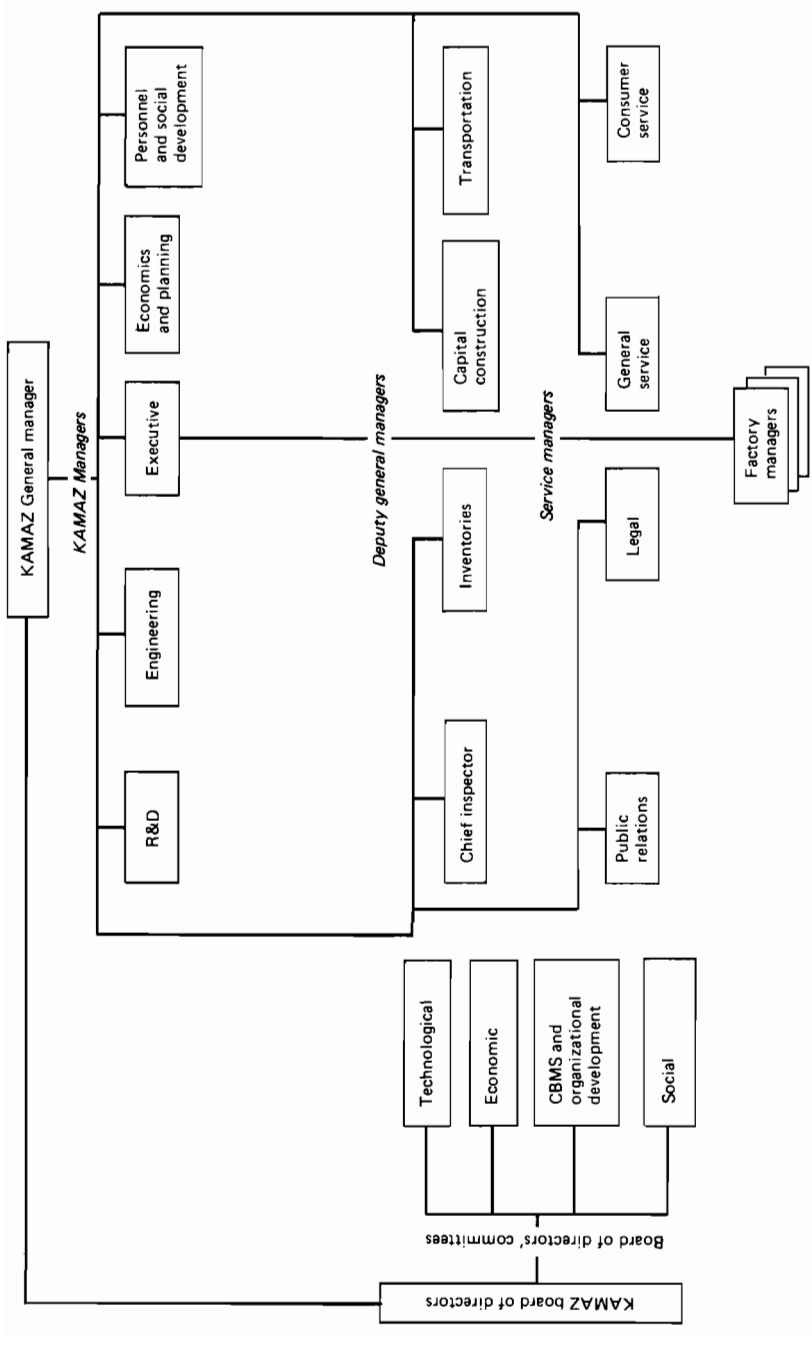


Figure 5.1 The composition of the top-level management of KAMAZ.

overburdened with operational matters. Trivial and routine though they are, they are urgent and, accordingly, push aside the solution of strategic and significant problems. The top management in large and complicated industrial complexes should be established so that it can deal exclusively with strategic questions concerning the entire system. This was how the problem of developing the managerial structure at KAMAZ was solved.

The managerial structure provides for an executive manager's office directing every plant of the amalgamation. This office constitutes a sort of a managerial filter between the top executive and the lower levels within the managerial system that carry out day-to-day and operational activities. This organizational solution had no analog in the past, when an appropriate office of a deputy general manager dealt exclusively with the current supervision of production and its coordination, while the most important production-related decisions were made by the general manager in person. The executive manager's office is a managerial body. It takes over a major share of the functions related to direct production management and has all the necessary authority to exert influence on the subordinate factories. Now the line managers address their current problems of business activity to the executive manager, and not to the top executive of the amalgamation. Of special significance is the transfer of marketing functions to the executive manager's office. This gives the executive manager a free hand in establishing efficient relations with the customer, which improves customer-to-manufacturer feedback.

The problem of separating the strategic from the operational functions in the management organization can also be solved in other ways. Thus, in the majority of Soviet enterprises the coordination of technological development and routine production engineering service is achieved through subordination of respective units to the first deputy factory manager, i.e., the chief engineer. This executive supervised new product development, technological development and equipment repairs, safety standards, and a host of other production-related issues. Naturally, the routine problems, pressing as they were, took up the lion's share of his time and actually prevented him from approaching long-term problems. This is admissible for small enterprises

complying generally with strategic decisions made at a ministry, but it is quite unacceptable for large-scale production complexes.

This problem was effectively solved at KAMAZ by setting up, within the management structure, a separate R&D service concerned with design forecasting, technological development, standardization, improvement of product quality, scientific and technical information, and dissemination of progressive techniques. The R&D service has to identify current trends in the technological advance of the industry and to develop prototype products, implements, and technology. Thus, the service, relieved of the daily engineering support of production, is oriented toward advanced technical and technological development. At the same time, the engineering manager and his staff perform a wide variety of functions, such as current engineering support of production, including tooling, repairing, power supply servicing, etc.

These two examples (the list could be extended) illustrate that the separation of strategic tasks and decision making from routine tasks must be organizationally formalized by all possible means.

It is equally important to ensure the proper combination of functional and program management in present-day organizational structures. It was therefore necessary to treat the KAMAZ management structure as a matrix structure with a spread system of program management based on the conventional forms of line and staff management of specialized services and units.

There is a three-level system of program management at KAMAZ, consisting of:

(1) The top level, i.e., the top executive of KAMAZ or one of his deputies assisted by a subordinate advisory body (an engineering, economic, or social committee, etc.).
(2) The middle level, i.e., the program leader reporting directly to the respective manager as well as the staff service concerned with planning, control, and coordination of the respective engineering, economic, or social projects.
(3) The lower level, i.e., the responsible officers and contributors to individual program stages with dual reporting, to the program leader (generally functionally) and to the superior of their units (line subordination).

Among the most important components of the organizational structure are the coordinating–advisory bodies (committees) set up at the top management level. For the formulation of important interfunctional decisions, four committees were set up and attached to the board of directors. These are the engineering, the economic, the social, and the CBMS (computer-based management system) and organizational development committees. They represent the horizontal management bodies charged with the development of interfunctional programs, and the integration of various links to attain major objectives in the engineering, economic, and social spheres of management, as well as in specific fields such as the development and introduction of a CBMS and new organizational forms. Experience shows that the specialized committees set up for participatory decision making are the most effective form for managing large-scale economic complexes. The principal task of these committees is the interfunctional coordination and comprehensive consideration of problems of the respective functions. In this task they enlist the cooperation of the managers and experts who contribute most to the making and implementation of the respective decisions.

A program leader is chosen from among the leading specialists and his status equals that of a deputy functional manager of the amalgamation, so that he is authorized to issue orders to the chiefs of departments. He heads the middle level of program management and bears the major responsibility for prompt and adequate implementation of every stage of the program. With regard to the program activities, the leader reports to the KAMAZ functional manager only and acts as his authorized representative.

The program leader exercises primarily the functional direction of the responsible officers. However, he does have the power to make decisions. He may approve or reject work and documents related to the program and presented by the responsible officers, dispose of certain resources and material incentive funds alloted to him, and evaluate program progress.

In any system of program management, its leader is mainly responsible for the efficient horizontal coordination of program activities. He must not substitute the line managers of functional units. His primary role is to use indirect levers and methods to

influence program contributors (through directive planning, allocation of resources, incentive funds, etc.).

An important element of the program management system is the staff service attached to the amalgamation manager and committee concerned and charged with the planning, coordination, and supervision of certain programs. The principal task of the service is to provide the program management system with the relevant documents, information, and organization. The staff services collect data on program progress, carry out routine monitoring of plan fulfillment, and formulate proposals for program adjustment. The services are authorized to demand any information from unit managers and from responsible officers engaged in the concrete program. They interact closely with the program leaders whom they are supposed to assist.

The responsible officers are appointed to every project activity on the advice of the functional unit chief. The matrix organization is characterized by dual reporting of responsible officers under the program management. Concerning any question related to the program they report to its leader, while on other activities and questions outside the program they report to their line manager.

In this case a program leader is allocated the separate resources required to accomplish the program. He is in charge of workers' payments and bonuses (for the accomplishment of a given program), as well as of procurement for the program. The remaining resources are allocated to the line managers of the units.

Serious attention is given to the CBMS and its role in the management structure. CBMSs are not infrequently developed separately from the entire set of measures aimed at management improvement and from their basic purpose – to improve the currently operating management system. In the KAMAZ case, the CBMS was developed with regard to managerial needs. The CBMS development was headed not by the developers (e.g., the representatives of an independent design institute), but by the functional and line managers of the amalgamation itself. The general manager of the amalgamation was appointed as the principal designer of the "KAMAZ CBMS", while the functional managers in

charge of planning, production, inventory, etc., became subsystem chief designers.

Strong emphasis was also placed on the management organization of employee social development. This is only natural as one of the principal goals of KAMAZ is to harmonize the interests of individuals, the whole body of employees, and society and, proceeding from this, to create a sound and efficient collective. KAMAZ runs an extensive social and personnel service charged with personnel recruitment and training, the analysis of personnel and social problems, and provision for the welfare of employees. Because there are so many services operating at the complex (housing and welfare services, medical and cultural services, etc.) they are supervised by a separate functional unit attached to the deputy general manager for welfare. The personnel service and the office of the deputy general manager for welfare coordinate the solution of particular problems through the system of social program management.

For the first-line amalgamation management, i.e., the management directly at the factories, the organization was designed so as to prevent the shops and operating departments from duplicating the functional activities exercised by the top- and middle-level management. If the top executives handle strategic problems then the first-line management should perform executive activities (i.e., accomplishment of plan targets, production engineering, and organization of labor). This is why the line management has no engineering or economic functional units and services. Services such as personnel and wages, accounting and statistics, repair and power supply, and inventory were centralized. Shop superintendents have to cope with problems directly relating to manpower and production engineering.

These are the general approach and design principles of the KAMAZ management organization. Realization of these principles was made possible through a program approach to the shaping of the managerial structure, studies of and experiments with the managerial tasks and functions, and evaluation of the required work force in various options for the managerial structure.

Let us now turn to some general organizational arrangements of the KAMAZ management subsystems.

5.3. The Management of the Technological Development and Quality of Products

Management of activities aimed at the amalgamation's engineering objective is exercised in three, large, line-functional units of the chief executive office (see *Figures 5.2* and *5.3*) and in the respective units of factory administration. The technical policy is unified by the coordinating activities of the engineering committee of the board of directors and by the introduction of program management with respect to interfunctional relationships. As the organizational structure of the technological development and quality management subsystem of KAMAZ differs substantially from others in the USSR and elsewhere, it is helpful to focus on the allocation of tasks between the units and the procedures for their interaction.

5.3.1. The R&D

The R&D service is concerned primarily with:

(1) R&D in the area of the basic product.
(2) Exploratory research and experiments aimed at new applications for technological processes and at a higher engineering level of production.
(3) Design and introduction of innovations with regard to the organizational development of the complex.
(4) Comprehensive analysis, planning, and organization of effort related to the improvement of product quality.
(5) Higher efficiency of the technological solutions through rational standardization and extensive use of relevant information.

The objectives of this service are characterized by a distinctive goal-oriented, organizational, and technological unity. Their accomplishment promotes adequate rates of technological advance. This is possible, however, only on the basis of comprehensive analyses and technological forecasts of an exploratory and research nature. These efforts are directly linked with operational production activities, but substantially differ from them in effectiveness criteria. By their nature they

require a special organization similar to that in research establishments, rather than to that in industrial enterprises.

The R&D service is built around the following offices: the office of the chief designer for the main products, the technological and organizational development office, and the quality development office, as well as the units responsible for standardization, patents and licenses, and scientific and technical information (*Figure 5.2*).

The chief designer's office is responsible for:

(1) Forecasts of the lines of development and improvement of the main products, based on analysis of world achievements in science, technology, and production, as well as on in-house research.
(2) Identification of the trends in exploratory R&D in relation to the design of the basic products and the application of new primary materials.
(3) Specification of technological and economic criteria for the assessment of design solutions and the feasibility of their application.
(4) R&D aimed at design solutions consistent with changing production requirements.
(5) The drawing up of design documents for the products subject to the full-scale production and maintenance of the proper design level for products consistent with consumer demands and the manufacturing environment.

The design preproduction office may use various forms for coordinating the formulation and making of decisions, including forms leading to matrix structures.

However, the centralized design organization adopted at KAMAZ provides also for an effective method of program structuring, such as the setting up of a centralized design office. In the specific environment this approach may be realized through the introduction of such positions as a chief designer for individual items, systems, or plants, who would direct the entire design cycle from the elaboration of specifications to the development of the final product. At the same time, the structure of the design office may be quite flexible.

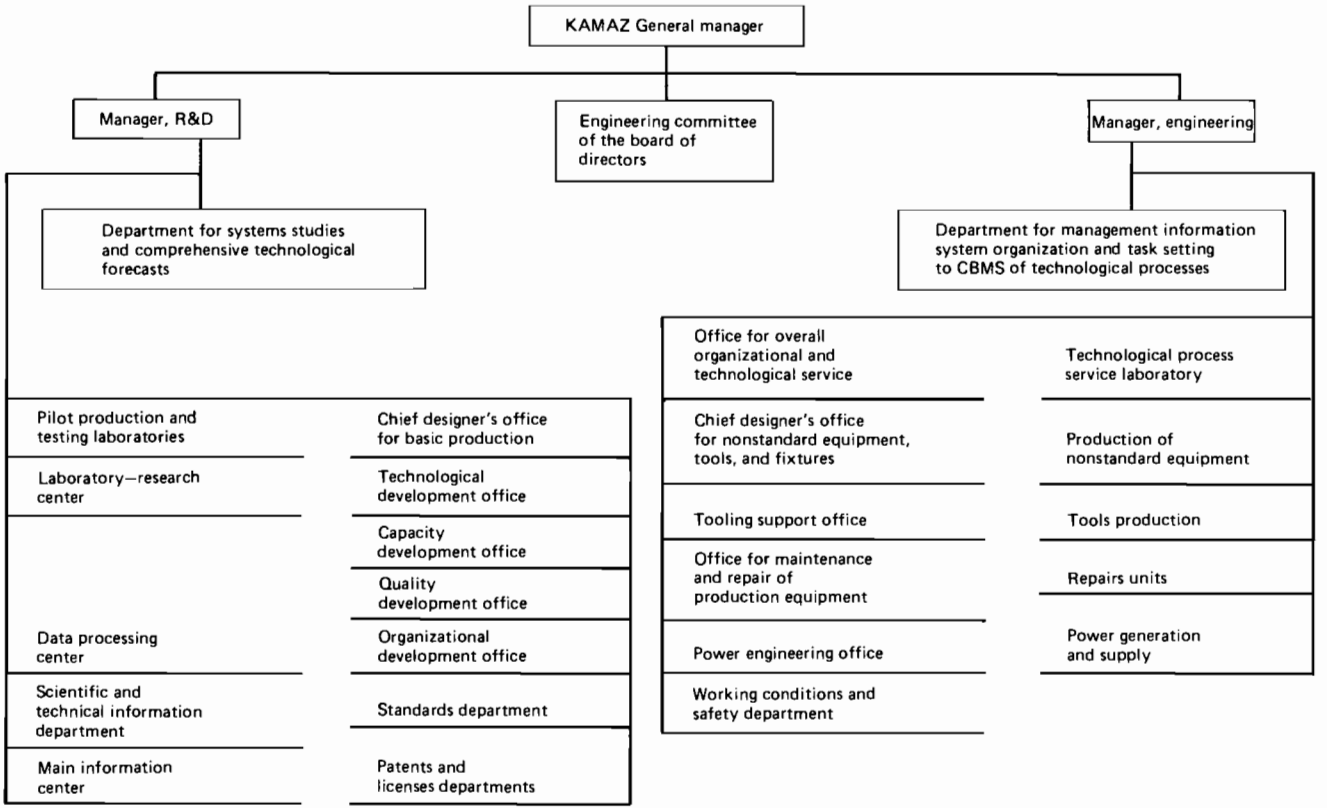


Figure 5.2 The composition and reporting chart of KAMAZ engineering services.

The development of advanced technology in the amalgamation is assigned to the technological development office. Consistent with the role of KAMAZ in the automobile industry and with the specific equipment employed, the office is charged with:

(1) The forecasting of trends in technological development with regard to the automobile industry, the analysis of the technological level at KAMAZ as compared to the world level, and the advanced planning of the introduction of more efficient technology with regard to world trends in development.
(2) Analysis and long-range planning of the development of production facilities with regard to changes in product mix, technological advance, and renovation.
(3) Research in the area of new technologies employed in the automobile industry and utilization of special machinery, fixtures, tools, and advanced materials.

The accomplishment of these objectives rests with the office for the development of production capacities, the sector for analysis and planning of the technological level, and a number of specialized departments concerned with advanced technology.

Laboratory support for the advanced technology departments is provided by the laboratory and research center, whose tasks are somewhat more extensive than those of the technological development department. Taking into account the significance of advanced technological development as well as the relative complexity and labor intensity of the corresponding laboratory operations, a decision was taken to place the laboratory and research center under the chief of the technological development office. Apart from the above-mentioned functions, the center should also perform any laboratory work offered by the office for overall technological testing for the central plant laboratories and render them methodological assistance.

KAMAZ needs the most advanced forms, techniques, and methods of management because of the extremely high concentration of manufacturing, service, and managerial units at a single geographical location and of the need for these to operate in a thoroughly coordinated, balanced, and goal-oriented way under the conditions of mass production. This is why the emphasis in

the existing structure is placed on the organizational development office. This office is the head and most powerful service charged with the organizational development and introduction of the CBMS. It was established, on the one hand, because of a need for strong departments staffed with highly skilled specialists capable of tackling the problems of development of the CBMS and the entire organizational system and, on the other, to ensure the complex-wide direction of a distributed system of services responsible for management improvement in other functional blocks of the top executive office and in production units. The office is not, however, assigned all the tasks in the development and operation of the CBMS. Its primary task is to function both as a "brain center" of the computer-based system, formulating the policy for its development and operation, and at the same time as a supervisor of the most complex activities related to the development of the amalgamation's CBMS. Hence, the internal structure of this office clearly involves such functions as computer maintenance, problem setting, software, algorithm development, and programming, as well as the organization and mechanization of management and the rationalization of information and document flows. This is achieved by grouping the departments under the respective deputies of the office chief.

The office described is only one part of the general organizational system of KAMAZ dealing with the development and introduction of the CBMS. The other part is made up of a network of organizational development and ADP (advanced data processing) departments within the headquarters services and in production units. Each of these departments comprises a bureau for management structures and functions, a bureau for norms and rational document flow, and a CBMS task-setting bureau. Under the general methodological guidance of the organizational development office these departments directly participate in the selection of the models and algorithms for solving problems (they develop neither models nor algorithms themselves). In the process of CBMS operation they receive information from the ADP center, prepare it appropriately, and disseminate it among the managers who need it. The essence of the partial decentralization in relation to the development and running of the KAMAZ CBMS boils down to closer integration of the development and operation of the CBMS, on the

part of a specialized office, with the needs of the functional and production units concerned with the solution of specific economic problems. This is achieved by forming problem task forces, each of which is engaged in the development and maintenance of a certain CBMS block and is staffed with all the necessary specialists.

To promote the advanced management, integration, and coordination of interfunctional activities in this field, the management structure involves the board of directors' committee for organizational development and the CBMS. This consultative body, comprised of the top executives and leading experts of the amalgamation, thoroughly reviews and makes substantiated decisions on the most important issues concerning organizational development and the CBMS, from specification of the requirements on the CBMS and its blocks to the staffing of key areas.

In the management of certain activities connected with the technological development of production, it is often actually impossible to separate organizationally the implementation of long-term and current tasks, though it is very important to secure the priority of the former. For example, in the management of quality and its development, in order to ensure that management is not oriented exclusively toward current production interests, it is generally considered worthwhile to incorporate the appropriate units in the R&D service.

The quality of a product is dependent on every stage of its development, from design to delivery to the customer. Consequently, the management of product quality cannot, in fact, be separated from the management of its development. However, if the volume of production is controlled through an established organizational mechanism realized in a certain management structure, then a quality management system will not fit into the traditional organizational forms. This pressing managerial problem can only be solved by using the systems approach to the organization of the production amalgamation. Hence, in the process of structural development product quality is viewed as a separate objective that can only be achieved with the assistance of special managerial bodies. The management of quality must be an integral part of the management of each established economic function. At the same time, it will have its own specific goals and objectives. The mechanism of such management can be realized only on the

basis of program structures. The system for attaining, maintaining, and improving the quality must involve three basic subsystems: executive, control, and managerial (*Figure 5.3*).

The executive subsystem embraces all the production management units that directly affect product quality or promote its attainment. These are the units for design, technological, and tooling services, the basic and auxiliary shops, the procurement service units, etc.

The control subsystem is composed of technological and line and functional supervision units. The major responsibility of technological supervision is to ensure that the work in progress and the semifinished and finished products meet the specified requirements. The technological supervision service also involves all the units of the established quality control department: units for rate control, input inspection, audit, special checks, etc. The line and functional control prevents poor performance by exerting various influences on production personnel in the process of line, functional, and methodological supervision. In this way the quality management agencies influence the executive subsystem.

The objectives of the management subsystem arise from the standard pattern of decision making: the setting of objectives for the system based on an analysis of its capacities and on the requirements on it; the elaboration and approval of a program of action to attain the objectives; the planning, organization, and coordination of activities for the accomplishment of the objectives; and the motivation of contributors. Within the matrix structure, the management subsystem should contain specialized subunits of the quality control service and the line and functional management units cooperating with it.

The function of the management subsystem is performed at KAMAZ by the quality development office, which is responsible for all the arrangements necessary to secure and improve the amalgamation's products. Of special significance is the relative independence of the quality development office with respect to current production needs, which, as experience shows, often run counter to the interests of consumers and hamper qualitative improvements.

In the KAMAZ upper-level management the functions of the controlling agency within the management system are assigned to

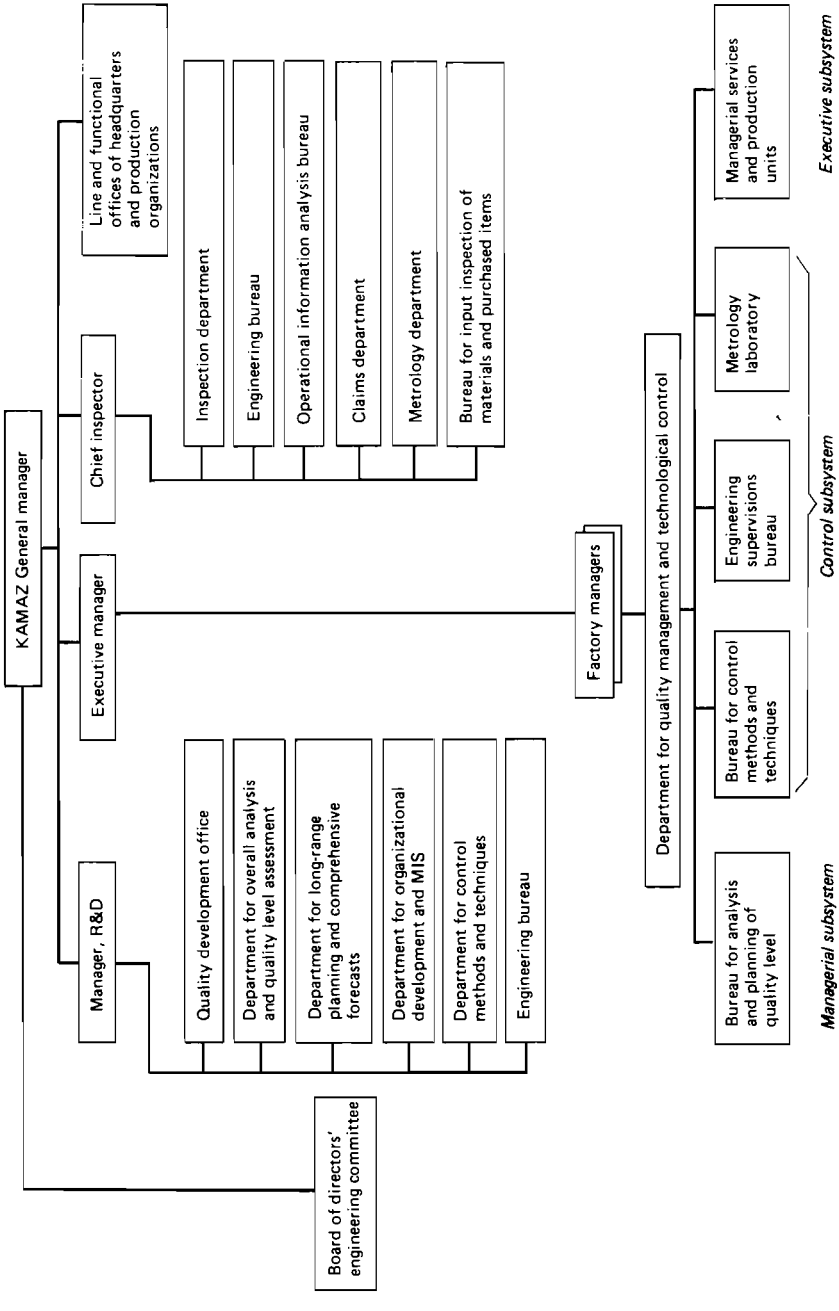


Figure 5.3 The composition and general structure of the KAMAZ quality-management system.

the chief inspector's office. This service is quite unique as it has no analog at the level of a single enterprise. It is responsible for supervising the adequacy and scope of the activities of the factory engineering supervision units. This approach ensures an unbiased and conscientious control to prevent the sale of useless products.

Unlike the structure of the quality development and control services at the headquarters level, there is a unified service at the plant reporting directly to the plant manager. It contains a bureau of quality analysis, quality planning, and techniques and means of control, a plant measurement laboratory, and a shop quality control bureau. The plant departments of quality management and supervision are fully responsible for the manufacturing process and for the resultant product. Only these units are authorized to accept finished and partially fabricated products and to assess their suitability for further use.

5.3.2. The Engineering Management Service

When the R&D functions are structurally separated from those of routine engineering preproduction, the distinguishing feature of the engineering manager's office is that it is responsible for the comprehensive integration of all activities related to the organizational and engineering preparation and to the support of production. The concentration of the entire office exclusively on the routine servicing of production makes it possible to adjust production relationships, to improve the organization and planning of preproduction, and to improve the specialization and cooperation of labor.

In tackling the most important problems, the line and functional units of R&D and of the engineering preproduction services collaborate within the engineering committee of the board of directors. In this committee the engineering manager's service acts as a customer and consumer of technological solutions, while the R&D service submits the strategic lines of technological advance and exercises a supervisory role over the execution of long-range decisions.

There are four major groups of objectives implemented by the engineering manager's office:

(1) The improvement of process technology and the supervision of its observance.
(2) The organization of preproduction activities.
(3) Production support with all kinds of tools, equipment, and power.
(4) The maintenance of basic production equipment.

The implementation of each group of objectives has its distinctive organizational features. One of the most complex issues related to the structure of the engineering manager's office is the definition of the place of units engaged in the overall technological and organizational preproduction activities and in the mechanism of their relationships with the plant technological services.

These units confront the following major tasks:

(1) The organization and coordination of activities related to the assimilation of new products.
(2) The development of new standard technological processes and the improvement of existing ones.
(3) The functional and methodological direction of the development and introduction of new technology.
(4) General supervision of the production engineering level and the observance of standard technology.
(5) The attainment of a higher engineering level and comprehensive organizational preproduction.

Depending on the level, complexity, and novelty of technological preproduction activities and on the availability of skilled personnel manning the individual production processes, the implementation of technological preproduction activities may be centralized to a greater extent. This is especially true in chemical and related technologies and in certain technologies of hot metal working, coating, and welding carried out at specialized plants.

Apart from specialized units concerned with the development and introduction of technology at KAMAZ there are, under the deputy engineering manager, functional departments that deal with the general technological, design, and organizational issues that concern all the major specialists of the amalgamation. These are the departments for the organization and planning of

engineering preproduction activities, of rates of material consumption, and of labor intensity. The principle of consistent, comprehensive integration of activities through the rational allocation of responsibilities and decision-making procedures requires that the technological service should affiliate the engineering design and organizational preproduction units. Also, the setting and solution of problems related to the analysis and planning of production engineering at KAMAZ are organizationally separate. This task is assigned to the department for specialization, cooperation, and expansion.

Another organizational feature of the KAMAZ engineering service is the separation, under a deputy engineering manager, of units providing engineering services to production, as well as a new principle of structuring the plant engineering services. At the majority of large Soviet enterprises these activities are carried out by autonomous factory engineering services, which makes it difficult to plan preventive maintenance and to coordinate operations and resources in case of emergency repairs, as well as reducing the responsibility of repair and maintenance units for the quality of their service.

A decision was taken at KAMAZ to centralize and separate organizationally, within the two general management offices, the planning and engineering activities related to mechanical and power equipment repairs, but to concentrate, under the plant engineers, the actual overall repair of technological equipment. Following this decision, functions were accordingly reallocated, both between the plant engineering and power engineering services and the central and factory management.

One of the most important features of the KAMAZ engineering manager's office is that it contains a variety of units providing amalgamation-wide engineering services. A powerful production base represented by repair and tool works, pilot production shops and sections, plant engineering production units, stores, etc., turns the engineering service from a purely staff agency into a complex line and functional unit that has every prerequisite to operate on a profit-and-loss basis, i.e., to become a "cost center".

5.4. Line and Operational Production Management

The KAMAZ management, oriented toward the systems implementation of explicitly defined and structured objectives and goals, involves a special mechanism for directing the production units. Behind this mechanism lies:

(1) The necessity to concentrate the authority and responsibilities for implementation of the entire set of decisions with respect to the organization of basic production.
(2) The availability of strictly specialized and highly concentrated functional subsystems to provide the required resources and information to basic production units.
(3) Upper-level program management bodies concerned with the key problems relating to the amalgamation as a whole.
(4) The utilization of a data processing system that operates a unified standards base and serves both the production and technological processes.
(5) A detailed and strictly observed set of directives (regulations, rules, instructions) laying down the duties, authority, and responsibility of all the interacting management units.

Another important reason for separating a specialized executive management for basic production is the need to separate strategic and coordinating functions from those of operational management. The chief executive must deal with the general strategy and development of the amalgamation, while the factory manager has to cope with tactical problems and to coordinate interfunctional activities. The chief executive and factory manager in their turn delegate authority and responsibility for operational management to individuals and bodies possessing the necessary power and resources [45].

At the headquarters these functions are delegated to the executive manager, who exercises the general direction of the plants with respect to the organization of uniform output and sales. This approach results in a special status for the factory manager within the amalgamation management system. His subordination to the executive manager with regard to operational and routine production management obliges him to apply to the

latter in solving the respective problems of functional support. Thus, with regard to the operational activities, the executive manager turns out to be an immediate line superior of the plant manager. To exercise this function he has a special staff and facilities and is authorized to make the necessary managerial decisions, to stimulate employees and units, and to exert administrative influence on them. The general manager of KAMAZ must oversee the activities of the executive manager, approve decisions that require interfunctional coordination or affect the strategy of the entire amalgamation, and adjudicate conflicts between the executive and plant managers.

Let us now consider the composition, interrelationships, and major tasks of the executive manager's office.

In spite of the fact that each basic production factory of the KAMAZ amalgamation is a huge enterprise independently running its productive assets and operating according to a stable plan, there is a close cooperation between all of them in both basic production and services. Consequently, the function of interplant coordination of production and service activities, which is the responsibility of the production scheduling office, assumes special significance at KAMAZ. On the one hand, close cooperation of the enterprises requires perfect coordination of a whole series and a large volume of highly synchronized operations to minimize the volume of work in progress, which already diverts a sizable share of the current capital in the automobile industry. On the other hand, though, the huge size of the resources utilized by each of the autonomous enterprises requires that they have a certain freedom of maneuver, even in operational activities. This is why the general management offices, while coordinating interplant cooperation, cannot regiment intraplant operational management. It should also be kept in mind that the operational production management at KAMAZ is exercised through a CBMS, which helps to coordinate production and services down to the first-line units.

What has been said above illustrates that though the traditional list of functions of the production scheduling office is formally preserved, its content has been substantially changed. The same is true for the nature of the interrelationships between the general management offices and the plant services. The office

contains the departments for production scheduling, operational production planning, and production control, as well as a bureau for operational planning of interplant traffic.

As the amalgamation is obliged to provide the national economy with a certain mix of products, the management organizational structure must reflect the subordination of immediate manufacturing tasks to product sales requirements. This made it necessary to include the sales office in the executive manager's service. The office itself contains a field service analysis department.

To the extent that the trucks produced in KAMAZ are utilized in large motor-transportation enterprises and organizations, the possibility arises of establishing fairly stable communications with consumers and of extending customer feedback. Great opportunities for developing relationships with consumers are opened up when products such as diesel engines, gearboxes, and wheels are delivered. The very nature of this cooperation determines the content and form of the interrelationships.

The contracts department of the sales office draws up the necessary documents for concluding business contracts with consumers. As the major share of the output of KAMAZ is manufactured according to special specifications and the amalgamation serves a great many customers, the internal structure of the department provides for a number of subunits specializing in serving separate groups of consumers.

A central unit within the sales office is, undoubtedly, the sales operational planning department, which:

(1) Breaks down the current sales plan and draws up the monthly shipment schedules on the basis of contracts and direct communications with consumers.
(2) Exercises operational management of depots for finished goods and arranges their proper storage and prompt shipment.
(3) Plans and organizes sales activities.

To deal with the specific features and significance of export sales, special orders, and spare parts, specialized units were set up, such as the export deliveries department, the special orders

department, and the spare parts center. They are not merely units for sales operational planning, but rather program management bodies responsible for the preparation, manufacture, and sale of certain groups of products. These departments organize and supervise the development and coordination of product specifications, the preparation and support of production, procurement, storage, and shipment, the manufacture of special containers, etc.

Thus, at the top of the operational management system for basic production at KAMAZ there is a group of specialized staff units. Of paramount importance, however, is the specific nature of their specialization, which does not overlap with the functions of managing other businesses (which are supervised by autonomous services operating on an intraplant profit-and-loss basis), but is aimed at the effective division of labor in processing information related to production and product sales progress: analysis, planning, coordination, adjustment, and supervision of production and sales at the level of the amalgamation.

This approach was mainly necessitated by the extremely large volume of work involved in the gathering, transmission, and processing of data, as well as by the complexity and variety of the functional relationships between the staff management and production manager's office and the headquarter's functional services and factory management units. It is worth noting that this type of structuring to a great extent conforms to the goals and objectives of the upper level of basic production operational management, which was set up primarily to coordinate sales activities and not production results. The organization of production interactions is the principal task of the middle-line operational management, i.e., plant management (*Figure 5.4*).

As there is no need to make strategic decisions at the plant management level and as the principal task of factory management is confined to the accomplishment of tactical and operational tasks, it is quite reasonable to concentrate the line management of basic production in the hands of the deputy plant manager for production. In order to secure managerial reach the direction of the operational management staff is entrusted to the deputy plant manager for production planning and supply.

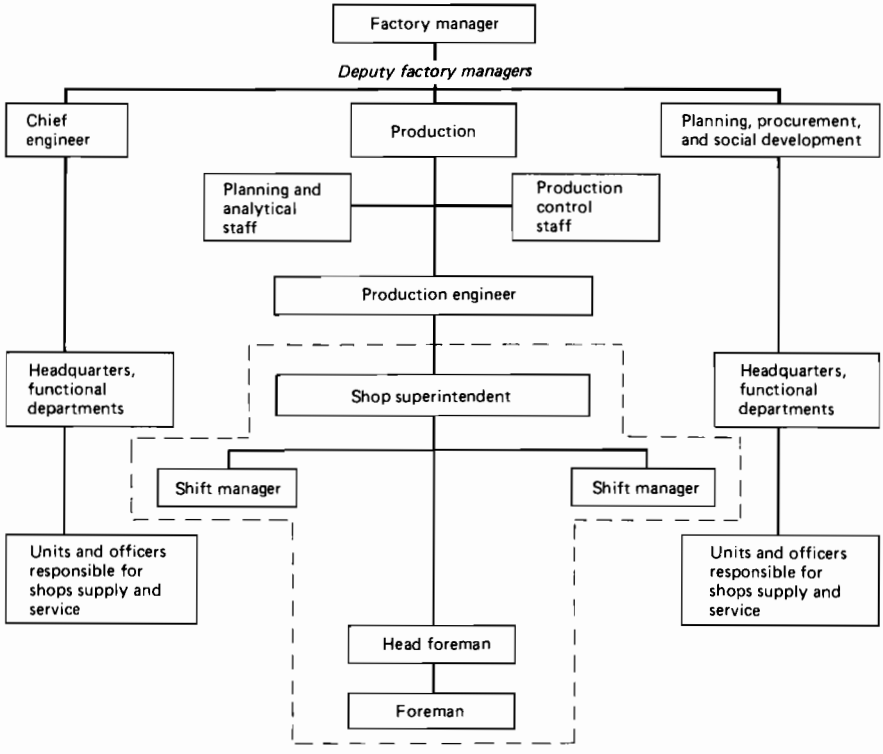


Figure 5.4 The management organization chart for a KAMAZ amalgamation factory.

Because of the conditions of highly centralized procurement, produce sales, and interplant transportation, there is an opportunity at the KAMAZ plants to set up integrated services responsible for the operational management of procurement, production, and deliveries of goods under a common management. The integration of the procurement function in a unified operational management subsystem was required by the fact that the purchased materials components are transformed at the factory into a product of labor, the control of whose movement is the principal task of the basic production operational management.

The plant staff service comprises the production scheduling and material procurement departments, as well as the bureaus of production engineering, product delivery, and planning of interplant traffic.

As can be seen, the specialization of the operational management staff becomes mixed at the plant level. On the one hand, there is still a division of labor involved in the planning and analytical, and the coordinating and controlling functions (accompanied by a trend toward their integration with the decreasing volume of work), while, on the other hand, the units already confine the scope of control to more narrow, operational subsystems within the production process: to the object of labor, its processing, transfer operations, and the product of labor. The trend toward integration of the functions of management with the differentiation of its operational subsystems is not as yet evident, owing to the multistage nature of the factory production structure necessitated by the great size of the amalgamation enterprises, which required the setting up of an intermediate level of line management, i.e., an operational department (building) management. Its objective is to increase the effectiveness of production operational management in a group of shops linked by a unified technological process (foundry plant) or output (diesel engine, repair, tool, and other plants). Such a complex organizational structure is necessary mainly because of the need for an intermediate concentration of managerial interrelationships before they are taken to the middle level. Given the large scale of the enterprises affiliated in KAMAZ, direct reporting of shops to the plant manager or his functional deputies would have meant greatly overextending the managerial reach of the latter. At

KAMAZ the plant engineer is a direct line manager of shops under him and is responsible for their operation to the plant manager. The superintendents of the respective shops report to the plant engineer on every issue involved in production activities and it is only through him that they may communicate with the plant manager and headquarters.

One of the most specific features of middle and first-line management at KAMAZ is the overall manufacturing support and service are carried out under the guidance of specialized functional services, and the responsibility for them lies with the plant management. This enables the plant management to carry out the consistent and effective division of complicated labor operations: that is, to arrange for the specialization of the employees engaged in analysis, planning, and decision making and of those handling the acquisition, transmission, and programmed processing of data, as well as of those concerned with direct manufacturing activities related to operational support and service subsystems.

Thus, one can conclude that the adherence to certain managerial principles and the conformity of organizational structure to the structure of a business organization's objectives make it possible to establish a unified, multilevel system of basic production and operational management that is essentially integrated with the specialized functional management in its operation, legal status, and economic interests.

CHAPTER SIX

Matrix Organization for Technological Innovation Management: The Case of *UralElectroTyazhMash (UETM)*

6.1. Specific Features of the UETM Amalgamation

The development of the management organizational structure of the *UralElectroTyazhMash* (*UETM*) production amalgamation was based on the same principles and methodology as the structure of KAMAZ. However, the amalgamation possesses a number of specific features, which necessitated the creation of a series of nonstandard organizational designs of considerable interest. We feel that the experience at UETM in designing systems of technological innovation management may find wide application, so we analyze its highlights in some detail.

The UETM production amalgamation is a typical, large-scale organization whose economic activity is based on a high proportion of R&D. It turns out large and powerful electrotechnical machines and equipment: electric engines, hydrogenerators, transformers, and many other products. The headquarters (the main plant) is situated in the city of Sverdlovsk – a major industrial center of the USSR. However, the consumers of the amalgamation's products are spread all around the country. In addition to the main plant, which produces two thirds of the total

output, the amalgamation includes four specialized plants operating in different towns of the regions, as well as an important R&D institute subordinate to this branch of industry and located on the same site as the main plant.

The amalgamation's main activity is closely connected with nine related enterprises in different parts of the country. These enterprises are administratively subordinate to different ministries, while the coordination of general.technological policy and the development and organization of material supply are the responsibility of UETM, as the central link in the cluster of interrelated enterprises.

The management organizational mechanism of UETM is structured to conform with the purpose and requirements of its products, the structure and type of production, the engineering level used, the mix of resources consumed, as well as the degree of sophistication of its external and internal relationships.

Let us examine the above-mentioned specifics in more detail.

6.1.1. The Multiprofile Nature of Production and Wide Range of Products

The basic electrotechnical products turned out by the amalgamation are generators for hydropower facilities, heavy electric machines and direct-current machines, synchronous compensators, high-voltage transformers, conversion equipment, and domestic appliances. Each type of product includes dozens of different modifications, which leads to a large number of nonrepetitive jobs in the engineering and technological phases of product development, in the preparation for production, and in the provision and maintenance of facilities.

The wide range of products turned out by the amalgamation promotes the development, manufacture, and delivery of large, electrotechnical equipment systems to different projects under construction within the USSR and abroad. The possibility of obtaining such complete and complex systems from a single enterprise facilitates the task of design and engineering organizations as well as the construction itself, since the development of items (complexes) based on unified technical specifications ultimately results in the earlier achievement of a plant's projected production capacity. It is worth mentioning, however, that the

management of a multibranch amalgamation with a wide assortment of products becomes far more complicated because of the necessity to tackle engineering, process, production, organizational, and economic problems concerning the manufacture of items that have nothing in common with one another.

6.1.2. The Amalgamation as the Main Developer and Supplier of many Types of Products

Its enterprises have the largest share in the total national output of such items as synchronous compensators, large vertical electric engines for irrigation system pumps and atomic power stations, the stimulation systems of hydro- and turbo-generators, and conversion transformers for electrolysis in the chemical and metallurgical industries. UETM has a network relationship with a wide circle of consumers for the majority of items and carries out the complete cycle of work from research to production and output. In a number of fields in electrotechnical production the amalgamation possesses the major part of the country's leading experts. The concentrated production of so many items necessitates the processing of a large volume of scientific, production, engineering, and management information and generates increased interfunctional relationships within the amalgamation.

6.1.3. The Manufacture of Single Items or Small Batches of Items; Consumer-oriented Work

The rapid change of products leads to an increased volume of preparatory production work and requires the elaboration of varied process engineering. The individual nature of production gives rise to one-time and unique parameters in the operational planning and scheduling of manufacture, and in all the related support subsystems. This type of production involves a large share of nonstandard engineering and managerial decisions that are prepared on an interfunctional basis.

New products account for over 40% of the amalgamation's total output. Much of this is exported to a total of 36 foreign countries, including France, Italy, and Norway. The total volume of export deliveries amounts to 13% of the output.

The specific consumer-oriented production presupposes attention to the customer's specific requirements at all stages of production, from R&D to installation and commissioning.

6.1.4. Continuous Increase of Scale and Growth of Production

In the last decade the average annual growth of output has been about 10%. To a large extent the production growth has been due to an improved performance and a better utilization of productive assets.

Improvement of the management system under conditions of greatly increased production growth rates and shorter product development periods became one of the decisive factors in the attainment of the amalgamation's goals. The organization of the amalgamation's management system was designed with due regard to all this. It differs considerably from the common designs accepted in industry and has a number of totally new organizational forms. The main task was to make the organizational structure contribute in the most effective way to the achievement of the technological progress goals. Reduction in the period "from idea to application" within the amalgamation and provision of a high engineering level of development in the industrial branches that consume the amalgamation's products were given high priority in the new organizational system. In this connection the amalgamation created a unified R&D service, a system of horizontal (interfunctional) management of new technology projects, a special council of the board of directors to assess new technology projects and their implementation, and a system of quality control. Key consideration was given to raising the responsibility of managers at all levels and to enhancing their goal orientation.

Proceeding from the necessity to face up to new management problems arising in connection with the larger scale of production, the greater specialization and cooperation between the amalgamation's plants, and the greater sophistication of scientific, technological, production, and managerial relationships, a series of principles were considered stepwise in the development of the organizational design. The basic principles are listed here.

(1) Reduction of the period (cycle) of new technology development, from project design up to the production application of new designs and technological processes.
(2) Creation of conditions for the structural units to engage in perspective issues along with implementation of the entire complex of current work.
(3) Clear delineation of structural units so that they can be more effectively supervised in, and have more responsibility for, their performance.
(4) Relief of the amalgamation's management from operational decisions and the creation of conditions for their concentration on key decisions concerning the development of production activity and the solution of the amalgamation's perspective problems.

These principles formed the basis of the organizational design, some aspects of which are analyzed in the next section.

6.2. The General Scheme of the Management of UETM's Technological Development

The specific purpose and great sophistication of products turned out by the UETM amalgamation, as well as the individual and small-scale character of production, necessitate an extremely large volume of R&D work, of engineering preparation for production and tooling supply, of mechanical maintenance, and of power engineering.

The large volume of work and the diversified scientific, technological, and production activities call for the creation at UETM of a complex organizational structure of R&D and engineering services. The general organizational chart of the units engaged in R&D and production support is given in *Figure 6.1*.

The unity of the amalgamation's technological policy and the comprehensive engineering service of all the production units is ensured by subordinating the appropriate services to UETM's Director for Engineering. This executive has the status of First Deputy to the General Manager of the amalgamation (as well as the Executive Director) and possesses full authority for supervision

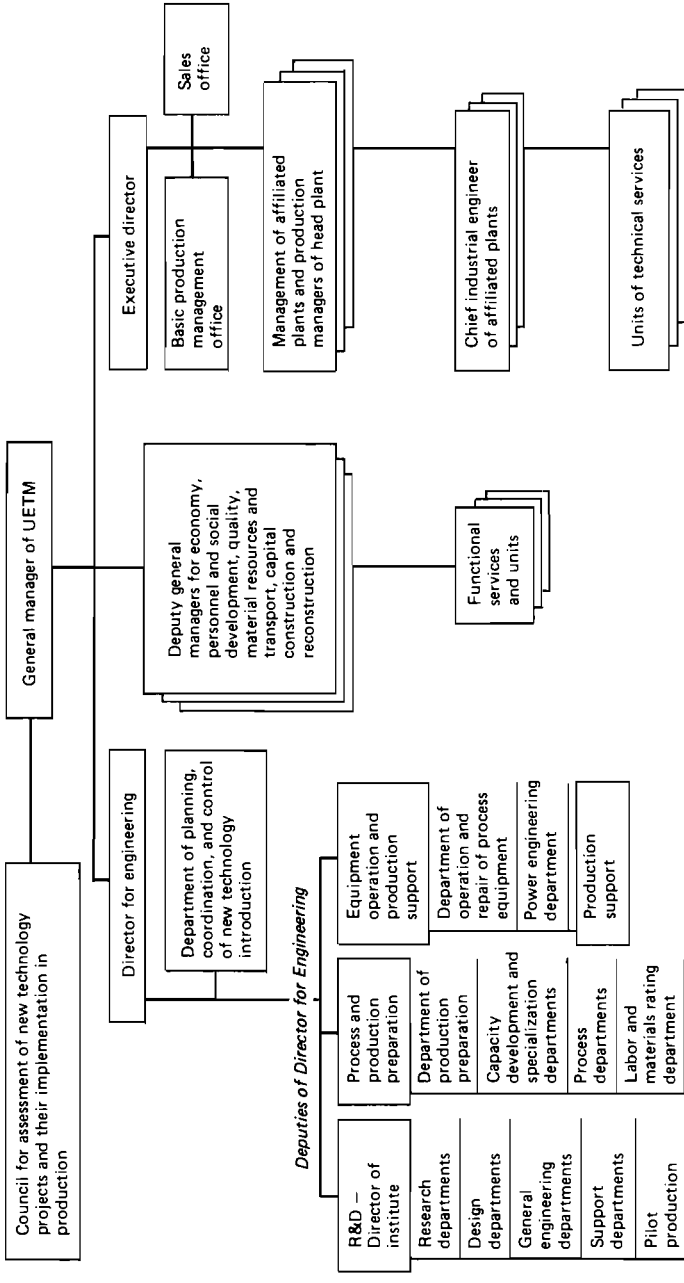


Figure 6.1 General schematic diagram of UETM's technological development management.

of the engineering preparation and service of production, for technological change, and for the introduction of advanced technology and processes. All the amalgamation's and head plant's management and production units related to these functions report directly to the Director for Engineering. The management of the engineering services of the affiliated plants is effected by their managers (directors), who take orders from the Director for Engineering as regards the preparation and technological development of production. If necessary, these orders are agreed with the Executive Director of the amalgamation. The functional management of production technology and process improvement is carried out by the Director for Engineering via the Chief Industrial Engineers of the affiliated plants.

The functional structuring of the engineering services of the amalgamation and head plant is elaborated to ensure the achievement of UETM's engineering objectives.

The task of creating and improving designs for the products of the amalgamation's enterprises is assigned to UETM's R&D institute. Its units conduct a whole complex of research on the requirements on the items produced, explore the possibilities of their technological improvement, design new and perspective products, elaborate all the working design documentation, supervise the industrial engineering and progress of production, and make the necessary corrections in the drawings.

The character of production at UETM (the production of individual items or small batches of items) does not allow the design units to specialize along the lines of current and future work (i.e., by time frame). However, specialization is possible on the basis of the common features of the items to be developed (with respect to the design or process involved). Accordingly, the appropriate departments were established: the Chief Design Engineer's Office and the R&D department. With due regard to the possibilities for functional cooperation and the span of control, these departments were grouped in two functional blocks reporting to the Deputy Directors of the R&D Institute. Each block has its own facilities for experiments.

At UETM a strong engineering service was formed that reports directly to the Director for Engineering. It is entrusted with the task of making comprehensive decisions concerning all

aspects of the engineering preparation for production, from the development of processes for basic and support production to the elaboration of labor and material standards, production capacities, and the supply of tooling and nonstandard equipment. Its manager – the Deputy Director for Engineering responsible for processes and preproduction – is also in charge of subordinate production shops: the tooling shop and nonstandard equipment shop. The engineering service is thus organizationally unified, which ensures a high level of responsibility for the quality of performance.

The amalgamation's need for a unified technological policy required that the units engaged in supporting the mechanical and power engineering of the head plant should be made directly subordinate to the Director for Engineering. The scope and complexity of jobs performed by these units confirm the expediency of forming an independent, functional block.

It was confirmed in practice that the functional structure of the engineering services is quite effective. However, there are some problems specific to UETM that cannot be solved using traditional organizational forms.

One of UETM's objectives is to develop and manufacture sophisticated electrotechnical items whose most specific feature is that they are nonstandard. Therefore, a special R&D process, complex engineering preparation, and constant changes in industrial engineering are required. The data shown in *Table 6.1* characterize the average share of labor consumption at various stages of the production process.

A large number of closely cooperating production and management units results in a multitude of horizontal linkages. The more varied the products, the larger is the number of links. However, with functional specialization of the management, control of this linkage (coordination, agreement, decision making on controversial issues, etc.) is possible at the top level only – via the General Manager or Director for Engineering and their deputies. With an extensive range of highly sophisticated products, difficulties arise in design and development and the number of problems that must be tackled by the top executives increases. Since it is impossible for them to solve so many problems with adequate effectiveness, some functions related to the creation

Table 6.1 Comparison of labor consumption (%) in various stages of production.

Stages of production process	*Average for all types of production*	*Large and complex products*	*Serial products*
Design engineering, research, testing	25	35–40	15–20
Engineering preparation of production (development of process, manufacture of tools and tooling, etc.)	25	20–25	20–25
Manufacture	40	30–35	40–50
Production support	10	5–10	10–15

and management of horizontal links are delegated to the middle level (chief experts, managers of functional and production units). As a result, it seems necessary to give up the unified criteria of decision making, coordinated management, the high degree of responsibility for the performance of certain functions, and the effectiveness of some research and production activities.

In view of the foregoing, a purely functional structure of management does not satisfy the modern requirements of a production amalgamation such as UETM. Therefore, forms such as the management of goal-oriented programs, which provide for the coordination and harmonization of all activities aimed at the accomplishment of a specific objective, were developed and applied at UETM.

6.3. General Principles of the Management System for Goal-oriented Engineering Programs

The management system of goal-oriented engineering programs developed and applied at UETM basically corresponds to the well-known types of matrix organizational structure (see Chapter 2). However, the nature of the system's component parts (units), their interaction, and the organizational mechanism of the system

operation are determined by the specific features of the design and manufacture of the amalgamation's products.

The new technology produced by UETM is divided into two categories. The first includes items for which there exists standardized technical documentation (for a pilot sample, for a series of program contributors, for a similar item). These items are characterized by parameters (size, capacity, body design, specialized assembly, etc.) that do not require special research and detailed design and process engineering; their manufacture involves little nonstandard equipment or tests. Preproduction and production of such items is effected by means of rather simple programs and is scheduled for a relatively short period of time; it involves fewer and lower levels of management and embraces a limited number of functional units. Practice has shown that these programs can be quite effectively implemented within the established structure and do not need any special subsystem or mechanism of management. In the amalgamation's classification they are referred to as "orders".

The second category of items is different. It involves innovative design and process engineering, which must be preceded by special research, pilot production, special tests, arranging additional suppliers of completing units and instruments, and a lot of new tooling. The development and manufacture of such items will then give rise to horizontal relationships that require coordination at a level as high as the Director for Engineering. In addition, most items of this type are characterized by high production costs and rigid terms of delivery. UETM's economic interests demand faster rates of product development and minimization of the labor and material resources used in product manufacture.

As well as the large variety of jobs involved in the creation of new technology, it is necessary to consider functional problems in the management of that work. Thus, on the one hand, managing the implementation of any program is a purely organizational process, including planning, control, motivation, coordination, etc., while on the other hand managing the work aimed at scientific and technological development requires direct participation in the analysis and adoption of decisions in research, design and process engineering, manufacture, etc. To create an effective system of engineering program management, all engineering decisions

were classified by organizational factors. It is possible to distinguish three types of similar factors.

The first includes decisions concerning the results of implementing a program as a whole, i.e., the total costs of the projects, the time frame of implementation (the deadline), the level of engineering, the technical and economic parameters of the product, the basic characteristics of the product and the specificity of its manufacturing process, the operational characteristics, the price (or cost?), etc. Decisions of this type imply approval of technical requirements, design specifications, and technical conditions related to the item, the scheduling and costs of the program, the requirements for design adjustments in connection with test results, trial operation, etc.

The second type of decision includes those decisions providing for the accomplishment of the results of the first class of decisions, as well as mutual decisions between the program contributors (concerning the completion times of particular stages of the project and the requisite resources, the interrelated parameters of the units and manufacturing processes for the item, and the content and quality of the supporting jobs and services). These decisions concern approval of the aggregate program plan and modifications thereof, of sections of the engineering project, of the subcontractors and the technical requirements for the parts finished by them, of the work project, of certificates (reports) of delivery from production departments and subcontractors, etc.

The third type of decision provides for the accomplishment of the content, schedule, and volume of work carried out by the cooperating departments, i.e., the program contributors. These decisions concern the formulation of the internal plans of the departments, the allocation of work assignments among the cooperating units, the competition between products within the established technological process, the operational rates of part finishing, the calculation of labor and material costs involved in decisions of the second type, and the choice of the processes and organization of supporting and indirect work, without direct relation to the schedules or quality. Typical decisions of this type are the approval of the working drawings for parts, of the preproduct operational process charts, of the intradepartment

production schedules, of the applications for the transportation or packing of supplies, etc.

In the management system of a goal-oriented engineering program (its structure is given in *Figure 6.2*), the authority to make decisions related to engineering is allocated in conformity with the foregoing classification. The top program management is UETM's General Manager or Director for Engineering. When a program includes work on the preparation of technical documentation for production and both production and testing of a prototype unit, the top executive of the management system is UETM's Director for Engineering. If the implementation of a project presupposes production of industrial prototypes involving new technology, as well as other work, whose management falls outside the sphere of the Director for Engineering [the expansion of working space, the modernization of departments, the recruitment of additional manpower, the attraction of financial resources, the establishment of a different system of relations with suppliers or consumers (clients), etc.], the process management is effected by the General Manager.

In addition, UETM created a staff organ of the top-line program management: the Council for assessment of new technology projects and their production. The Council is a permanent operational unit of the program structure and its authority covers all the projects tackled by UETM.

The manager of a goal-oriented engineering program is the central link in the system. The organization of the program's implementation at a high level of quality, on schedule, and in strict conformity with the strategy worked out by the Council, is assigned to the program manager, who bears full responsibility for the schedules and results and reports to the General Manager. In all matters concerning the project, the program manager is subordinate (in terms of line relations) to the General Manager or any other executive acting for him. In relation to all other units and management executives the program manager acts as a plenipotentiary representative of the General Manager.

In order to provide for the accomplishment of the objectives with which he is entrusted, the program manager formulates and submits for the General Manager's approval a program plan where he:

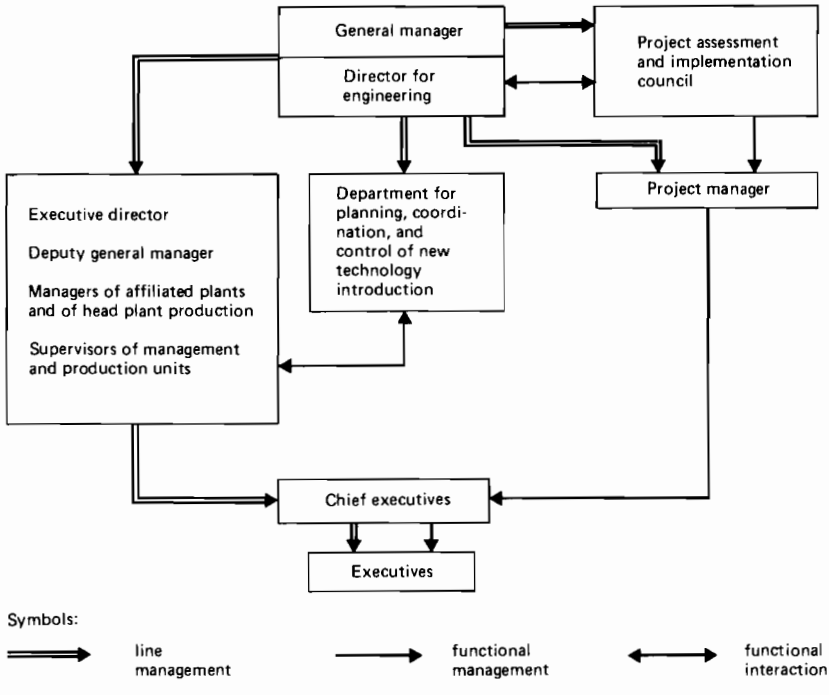


Figure 6.2 General schematic diagram of the relationships in the management of a goal-oriented engineering program at UETM.

(1) Identifies the units and individual employees who will implement the program and coordinates the composition of the team with the managers of functional units.
(2) Requests department managers to designate teams who will be program contributors and considers their proposals as to the number of team members and the candidates for roles as chief executives.
(3) Contacts chief executives and considers their proposals as to work content, volume, schedules, and the requisite resources, coordinates the proposed parameters with the departments for planning coordination and control of the introduction of new technology, with UETM's central planning body, and, if necessary, with the managers of departments and functional units.
(4) Works out proposals for subcontractors and suppliers of externally manufactured items and coordinates the proposals with the functional managers and planning bodies of the amalgamation.

In addition, the program manager, supplied with the necessary information from the planning department and the department for coordination and control of new technology, as well as from the chief executives, effects regular control of work progress with regard to content, volume, and schedules. He also elaborates the necessary measures to influence the executives in order to prevent deviations from plan and implements them within his authority or through the appropriate line managers.

When necessary, the program manager, with the help of the planning department and the department for coordination and control of new technology, maps out alternative corrections to the plan, coordinates them with the personnel and departments concerned, with the line managers, and with the planning bodies, and issues orders with regard to their realization. In controversial cases he submits draft orders about plan corrections for the consideration and approval of the General Manager or Director for Engineering.

The program manager is also entrusted with line supervision of the project team subordinate to him. He assigns and reassigns tasks among his subordinates, personally controls and evaluates

their performance, rewards or punishes the employees within his authority, plans annual leave (holidays), etc. For the duration of the project, members of the project team are not subordinate to the managers of the departments where they were before the project was initiated.

In the performance of his functions and in his relationships with the client, as well as with superior-level organizations, subcontractors, and other outside organizations, the program manager represents the amalgamation within the authority granted to him by the General Manager. When necessary, he coordinates his decisions with the amalgamation's planning bodies and functional managers.

In addition to his administrative, planning, and coordinative functions, the program manager performs general (interfunctional) management and directly participates in the elaboration of the process and engineering documentation and in the organization of tooling support, material and technical supplies, tests, pilot production, and delivery of the prototype item to the appropriate interdepartmental (interbranch) commission.

Besides the above-mentioned functions, the program manager organizes all the required project accountability (determines its conformity to the established criteria of completeness and reliability and approves it). He also provides for the required feasibility studies, as well as for the relevant documentation of the actual effectiveness of the new technology, so that he can establish and approve a central bonus fund for its development and assimilation. He elaborates proposals for the allocation of the expected and actual bonus fund among the chief executives and support departments and submits them to the General Manager for approval.

In this activity relating to organization, engineering, and paperwork, for some jobs the program manager can involve:

(1) Employees directly subordinate to him.
(2) The department for planning, coordination, and control of new technology.
(3) Chief executives and contributors.

In order to accomplish successfully the objectives set for him, the program manager is given the following authority:

(1) He may supervise formulation of the program plan in relation to the orientation, content, resources, and schedules of work and submit it for consideration by the Council for project assessment and for the General Manager's approval.
(2) He may approve all the corrections (adjustments) in the operational plan of action. If necessary he may reallocate or additionally allocate resources, and in the case of conflicts relating to the nature and content of plan corrections he refers the matters to the General Manager, who makes a decision after mandatory consultation with the program manager.
(3) He may order all the alternative organizational and technological decisions of the first type and the relevant documentation to be initiated by the General Manager or Director for Engineering.
(4) He is authorized to approve:

    (i) The technical documentation reflecting decisions of the second type (working drawings for components, partial assemblies, tools, tooling, packing, etc.; flow process charts for the basic production; the technical requirements on externally furnished items, semiprocessed products, and materials; programs of tests and pilot production) and any necessary modifications thereto.
    (ii) Interfunctional work schedules.
    (iii) Summary cost accounts for labor, materials, tools, and power.
    (iv) Inventory standards and their delivery schedules.
    (v) All other documentation related to the quality and schedule of program implementation.

    Before approving the documentation, the program manager may ask for any kind of information concerning the reliability of the submitted calculations and for additional justification of the proposed alternative decisions; he may also urge additional projection, calculation, and production to allow better substantiation and realization of a decision, as well as

to allow the necessary amendments to be made to the proposed documents.

(5) He may insist that department managers and chief executives supply information about the progress of project implementation and explain the reasons for failures to fulfill work envisaged by the plan. He may issue instructions to chief executives about actions needed to ensure timely and proper performance and he may suggest that the superior line managers exert influence on the chief executives in order to guarantee implementation of the program plan. He is also empowered to reject adjustments of the plan and activities that were made without his consultation and that do not contribute to the timely and appropriate fulfillment of the project work. All similar activities, no matter who suggests them, should be discussed with the program manager and no decisions should be taken without his agreement.

(6) The program manager may evaluate the fulfillment of the program plan by the cooperating departments and approve the monthly or quarterly reports submitted by them; the reports serve as a basis for the current bonus allocation. If the reports do not bear the program manager's signature, which confirms the timely and complete fulfillment of the planned volume of work on the program, a department is not entitled to a quarterly bonus or the premium wages for the results achieved in socialist competition.

(7) The program manager may submit proposals to the General Manager for allocation of the centralized incentive fund for the development and introduction of new technology among the departments and chief executives. This document will not be approved unless the program manager signs it to confirm his agreement with the proposals.

The accounting documents dealing with costs are only considered to be valid if they are confirmed by the signature of the program manager. Overspending of resources allocated for program implementation is only acceptable with the program manager's agreement and when properly substantiated. The program manager's approval is also necessary before resources can be expended for purposes other than those of the program.

The program manager bears full responsibility for (and reports to the General Manager on) the scheduled and complete implementation of decisions approved by him personally or by a superior executive, for the timely referral to UETM's top management of matters requiring their attention, and for the performance of employees directly subordinate to him.

The implementation of goal-oriented programs is financed from the aggregate resources of the amalgamation; therefore one of the functions of its top management is to allocate, coordinate, and control the utilization of resources. A specialized functional body was established for this purpose at UETM: the department for planning, coordination, and control of the introduction of new technology. In the matrix organizational structure this department is engaged in the following tasks:

(1) It examines the assignments of the Engineering Department of the Ministry of the Electrotechnical Industry of the USSR and the proposals of external bodies for the design, engineering, and production of new technology. It also formulates a draft plan, balanced as regards volumes, schedules, and resources, coordinates this plan with UETM's planning bodies and functional unit managers, and submits a draft plan of the development and introduction of new technology for the approval of the Director for Engineering.
(2) It studies and coordinates the schedules and resources of plans related to R&D for new technology, the engineering preparation of production, and the production of new items and program plans.
(3) It obtains information from department managers and chief executives about the progress of plans, analyzes this information, and submits proposals to department and program managers for the required adjustments to the plans and to the measures aimed at elimination of deviations from plans.
(4) It considers the suggestions made by department and program managers about amendments to plans, coordinates them with the managers concerned, approves amendments to plans for work that is not included in the programs, and introduces the necessary corrections in the plans of functional units.

(5) It keeps the accounts for work related to the design and production of new technology.
(6) It prepares documentation connected with the appropriation of bonuses from the centralized bonus funds and with the introduction of new technology in projects not included in the programs, it assesses the completeness and relevance of this documentation, submits it for the approval of the Director for Engineering, and coordinates it with a superior-level organization.
(7) It provides for the necessary reports and decisions of the Council for Project Assessment, for collection and duplication of the material, for notification of the Council members of the time and agenda of sessions, and for the keeping of the Council's files.
(8) It provides for the preparation, registration, and duplication of general and technical documentation for program managers, for the collection and processing of information for program managers, and for the organization of meetings called by program managers (notification of participants, taking of minutes, formulation of decisions, etc.).

In accordance with the objectives set for the department of new technology planning, its manager is granted the following authorities:

(1) He may apply to department managers and chief executives for proposals relating to the development and manufacture of new technology and he may make the necessary corrections to the plan.
(2) He may demand from department managers and chief executives the accounting documents (specifying the required format and time of presentation) concerning the results of the work accomplished.
(3) He may confirm the fulfillment of the parts of department plans related to the work included in the programs.
(4) He may inform the functional unit managers and the Director for Engineering of the need for administrative measures relating to department managers for the elimination of deviations from the plan.

The employees of the department for planning, coordination, and control of the introduction of new technology are responsible to the Director for Engineering for:

(1) The timeliness of the elaboration and submission for approval of plans (and corrections to plans) for the development and production of new technology.
(2) Timeliness in the presentation of progress reports.
(3) The correctness of calculations of volumes, schedules, and resources connected with the development and production of new technology.
(4) The completeness and reliability of information presented.
(5) Timeliness in notifying the functional managers and the Director for Engineering of the need for interference in order to prevent or eliminate deviations from the plan in the course of work.
(6) The implementation of decisions of the General Manager, the Director for Engineering, and the Council for project assessment.

The implementation of a program often requires the involvement of a large number of participants, and the program manager cannot keep in direct contact with all of them. In view of this, the program management system introduced the category of ***chief executives***. The purpose of this functional level is as follows. All the participants in the program whose job results do not directly influence the objectives or schedules of implementation of the program (or its phases) do not report directly to the program management. They are directly subordinate to their line manager, who sets objectives for them, to orient their decisions, and provides methodological guidance for their activities. It is this manager who is given the status of chief executive, and in the context of the program plan he becomes an element in the functional relationship with the program manager.

Chief executives are usually assigned to all the jobs that are included in the program and performed within independent structural units of the management and production systems. A candidate for the role of chief executive is usually nominated by the manager of the corresponding department and is then considered

and approved by the program manager. The chief executive is officially appointed by the General Manager when the aggregate program plan is adopted. The grounds for appointing an employee as chief executive are his professional competence in relation to the program jobs and his possession of the authority (consistent with his position) for line and functional supervision of the work performed by other executives.

In the line subordination a chief executive reports to his superior manager (concerning fulfillment of the plan in terms of purpose, content, volume, schedule, resources, direct accountability, reward and punishment – as far as the organization of work is concerned), and in the functional relationship he reports to the program manager (on the content and nature of decisions concerning the program, as well as on methods of their development and on the content and character of management information). When a chief executive is assigned jobs connected with only one program, he may be transferred into direct line subordination to the program manager.

The functions of each chief executive are defined in the context of the character and content of his objectives and flow from the responsibilities fixed in his position description and his department's "charter". In addition, a chief executive performs some organizational functions stemming from the program management mechanism:

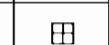
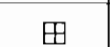
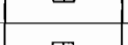
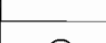
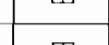
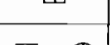
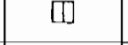
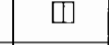
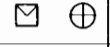
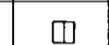
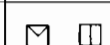
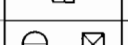
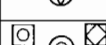
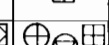
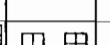
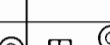
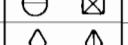
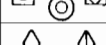
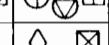
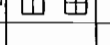
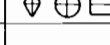
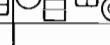
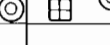
(1) He submits progress reports in the required format and at the required time to the department for planning, coordination, and control of the introduction of new technology. He reports possible deviations from the plan in good time and submits to the program manager (at his request) explanations for deviations from expected results.
(2) He also informs the project manager and his superior manager of the need for adjustments in the plan relating to schedules and resources, if there are sufficient grounds for these changes.

6.4. Specific Features of the Matrix Structures and their Efficiency

The bodies of goal-oriented engineering program management mentioned in the previous section may effectively function, within the line-functional structure, only if managerial functions are thoroughly distributed among individuals and units for the duration of program implementation.

Figure 6.3 contains a typical redistribution of functions consistent with the job and unit descriptions used at the UETM amalgamation, and could well be applied to management systems of different goal-oriented programs of economic, social, and product quality improvement, etc. The chart illustrates the delegation of decision-making authorities to lower management levels (e.g., the functions of goal-oriented engineering program leaders and responsible officers), while the key strategic questions remain the prerogative of the uppermost level. It can also be seen that such managerial functions as decision making, administrative direction, and coordination are no longer duplicated. Only those functions that are easy to monitor from above and that do not affect the decisions made are distributed among several officers or bodies. This approach ensures the required organizational level of managerial interrelationships, a correct understanding of the goals faced, and a balanced responsibility for their accomplishment.

The redistribution of functions should also entail a new status for each person or body within the management system with regard to their responsibilities and authorities. The matrix shows that some persons acquire increased powers and new responsibilities relative to implementation of the engineering program. However, in other functional activities their subordination and powers remain unchanged. This creates a certain instability in managerial relationships, promotes informal relations, and requires higher professional competence from individuals whose status can change upwards or downwards. The introduction of program management systems requires extensive preparation, not only in the organizational and legal spheres, but also in the psychological sphere.

Amalgamation's management organs \ Stages of work and program of management system's functions	Formulation of program plan	Control of plan fulfillment	Correction of plan	Motivation and plan execution assessment	Preparation and taking of organizational and technical decisions of type I	Preparation and taking of organizational and technical decisions of type II	Preparation and taking of organizational and technical decisions of type III	Program implementation
General manager (director for engineering)								
Council for assessment and implementation of projects								
Director for engineering as manager of technical services								
Deputy general manager and director for engineering								
Manager of goal-oriented engineering program								
Department for planning, coordination, and control of new technology introduction								
Managers of functional units – contributors to program								
Chief executives								
Planning bodies of functional units								
Control and regulatory functional units								
Managers of support units and services								
Executives								

Symbols:

Figure 6.3 The distribution of a project's basic management and implementation functions among the bodies of the amalgamation's management.

Experience at UETM revealed that special emphasis must be placed on the selection of goal-oriented program leaders. Although their assignment is only temporary, their high status and authority imply a high level of responsibility.

To ensure the maximum proficiency of program leaders and the maximum efficiency of the entire matrix management mechanism, the UETM amalgamation broadly employs a network planning and management system for the development and introduction of new technologies. The work in this area is distinguished by a large number of varied activities and contributors that cannot be properly standardized. Accordingly, the R&D plans are always uncertain with respect to timing and resources.

World experience has shown that the best method of managing this kind of project is by network modeling and minimization of the length of critical paths. No program plan is approved by the Chief Executive of the amalgamation unless the appropriate network chart is presented.

Depending on its volume and complexity, each activity may be carried out according to a separate, more detailed plan. The development of network charts, the calculation of critical paths, and the estimation of the time for completion and introduction of changes into the plan require extensive participation of the organizational development and CBMS center employees.

The matrix management of innovations, the elaborate allocation of functions, authorities, and responsibilities among the operating and newly established bodies, and the broad application of the data-acquisition system and computer technology to monitor progress have made it possible to accelerate substantially the technological advance at the amalgamation and to achieve substantial increases in the efficiency of new technology.

It should be noted that the development of a management system for goal-oriented engineering programs at the amalgamation is not yet over. Although the general methodological and organizational solutions regarding the system structure as a whole have been found, the specific management organizational forms of various programs and the mechanism of relationships between the established and new services and units have still to be developed.

Practice has shown, for example, that the leaders of the most complex projects need a small functional office staffed by

the most qualified specialists, as well as by administrative personnel and public representatives. This office must quickly solve some of the simpler problems (the solutions later go for the approval of the Project Assessment Council), secure more effective supervision of responsible officers at all levels, and develop and apply certain administrative measures for influencing amalgamation employees.

This is how, for example, the order for the manufacture of hydraulic generators for the Nurek hydraulic power plant was executed. First, the project was given the green light. The teams at the parent plant – the manufacturer of the generators – and the installation teams at the Nurek hydroelectric plant challenged each other to a program of "socialist emulation". As a result, the development and production processes were significantly accelerated and the first generators were manufactured, installed, and put into operation well ahead of schedule.

The efficiency of horizontal management of the development and introduction of new technology can be clearly proved by comparing the results of two job-organization options.

Thus, the development and introduction of a unified system of aerial, high-voltage switches went on for six years. This project involved a great number of research institutes, design and technological bureaus, laboratories, and production units. Activities were managed around the line-functional principle on the basis of a vertical hierarchy. All the problems were solved exclusively at the top level, since the engineering design and part of the research were carried out at the Lenin All-Union Electrotechnical Institute, the technical documentation was developed at the research institute attached to the amalgamation, the start-up and monitoring of the order were the responsibility of the plant's designers and production engineers, pilot samples and prototypes were manufactured by pilot and production shops of the parent plant, tests and research were carried out at the research institute, and the development batch and installation were the responsibility of the production services. This procedure of project implementation, where there was no single manager responsible for the entire project, resulted not only in a longer lead time, which extended beyond schedule, but also in a number of mistakes and failures.

A quite opposite example is provided by the development of high-voltage thyristor blocks for direct-current power lines, where a matrix management structure was employed. It took less than a year to carry out the research and design, to develop the technology, and to manufacture for the first time in the USSR unique devices for converting extra-high alternating current into direct current. With the old management system, this volume of research, design, technological, and other activities would have taken three to four years. It is worth pointing out that the job structure and relationships were nearly the same in this case as in the first example (with the involvement of the Lenin All-Union Electrotechnical Institute, factory designers and researchers, production engineers, pilot and production shops, etc.).

The horizontal management structure made it possible to develop engineering documents for, and to manufacture and deliver, the 240 $MW_{thermal}$ generator to the Ust–Ilim power station construction site in a short period of time. Several other examples of the effective application of project matrix management structures could be cited. Experience of the successful application of goal-oriented engineering programs for managing the development and introduction of new technologies has provided the amalgamation with solid grounds for applying this form of organization more extensively and for shifting exclusively to matrix management structures.

CHAPTER SEVEN

The Management System of the Goal-Oriented Environmental Protection Program in the Latvian SSR

7.1. The Role of Environmental Protection Programs

The problems of environmental protection and the rational use of natural resources have, in recent years, been at the center of attention in the USSR. They are regarded as tasks of national priority, requiring the concentration of considerable resources, a scientifically sound approach to the development of environmental protection measures and to the utilization of natural wealth, and the appropriate large-scale organizational and management changes.

Leonid Brezhnev noted that "there are different ways of using nature. One can leave in one's wake barren, lifeless expanses that are inimical to man – the history of mankind knows many such examples. But it is possible and necessary to improve nature, to help it unfold its vital forces more fully." The law adopted by the Supreme Soviet of the USSR in 1972, the decisions of the 25th Congress of the CPSU, and the special decrees of the leading state bodies on various aspects of environmental

protection have determined that this problem should be approached as a task of state importance, requiring the allocation of large funds for its solutions and enormous development work at different levels and in various spheres of activity.

Environmental protection measures and the rationalization of the use of resources are being carried out in many different directions. At present, they are designed and implemented according to various national economic plans, such as national economic, branch, and regional plans for environmental protection, schemes for the comprehensive protection of the environment and the rational use of natural resources, and goal-oriented programs of environmental protection. These plans are characterized by the following features.

The plan for environmental protection is a totality of targets worked out by Gosplan and the planning committees of Union republics, together with assignments of tasks and allocations of resources to specific organizations for environmental protection measures by branch (republic) ministries and agencies, by bodies of the Soviets of People's Deputies, and by industrial, city, agricultural, transport, and other organizations. At present, the plan for environmental protection measures is being developed at branch and territorial levels. It is coordinated with the overall plans for capital investment and for increased production capacity.

The scheme for comprehensive environmental protection and rational utilization of natural resources is a preplanning document containing scientifically based elaborations of environmental protection measures aimed at the solution of environmental problems in a certain region; it serves as the main guide in the formulation of final plans for environmental protection measures. This scheme should be regarded as a basis for the long-term planning of environmental protection measures. At the same time the scheme is a part of the comprehensive program for environmental protection and the rational utilization of natural resources. It specifies environmental protection measures at a regional level.

The program of environmental protection measures is a set of documents for future (medium-term) planning, oriented toward the achievement of the final goal (the solution of ecological problems). It coordinates environmental protection measures

with the rational utilization of natural resources, determines the content and the schedule of implementation of measures, and assigns the responsibility for implementation of the program to specific organizations. This program is a planning document whose enactment is obligatory. For this purpose it is necessary to coordinate it completely with the branch and republic plans for capital construction and financial, labor, and material supply.

The types of planning mentioned serve different functions in the solution of environmental protection problems. The scheme is a scientific elaboration of environmental protection measures from the point of view of ecological problems. The goal-oriented program links all the environmental protection measures into an integrated system and envisages all the activities, from R&D to planning, organization, and implementation. The plan transforms the program into targets for existing organizations and allocates appropriate resources to them.

Elaboration and implementation of goal-oriented programs plays the most important role in all the planning and management activities in environmental protection. This follows from particular features of the environmental protection activities and of the rational use of natural resources, such as the following:

(1) The effective implementation of environmental protection measures requires close coordination of current activities with regard to final program goals.
(2) Environmental protection problems are of an interbranch and interagency character, owing to the unity and interrelationship of all the elements of an integrated ecosystem. Measures for the protection and use of water, land, forest, and other resources, as well as of wild life, cannot be elaborated and implemented separately according to administrative and territorial divisions.
(3) The spatial dividing lines of problem situations (in river basins, zones of air pollution, in large tracts of forest, etc.) may not correspond to the existing administrative, economic, or territorial boundaries. It is therefore impossible to assign the task of implementation and control of environmental

protection activities to a single, responsible administrative unit.

(4) The appearance and solution of problem situations may not coincide with the adopted system of one- and five-year planning cycles or with the elaboration and implementation of national economic plans.

The planning documents that can be developed, with due account of these specific features, are goal-oriented programs for environmental protection. However, these programs cannot replace branch and regional plans for environmental protection and the rational use of natural resources, since organizations actually make economic use of natural resources and create a human impact on the environment at branch and regional levels. Therefore, it is necessary to coordinate goal-oriented programs for environmental protection with branch and territorial plans on the basis of a program management approach.

Nationwide environmental protection activities can be described as a hierarchy of programs, both national and regional. The latter can be classified according to different dimensions:

(1) Administrative (comprehensive republic, *oblast*, and city programs, etc.).
(2) Ecological zone (a program for the purification and the rational use of a river basin, or a program for the protection and rational use of a large forest or mountainous tract, a land area, etc. regardless of its administrative affiliation.
(3) Problem of installation (programs to restrict the impact of pesticides, to rehabilitate an animal population, to set up purification installations at a particularly large enterprise, etc.).

The present strategy is to elaborate gradually a set of linked, goal-oriented programs based on different dimensions and having different degrees of urgency and priorities with a view to their eventual amalgamation into a single system of environmental protection measures.

7.2. The Environmental Protection Program of the Latvian SSR

The Latvian SSR, one of 15 Union republics of the USSR, has an area of 63700 km^2 and borders on the Baltic Sea. Its population is 2530000 people. The leading branches of industry in the republic are transport engineering, the electrotechnical industry, radio engineering, instrument making, the knitwear industry, and the meat-and-dairy and fishing industries. Agriculture is advanced, specializing mainly in beef and dairy cattle and hog breeding.

The republic is situated in the zone of temperate continental climate affected by the air masses of the Atlantic. The annual precipitation is 600–700 mm. About a quarter of the territory is occupied by mixed forests and turf–podzol soils are predominant. Soil drainage increases the amount of arable land. The relief of the territory is mostly plains. The total length of rivers is approximately 4500 km, the most important rivers being the Western Dvina, the Lielupe, the Gauya, and the Venta. The republic is rich in lakes. The economy and ecology of the republic are greatly influenced by the Baltic Sea, with its ports free of ice all year round and with its fishing trade.

There are 56 cities in the republic, the largest of which are Riga (population 765000), Daugavpils (107000), Liepaja (97000), Elgava (56000), Yurmala (56000), Ventspils (43000), and Resekne (33000). There are also 35 settlements of city type. The rural population comprises 36% of the total.

Since the adoption of government environmental decrees a whole set of measures aimed at the prevention of negative impacts of human activities on nature have been carried out in the Latvian SSR. Although in the republic as a whole there was no immediate ecological danger and significant deviations from the approved standards of quality of air, water, and soil were observed only in certain isolated cases and periods, nonetheless the long-term task of environmental protection has been established. Accumulated experience and practice confirm that a problem of such a great scale as environmental protection and the rational use of natural resources cannot be effectively solved by dispersed efforts, and that a system of separate measures planned for

different natural resources and spheres of the ecosystem does not guarantee the desired results. New conditions required the creation of a new interbranch system to coordinate the economic use of natural wealth and resources with environmental protection.

In accordance with the Decree of the Council of Ministers of the republic a comprehensive program, *Protection of the Environment and Rational Use of the Natural Resources of the Latvian SSR for 1976–1990*, has been worked out. It is a system of interrelated and coordinated economic, production, organizational, R&D, and social plans for activities intended to achieve considerable improvement in the state of the environment. The implementation of the plans, already at the first stage in the tenth five-year period, requires the expenditure of 827 million rubles. The comprehensive program includes a list of the main targets in every aspect of environmental protection, the totality and schedule of activities, the definition of required funds, the assignment of program tasks to specific organizations, the timing of their fulfillment, and the expected results. The program required the participation of a large number of organizations belonging to different branches and agencies, not only at republic, but also at Union and Union–republic levels.

As guidelines for developing comprehensive programs of environmental protection and the rational use of natural resources the following classification scheme has been adopted [46].

A comprehensive ***program*** is a list of a whole set of interrelated socioeconomic, production–technological, R&D, and organizational measures for the protection and rational use of the environment, together with calculations of the necessary resources, identification of the participants, and timing of the realization of the measures. The implementation of the measures ensures the achievement of stated program objectives, based on the scheme for environmental protection and the rational use of natural resources.

A ***subprogram*** is a composite part of the comprehensive program characterized by one objective, homogeneity of the sphere of activities, and relative independence of implementation

(e.g., a subprogram for the protection of an air basin as a part of the comprehensive program).

Program activity is the main component of a subprogram and is characterized by distinct, quantitative criteria for its implementation in relation to the solution of a problem situation by a group of participants appointed on the direction of higher authority and allocated resource support. (One example here is "drainage of waterlogged forest territories over an area of 240000 ha".)

The initial stage in forming a system of program management is the definition of program objectives. The general long-term purpose of the program is to ensure the necessary ecological conditions for social production and for the normal activities of the population of the republic through conservation and all-round development of the resources of the environment.

In the first stage of the realization of the long-term program, covering the tenth five-year period, a more specific objective has been established to ensure a considerable decrease in the negative impact of industry, agriculture, and other branches of the national economy on the environment: the protection and improvement of the natural resources of the Latvian SSR. This objective is divided into second-level subgoals, which include the following:

(1) To rationalize water consumption, to decrease sharply the discharge of polluted effluent into open water reservoirs, and to create conditions to stop completely the discharge of untreated effluent by 1985.
(2) To decrease by 1980 the total discharge of pollutants into the atmosphere by enforcing standards for the concentration of pollutants of all types in the air basin.
(3) To expand the arable area through soil improvement, irrigation, recultivation, and implementation of the program of soil erosion control.
(4) To ensure speedy reproduction of forest resources and conservation of their water-protection and erosion-control qualities.

(5) To expand reproduction of the fish population and to increase the fish resources of natural water reservoirs and other water-storage bodies.
(6) To ensure conservation, expansion, and regulation of the development of the ecosystem by eliminating the unfavorable impacts of economic activity.

It was considered expedient to set up a three-level structure of goals and types of program activities. The overall objective corresponds to the whole program, the second-level goals correspond to subprograms, and the lowest level of goals corresponds to the program activities of the basic components of the subprograms.

The analysis of the set of measures of the program for environmental protection and the rational use of natural resources reveals the expediency of dividing all the subprograms into two major groups:

(1) *Subprograms of main activities* are aimed directly at the conservation, development, and rational use of particular types of natural resources in the following elements of the environment: the air, water bodies, land and soil, forests and plant world, mineral resources and subterranean waters, hydrobiological units, reserves and wild life, etc.
(2) *Subprograms of support activities* are aimed mainly at the creation of the conditions necessary for successful fulfillment of measures in the subprograms of main activities. It is recommended that this group should include the subprograms that provide material–technological conditions and that develop the construction potential for the realization of the comprehensive program: that is, the implementation of R&D activities; the development of control and monitoring systems; the provision of information support of programs for conducting research and making sound program-management decisions; the training of personnel to carry out activities envisaged by the program; the provision of ecological education and propaganda among the population; the administrative, legal, and organizational support of the program.

Together with the above-mentioned classification of types of environmental protection activities it is expedient to single out *problem situations* as a main element in the schemes for environmental protection. The problem situation should be regarded as a starting point for one or several program activities included in subprograms of the main activities.

In conformity with the specific character of the Latvian republic program a list of subprograms of main and support activities was adopted (*Figure 7.1*). Each of these subprograms has its own goals and several hundred concrete measures mapped out for realization in the tenth five-year period. Among the subprogram activities projected for the tenth five-year period are: the construction of water purification installations in the Moscow district of the city of Riga (with a capacity of 42000 m^3 per day), at the Sloka cellulose and paper plant (120000 m^3 per day), and elsewhere; the setting up of gas and dust trapping installations at the enterprises of the Latvian Ministry of State Agricultural Purchases (with a total capacity of 2745000 m^3 of gas per hour), at the Valmiery mixed feed plant (400000 m^3 of gas per hour), and elsewhere; artificial forest rehabilitation over an area of 52000 ha; the draining of marshy forest tracts over an area of 83000 ha.

The implementation of these large-scale measures was intended by 1980 to decrease the volume of polluted effluent discharged into open water reservoirs in the republic by 21.4%, to decrease the total discharge of harmful substances into the atmosphere by 8.5%, to expand the area of drained land by 34% and of irrigated land by 107%, to increase the stock of valuable edible fish in natural water bodies by 68%, to reforest artificially an area of 42000 ha, to take stock of protected territories, and to prevent the degradation of demonstration ecological plots and national parks. The planned rates of growth of environmental protection activities for the given planning period are appropriate, since with the expansion of production activities the growth of pollution is being restrained and the state of the environment is being considerably improved. Thus, a solid basis will be established for achieving the final objectives of the subprograms and the whole comprehensive program during the subsequent period.

The elaboration of program activities included the design of various alternatives, allowing for the comparison and choice of

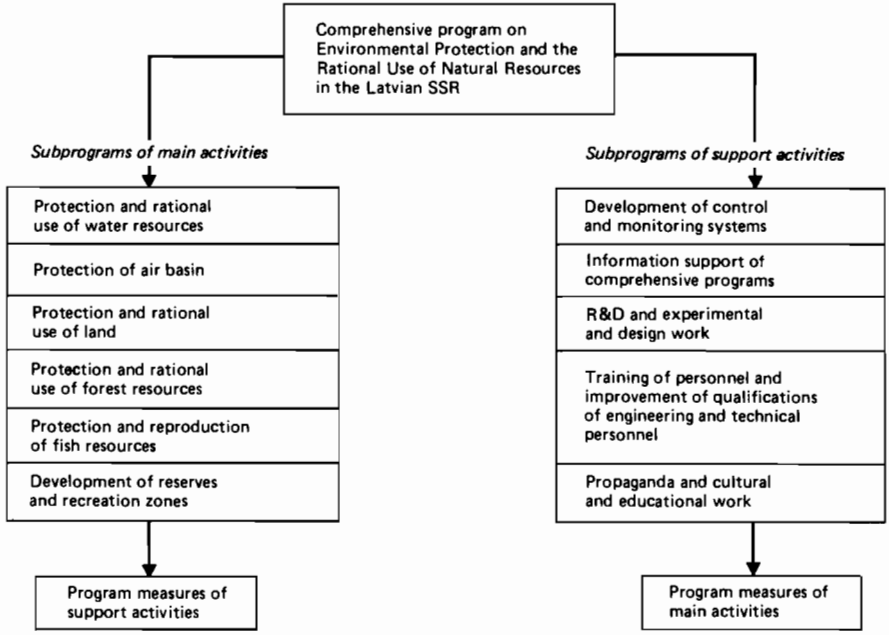


Figure 7.1 General structure of the program for environmental protection and the rational use of resources in the Latvian SSR.

more effective and economically sound decisions and for the coordination of environmental protection and production goals. Thus, for instance, the assessment and analyses of the subprogram "Protection and rational use of water resources" have shown that by traditional methods alone it would be impossible to achieve the planned goals for ensuring a rigid economy in the use of fresh water in all the branches of the national economy, while simultaneously achieving a sharp decrease in the discharge of polluted water into open water reservoirs. Taking this into account, an alternative has been chosen that provides, together with an increase in the capacity of purification systems, a considerable expansion in the use of recycled water and the implementation of technological processes aimed at reducing effluent and the degree of its pollution.

The most interesting measure in recycled water use is the establishment during the tenth five-year period of a system at the Daugavpils chemical fiber plant, with a capacity of 355 000 m^3 of recycled water per 24 hours, and a system at the Valmiery glass fiber works, with a capacity of 54 000 m^3 of recycled water per 24 hours. Both these chemical works will cease to discharge polluted effluent and will ensure considerable economy in utilization of water resources. Overall, by the end of the tenth five-year period the amount of recycled water should be increased by 86% compared to the 1975 level. During this period the share of recycled water in the total volume of water utilization should increase by 10%. Together with other water protection measures this will decrease the amount of polluted water discharged into open water bodies in the republic by 21.4%. Other subprograms were analyzed in the same manner.

7.3. The Organization of Program Management

In considering the problems of managing the environmental protection program in Latvia some difficulties were identified. The first problem is the great number of participants and their interrelationships due to the large-scale interbranch and interagency nature of such comprehensive programs. For the elaboration of the program alone it is necessary to involve over

200 R&D, design, and other organizations. Nineteen republic and 11 Union–republic ministries and agencies, 69 enterprises of Union subordination, 25 enterprises accountable to All-Union bodies, 27 district and seven city executive committees of Soviets of People's Deputies will participate at all the stages of formulation and realization of subprograms and program activities. The second problem is that among the organizations who produce negative impacts on nature and who use natural resources, there are enterprises and other organizations of both Union and republic subordination. This leads to the dispersion of decision-making authority in this field among different levels of economic administration. The third problem is the necessity to integrate all these activities because of the holistic nature of the ecosystem; with regard to management this requires the concentration of authority and responsibility and their appropriate distribution among program participants in accordance with their place in the program structure [47].

The important point is that the set of bodies that deal with environmental protection in the republic did not comprise a comprehensive management system. Therefore, they could not provide effective management of the comprehensive program from its scientific elaboration to its practical implementation. The department of environmental protection of Gosplan of the Latvian SSR, a planning unit established at the beginning of the 1970s, could not solve all the problems of implementation and coordination of activities in the sphere of environmental protection. A commission on environmental protection under the Council of Ministers of the Latvian SSR possessed sufficient authority, but it could not effectively discharge the activities owing to the absence of an authoritative middle layer of management that could become a connecting link between specific program participants at lower levels and the top republic executive level.

The application of a goal-oriented program approach to the problems of nature protection and the rational use of the natural resources of the republic raised the elaboration and planning of environmental protection activities to a new level and demanded new organizational decisions.

The organizational structure of program management should ensure the effective performance of major management functions:

the provision of general management of the program and its integration into a unified set of interrelated activities; the planning and analytical elaboration of program measures and their linkage with the national economic plan and with the allocation and utilization of resources; goal-oriented implementation of program measures and control and feedback in the system of program management. The set of bodies, units, and positions carrying out these functions is shown in the scheme of program management bodies in *Figure 7.2*.

The scheme of management was based mainly on the use of already existing bodies of economic management of the republic. It is designed as a matrix system with line control over program participants proceeding vertically from the chief executive of the program through successive levels of the Commission on Environmental Protection of the Council of Ministers of the Latvian SSR attached to him, and the chief coordinators and responsible planners of subprograms. Horizontal influence goes through the department of environmental protection of Gosplan of the Latvian SSR and its curators.

Let us now examine the purpose and main tasks of the separate elements in the organizational system of program management, which is divided into the following major subsystems.

7.3.1. General Program Management

The subsystem of general program management should provide the overall administration of the program at all stages of its elaboration, planning, and implementation, together with the subordination of the separate environmental protection measures to end results and their integration into a total organizational system. It should be based on the unity of command and collective leadership principles and include the following elements.

The chief executive of the program is a person who bears the main responsibility for the realization of the whole program in the region. He is vested with the necessary power to make the most important decisions at all stages in the elaboration, planning, organization, and implementation of the program. The chief executive of the program should be appointed by a sufficiently high authority to provide him with the necessary rights to direct

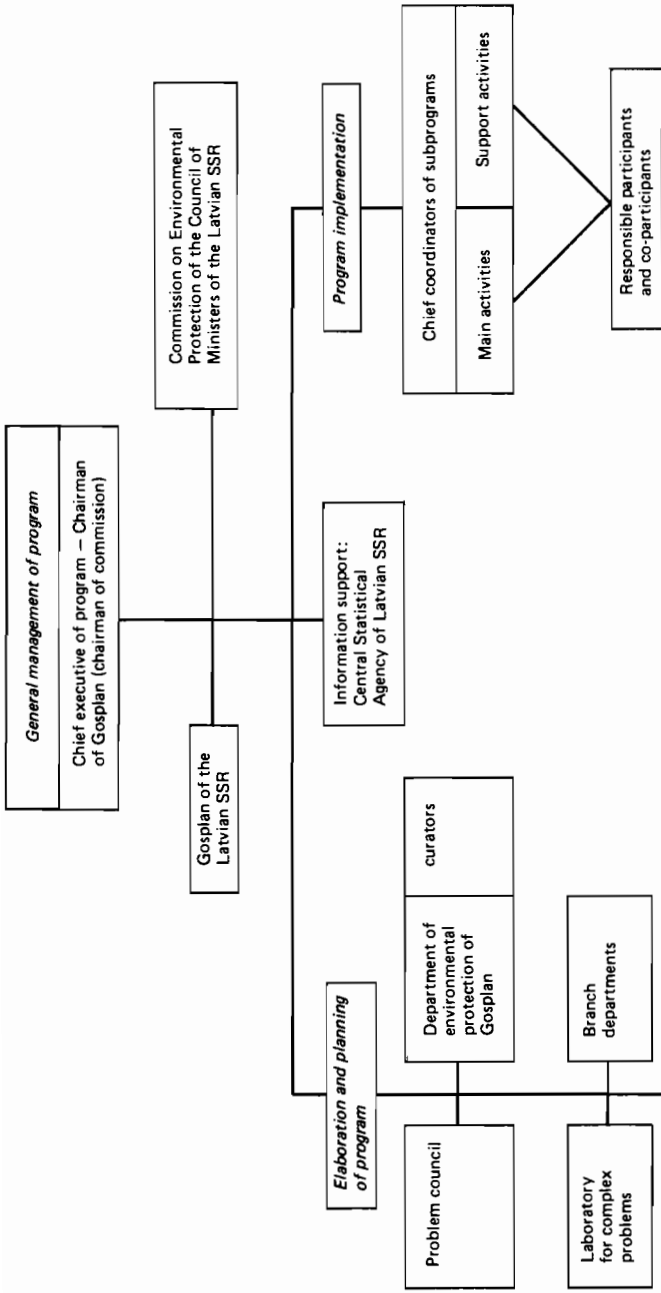


Figure 7.2 The organizational structure of program management.

program participants and to be a chairman of the commission supervising the program.

It was decided that, because of the interdepartmental and multibranch character of the program, general administration could be effectively carried out only at the level of the Council of Ministers of the republic (though for some other programs the level of separate ministries and agencies might be sufficient). General supervision of the comprehensive program was therefore assigned to a deputy chairman of the Council of Ministers, who is also chairman of Gosplan of the republic. He is the chief executive of the program, the person who has the most responsibility in the republic for the implementation of the program at the highest level of authority.

The commission on program management is the program's main collegiate body. It defines objectives and measures for the program, approves plans for its implementation, and organizes and controls the course of its realization. The main purpose of the commission is to ensure joint decision-making concerning the most important problems of the program. It should therefore be staffed in such a way as to have representatives of all the organizations (including large-scale enterprises) whose activities create problem situations or assist in their solution. These representatives should be executive officers of organizations and possess sufficient authority to make decisions in relation to their organization in the course of the commission's work.

The permanent members of the commission are the chairman of Gosplan of the Latvian SSR (the program's chief executive), his deputy, the ministers for forestry and the timber industry, for soil improvement and water economy, and for agriculture, the chief sanitary inspector of the republic, the vice-president of the Latvian Academy of Sciences, the first deputy chairman of the Society for Conservation of Nature and Historical Monuments of the republic, the director of the scientific research planning institute of Gosplan of the Latvian SSR, and the minister for higher and special secondary education. The coordinators of the chief subprograms are enlisted members. When necessary, other executive officers and participants of the program are included in the commission.

The *staff body* of the subsystem of general program management is a special unit with one or more employees that provides information and analytical services to the chief of the program and the commission. In the present program this job is done by the department of environmental protection of Gosplan of the Latvian republic.

7.3.2. Program Elaboration

The subsystem of program elaboration should organize the whole set of activities in program elaboration, from schemes for the rational use of natural resources to concrete program measures intended for inclusion in the national economic plan. It should ensure the coordinated implementation of scientific solutions to the problems of protection and rational use of the environment, and should carry out perspective planning and forecasting of program activities.

The main role in this subsystem is assigned to Gosplan of the republic. Attached to it is a *problem council* for the elaboration of the comprehensive program; this consists of representatives of the major scientific institutions, ministries, and agencies that develop general strategy in environmental protection and who fulfill the functions of head planners of subprograms. Together with Gosplan of the Latvian SSR, the problem council formulates program and subprogram problems and defines the character of and assesses the most important environmental protection measures. It selects head planners and sets initial targets for program elaboration. In addition, a council of scientific experts has been established under the Latvian Academy of Sciences; this council includes prominent scholars and representatives of academic institutions, universities, and institutes. It deals with scientific problems concerning the protection of the environment and the rational use of natural resources.

This subsystem also includes a head program planner: the Gosplan scientific research institute of planning. It provides scientific guidance for program elaboration activities, ensuring proper consideration of problem definition; it also assesses the methods of problem solution and provides overall coordination of planned measures. This institute provides functional guidance to

organizations developing program measures for the solution of particular ecological problems.

This system has made it possible to coordinate the activities of the many scientific research institutions and design organizations that are involved in the elaboration of the subprograms, and to prepare in a short time (approximately one year) a detailed plan of the comprehensive program.

7.3.3. Planning Subsystem

The ***planning subsystem*** should ensure the integration of the environmental protection measures recommended by appropriate schemes into the national economic plan, as well as control of their implementation through the use of the established planning mechanism. This subsystem consists of the following components.

The regional planning body is a department responsible for environmental protection measures within the sphere of its responsibility and for the integration into the regional economic plan of all other measures (among them measures planned by the organizations of All-Union and Union–republic subordination). This function is carried out by the main staff body of the whole system of program management, i.e., the environmental protection department of Gosplan of the Latvian SSR. In close coordination with branch departments of Gosplan it develops plans for the comprehensive program of environmental protection, taking into account the corresponding section of the economic plan of the republic. It also coordinates the whole process of elaboration and planning of particular measures and sections of the comprehensive program.

As a program planning body the department carries out the following functions:

(1) Together with the head planners of subprograms it defines the list of targets that are related to environmental protection and subject to inclusion in the economic plan.
(2) It elaborates preliminary targets in corresponding sections of the economic plan and passes them to enterprises and

organizations of local, republic, and Union–republic subordination.

(3) It participates in balancing expenditures for environmental protection measures on equal terms with integrating departments for capital investment and for the economic plan.

(4) It controls (through corresponding branch departments of Gosplan) the appropriate expenditure of funds for environmental protection activities.

(5) It receives in proper time from branch departments draft plans for capital investments and the implementation of new facilities (including water purification installations) to be composed into an integrated plan for environmental protection.

The department also carries out control and administrative functions through newly appointed subprogram curators. *Subprogram curators* are responsible for the balanced definition of objectives, the coordination of activities, the rational allocation of resources within each of the spheres of activity, such as water resources, the air, land resources, and natural parks, covered by the program; they also have similar responsibilities in support subprograms. The curators also serve as a liaison with All-Union planning and management bodies. There are five curators in the department. Their main task is to ensure that actions in different program spheres are coordinated from the point of view of their final program objectives, both at the elaboration and planning stages and at the implementation stage. They should ensure feedback from implementation to planning of the program by influencing the system, mostly through the national economic plan, rather than through direct administrative control.

Acting on behalf of the program chief executive the curators carry out their functions through the chief coordinators of subprograms in head ministries and agencies, and take an active part in the work of program commissions established at their organizations. They prepare and submit to the chief executive of the program and his commission all interagency matters that require decision making at the highest level of program management.

7.3.4. Control and Monitoring Subsystem

The control and monitoring subsystem exercises control and monitoring in particular environmental spheres through the organs of the State Committee of Hydrometeorology and Control of the Environment of the USSR, the Ministry of Health Care of the USSR, the Ministry of Agriculture of the USSR, the Ministry of Fisheries of the USSR, the Ministry of Geology, and the State Committee on Forestry. These organs gather information on the state of the environment with the help of a control and monitoring network and, when necessary, they apply sanctions within the scope of their authority.

7.3.5. Program Information Subsystem

The program information subsystem includes the bodies of the Central Statistical Agency of the USSR and the subsystem "MIS–nature" set up in the framework of the republic's computer-based system of planning calculation. This subsystem primarily ensures the necessary planning and reporting of information on the environmental protection activities. Work is also being done on the setting up of a multipurpose data bank on the ecosystem of the region that will be used to elaborate environmental protection measures (including comprehensive schemes for the protection of the environment and the rational use of natural resources).

7.3.6. Program Implementation Subsystem

The subsystem of program implementation should ensure the implementation of program activities in environmental protection through industrial, construction, and other organizations by exerting administrative and economic influence over them and by controlling and coordinating their activities with regard to final program objectives. The subsystem includes the following participants.

Chief coordinators of subprograms are selected from among executives of the organizations (a republic ministry or agency, a department of a city executive committee, a large enterprise, etc.) that are responsible for the greatest volume of

work in the given subprogram or that possess high competence in the particular problem area. The chief coordinator carries out a double function:

(1) He is an executive for environmental protection activities of the subprogram in his agency and in this respect he has authority and responsibility according to his position in the agency.
(2) He is a coordinator of all the activities of the subprogram and in this capacity he carries out a number of specific functions and is vested with additional authority to exercise functional guidance over the responsible participants in the program activities of the subprogram entrusted to him.

In his activities the chief coordinator uses the authority of participating organizations and the executive committees of local Soviets for the effective and timely coordination of the work of All-Union and Union–republic enterprises participating in the subprogram. To carry out his functions he must have adequate supporting staff.

Responsible participants in organizations in the region are appointed in all the regional agencies, in the enterprises, and in the local bodies whose activities are related to the implementation of the program measures. In the system of matrix management they are doubly subordinate: vertically to their line manager and horizontally (functionally) to the chief coordinator of the appropriate subprogram. They carry out their functions through personal contacts with their line manager and with the program managers, thus minimizing direct contacts between them. The responsible participant plays a leading role in the program management, since he directly organizes the implementation of program activities entrusted to his agency (enterprise).

In the systems for management of regional programs it is also expedient to appoint *responsible participants in higher bodies* (All-Union, Union–republic, republic) that supervise enterprises located in the region. Their main roles are: to ensure the realization of environmental protection measures that are integrated into the national economic plan and that are being implemented by enterprises subordinate to them in the territory

of the region; to inform regional bodies of program management of the intended changes in good time; and to coordinate with these regional bodies any actions that bring about considerable changes in program activities.

At different levels of the implementation subsystem (as well as the elaboration and planning subsystems) it may become necessary to strengthen coordination of interrelated matters. For this purpose permanent committees can be set up; these committees are regarded as working bodies for the consideration and making (within the limits of the authority of their members) of decisions that require thorough interagency and interbranch coordination in their implementation.

7.4. Conclusions

Thus, the described organizational system for program management makes it possible to coordinate the activities of regional, local, and All-Union bodies that use natural resources and implement environmental protection. However, it should be taken into account that this organizational mechanism of program management is only a part of the general mechanism of environmental protection. Other means of directing program planners and participants are no less important, especially where there is no direct or indirect organizational subordination to the bodies of program management. Among such means of direction are:

(1) The national economic plan, which has the status of a legislative decision and into which environmental protection measures in the region are integrated according to planned volumes and schedules.
(2) Legal control through the application of appropriate sanctions for deviation from the established standards concerning the state of the environment and for failing to fulfill environmental protection measures.
(3) Administrative control through the inclusion in the organizational system of regional program management representatives from higher administrative bodies that control the program participants.

(4) An economic mechanism for implementing environmental protection measures that transfers a certain share of resources for environmental protection to the heads of corresponding subprograms, and makes the financial position of an enterprise more dependent on its implementation of planned tasks for environmental protection.
(5) Moral influence on executives and on the collectives of enterprises and other organizations through party and public channels.

A comprehensive approach to program management (i.e., the use of the whole set of planning, economic, legal, and other means of direction, together with organizational means) is the basis of a modern system for the implementation of environmental protection activities, which has still to be developed fully.

The proposed organizational system embraces and integrates all aspects of the formation and implementation of the comprehensive program. Its specific feature is the strengthened role of Gosplan of the Latvian SSR in this process, with a simultaneous redistribution of functions and objectives in the system of line management of program activities. The system as a whole works on the basis of combined vertical and horizontal management, i.e., according to the principles of matrix management structures, where top management delegates to a lower-level unit the authority to direct program participants horizontally and not vertically. Gosplan of the Latvian SSR can be regarded as one such lower-level unit.

The expediency of such an organizational option is determined by the fact that a comprehensive approach to the protection and rational use of the environment in Latvia is quite new and requires the finding, elaboration, and mutual coordination of new and nontraditional measures. Consequently, the central role in program management should be given to planning (to Gosplan). In the system of Gosplan of the Latvian SSR the necessary experience and potential has been accumulated for the effective application of goal-oriented program management, particularly in environmental protection programs. The necessary information is also concentrated here, and Gosplan has been entrusted with the elaboration of a republic computer-based management information

system ("RASU-Latvia"). Conditions have been created for the setting up of a laboratory for comprehensive environmental problems, together with the scientific research institute of Gosplan. Channels and forms of environmental protection activities have been worked out for interaction with the All-Union bodies that influence the implementation of environmental protection measures in the republic. The chairman of Gosplan is a deputy chairman of the Council of Ministers, which establishes an administrative and legal foundation for exerting their influence on ministries and agencies engaged in the present program, along both functional (planning) and line-administrative directions.

Of considerable significance is the fact that such an organizational option seems to be the most economic with regard to the level of administrative and management expenditure for the program, since it does not result in any considerable increase in the size of administrative staff.

It should be emphasized that the described organizational system is sufficiently flexible for its main principles and central elements to be duplicated in the establishment of similar bodies for environmental protection and the rational use of natural resources in other regions.

At present, the Council of Ministers of the Latvian SSR has decided that this comprehensive program of environmental protection and the rational use of natural resources, including the organizational system for its management, will promote the most effective solution of new tasks, both in the protection of the environment and in the wider application of goal-oriented program methods in planning and managing the socialist national economy.

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