

COMPUTER BASED MANAGEMENT SYSTEMS  
(Some systems aspects of the planning and  
management of the production complex)

Bohumil Mazel

June 1976

Research Memoranda are interim reports on research being conducted by the International Institute for Applied Systems Analysis, and as such receive only limited scientific review. Views or opinions contained herein do not necessarily represent those of the Institute or of the National Member Organizations supporting the Institute.



## Preface

The objective of this study is to introduce the members of the IIASA team concerned with Management and Technology tasks to problems assessed as Computer Based Management Systems (CBMS) - a comparative study. As a conceptual basis for detailed understanding of the factors involved in production management decisions, some systems aspects of the structure of Automated Management Systems\* in the socialist and planned economy are discussed.

Each stage of development has its own mode of organizing social structure and systems of control. This paper discusses the principal areas of planning techniques and how they are applied in the socialist economy. The main interest is given to the characteristics of individual phases of the planning activity, namely integrity of forecasts to the long-term planning as a principal factor for modern management in individual complexes.

Special features of the hierarchy of a planned system and a short classification of plans is given as a significant presumption for the further research study of Computer Based Management Systems. Explanation of the basic function of the planning activity as one of the subsystems of CBMS will help for a better understanding of the integrated structure of management and control under planned production economy.

The second part of the study briefly describes the other main subsystems of the CBMS which must be taken into consideration for the future research of the management systems in the industrial complex. According to the limited scope of this introductory study no detailed description was intended to be included here.

The purpose of existing research in this area has been to clarify functions of the decision-making process based on planning with a defined hierarchical structure of the national economy, especially of an enterprise as an integral part of the economical complex.

---

\* AMS = ASU in USSR and ASR in CSSR



## Table of Contents

|   | <u>Page</u> |
|---|-------------|
| Preface .....   | iii         |
| Abstract .....  | vii         |
| Systems Theory and Management .....                                     | 1           |
| Planning System .....   | 2           |
| Forecast of Basic Trends of Development .....                           | 3           |
| Concepts of Development .....   | 6           |
| Classification of Plans .....   | 6           |
| Brief Characteristics of Different Kinds of Plans .....                 | 7           |
| 1. Conceptual and Operational Plans .....                               | 7           |
| 2. Long-, medium- and short-term plans .....                            | 9           |
| 3. Time-fixed and Sliding Plans .....                                   | 10          |
| 4. Material and Financial Plans .....                                   | 11          |
| 5. National-Economy and Enterprise-Economy Plans .....                  | 12          |
| Basic Methods for Economy Development Planning .....                    | 14          |
| A. Method of Balances .....   | 15          |
| B. Method of Analysis and Synthesis .....                               | 15          |
| C. Comparative Methods .....  | 17          |
| D. Mathematical-Economical Models .....                                 | 17          |
| E. Method of the Basic Factor .....                                     | 19          |
| Basic Sources of Information for Planning .....                         | 20          |
| Superior Level Directives .....   | 22          |
| Organization of Planned Activity .....                                  | 23          |
| System of Standards .....   | 26          |
| Long-Term Planning for Development of an Economic<br>Organization ..... | 29          |
| One-Year Plan .....   | 30          |
| Automated Management Systems - Concept .....                            | 32          |
| Objectives and Goals of AMS .....                                       | 35          |
| Requirements Applied to AMS .....                                       | 37          |
| Management System and Subsystems .....                                  | 39          |
| Technical Production Preparation (TPP) .....                            | 39          |
| Sales .....   | 41          |
| Material Supply Subsystem .....   | 43          |
| Operational Production Control .....                                    | 45          |
| Economical Information and Accounting .....                             | 46          |
| Summary .....   | 46          |
| Bibliography .....  | 48          |



## Abstract

The purpose of this research is to identify the relative degree of centralization and integration of management within industrial sectors, in particular to clarify functions of the decision-making process based on planning. Special features of the hierarchy of a planned system and a short classification of plans and methods used is given. The main functions and objectives of Computer Based Management Systems are described with the typical structure of a production enterprise as a complex of subsystems having specific functions.





COMPUTER BASED MANAGEMENT SYSTEMS  
(Some systems aspects of the planning and  
management of the production complex)

Bohumil Mazel

System Theory and Management

Scientific and technological revolution is an objective process, the process of the development of society. Compared with the previous stages of development, management - particularly its scientific nature - has gained in significance. Strategic changes and interventions in the production programs and the production apparatus of economic organizations become evident within periods which with the entire acceleration of the real time of changes exceed the current capability of management.

The growing complexity of virtually all of the organizations with which people on different levels of management must interface has created a tremendous need for systems that can transform data into information for quick, efficient, decision-making.

The systems concept can be a useful way of thinking about the job of managing. It provides a framework for visualizing internal and external environmental factors as an integrated whole. It allows recognition of the proper place and function of subsystems.

The systems within which a manager must operate are necessarily complex. However, management via systems concepts fosters a way of thinking which, on the one hand, helps to dissolve some of the complexity and, on the other hand, helps the manager recognize the nature of the complex problems and thereby operate within the perceived environment.

It is important to recognize the integrated nature of specific systems, including the fact that each system has both inputs and outputs and can be viewed as a self-contained unit. The term system covers an extremely broad spectrum of concepts. L. v. Bertalanffy's definition of a system is "an organized or complex whole; an assemblage or combination of things or parts forming a complex or unitary whole." General systems theory is concerned with developing a systematic, theoretical framework for describing general relationships of the empirical world. Within the general theory and its objectives as background, we direct our attention to a more specific theory for information systems, a theory which can serve as a guide for management in a planned as well as a market oriented economy. Integrated decision making on the part of the specific hierarchy of management and control in a machine industry will be the subject of this Computer Based Management System comparative study.

#### Planning System

Planning may be considered as a recognition of objectively necessary and possible development.

The method of recognition is analysis of the state of the system and its environment in the present and preceding time periods. The analysis should establish the present state of the system, the main factors in its development and the relationships between them.

For example, the basic information for macroeconomic analysis consists of the data about the gross national product and its components including prices and wages, studies concerning tendencies in techno-economic progress, development of the structure of end demands etc. Analysis of the enterprise level is concerned with the quality and quantity of production output, present state and development of resources entering the production process (i.e. labor, materials and machinery), reserves and ways of utilizing them.

The methods of operations and system analysis are used to study these factors, their relationships and the behaviour of the system.

#### Forecast of Basic Trends of Development

Problems of planning change considerably if we leave the analysis of the past and try to deal with future situations. Then the model, e.g. a system of fixed relations between factors, becomes a tool for forecasting a situation which occurs in the planning interval under study with a certain probability.

Today the term forecasting is usually understood as both an independent scientific discipline and a practical activity. As a scientific discipline it comprises methods of other disciplines concerned with analysis of the future. Its goal is to present a theoretically based and empirically approved forecast of the future state of objective reality.

A forecast is a qualified prediction of the future, based on scientific knowledge and methods, and encompassing its processes, states and events, and their relationships. Its content is a probabilistic expression of the future stated with some degree of reliability. This distinguishes a forecast from a hypothesis which is only a probabilistic assumption of events which so far cannot be proved; an assumption which must be first tested and verified before it can become part of a forecast. In the context of controlled economic systems, forecasting becomes an integral part of economic planning as it offers information on the basis of which decisions influencing future development are made. Forecasting for planning an economy means to predict, on a scientific basis, the probable trend and the optimal use of those tendencies in science, technology and economy which are becoming apparant at the present time.

Forecasting for management of a national economy has two distinct features:

1. Factors and tendencies of change in economic structure which are important for the rate of economic growth may be expressed.
2. The targets and tools for the development of controlled systems of economy can be found in a setting aimed at an optimal solution.

The use of forecasting is, of course, meaningful only when the development is not unambiguously determined. (There exist more than one variant of development.)

The information obtained from a forecast includes the following:

- initial assumptions
- time horizons
- probability with which the forecast becomes true
- conditions needed for the forecast to become true
- other connections and consequences of development

An assumption of objective decision-making is the possibility of choice among several variants of probable future development. A forecast must therefore present a complex of variants of possible future events and the ways leading to them, which have been developed under precisely defined assumptions.

Forecasts are usually formulated in terms of alternatives and expressed quantitatively, and should serve as possible choices for the general goals of society. This assumes a synthesis of partial forecasts, usually elaborated for different time intervals, into a complex national-economy forecast developed for a period of more than 10 years.\*

---

\* A global forecast of development is synthesized from forecasting variants of: long-run development of science and technology, resources (labor and material), social demands (productive and non-productive), and material conditions of reproduction (growth of reproduction for development of demographic factors, etc.).

The importance of forecasting varies at different levels of management. In systems with a controlled national economy, the most important is macroeconomic forecasting which provides the basis for lower levels of management.

A forecast represents the first, so-called recognition, level of long-term economic planning. Its basic characteristic is that it does not include any directives or orders for lower levels of management and it is not a subject of approval.

Forecasts may be classified into groups according to the following criteria:

1. Subject

- social forecasts
- scientific and technological forecasts
- economic forecasts

2. Forecasting interval

- short-term forecasts (3 to 24 months)
- medium-term forecasts (3 to 10 years)
- long-term forecasts (over 10 years)

3. Degree of complexity

- national economy forecasts encompassing all features and connections of reproduction processes.
- partial forecasts concerned with some area of socio-economic development, such as living standard or reproduction of capital investments.

(The actual structure is even more complex. For example the national economy forecast includes the forecasts of inventions and their utilization, forecasts of innovations in materials and equipments and their utilization, etc.).

4. Degree of Liability

- research (investigative) forecasts, independent of previous (initial) conditions and with a specific orientation basic in character.
- programs which must respect the constraints introduced during the forecasting process.

### Concepts of Development

Concepts (i.e. development policies) translate the general conclusions of forecasts into more real terms. They concern selected branches of national economy; for example, the concept of development of automobilism includes car production and import, development of a roadway network, service stations, consumer demand, etc. Other examples are the concept of development of water systems, chemical industry, etc. The time horizon for concepts of different areas may differ, usually between 20 and 50 years. For example, the concept of utilization of fuel supplies might have an horizon of 50 years with respect to the development of nuclear energy and considering the limited supplies of fossil fuels.

The essence of these planning documents is the recognition of specific long-run socio-economic conditions of development. The concepts must take into consideration the interface of a national economy in an international economic system, including the relations and interrelations of individual branches and basic economic proportions. They represent a higher level of coordination. Concepts always represent suggestions of managerial bodies responsible for a certain area which are submitted for approval in the course of planning. They are the basis for developing a long-term plan.

### Classification of Plans

An extensive planning system represents a projection of a complicated and extensive set of activities of all components of the objective system considered from different viewpoints and aspects. Consequently, a number of partial plans are needed, tied together by different aspects (content, time continuity). Beside that, some plans have a specific purpose, e.g. to describe certain qualities of the planned system, to reflect expected special and real events etc. All these partial plans represent components of a complex planning system.

Plans may be classified according to the following criteria:

1. Relationship of the Plan to the Activity
  - a) conceptual plans
  - b) operational plans
2. Planning interval
  - a) long-term plans
  - b) medium-term plans
  - c) short-term plans
3. Dynamic function
  - a) time fixed plans
  - b) sliding plans
4. Material and value features
  - a) plans in terms of physical units
  - b) plans expressed in financial units (budget and calculations)
5. Management level of economy
  - a) national-economy plans
  - b) enterprise-economy plans

#### Brief Characteristics of Different Kinds of Plans

##### 1. Conceptual and operational plans

This classification distinguishes between the overall, conceptual intention (suggestion) of a plan and the actual program of actions to be undertaken to achieve the goals.

Conceptual plans define the complex targets and factors and the relationships between them as well as basic principles to be followed during the planning activity. They follow directly from the economic policy for the controlled system and from the results of forecasting.

The objectives of conceptual planning are the two main factors of dynamic equilibrium of the controlled system:

- a) to increase the rate of growth;
- b) to maintain its proportionality.

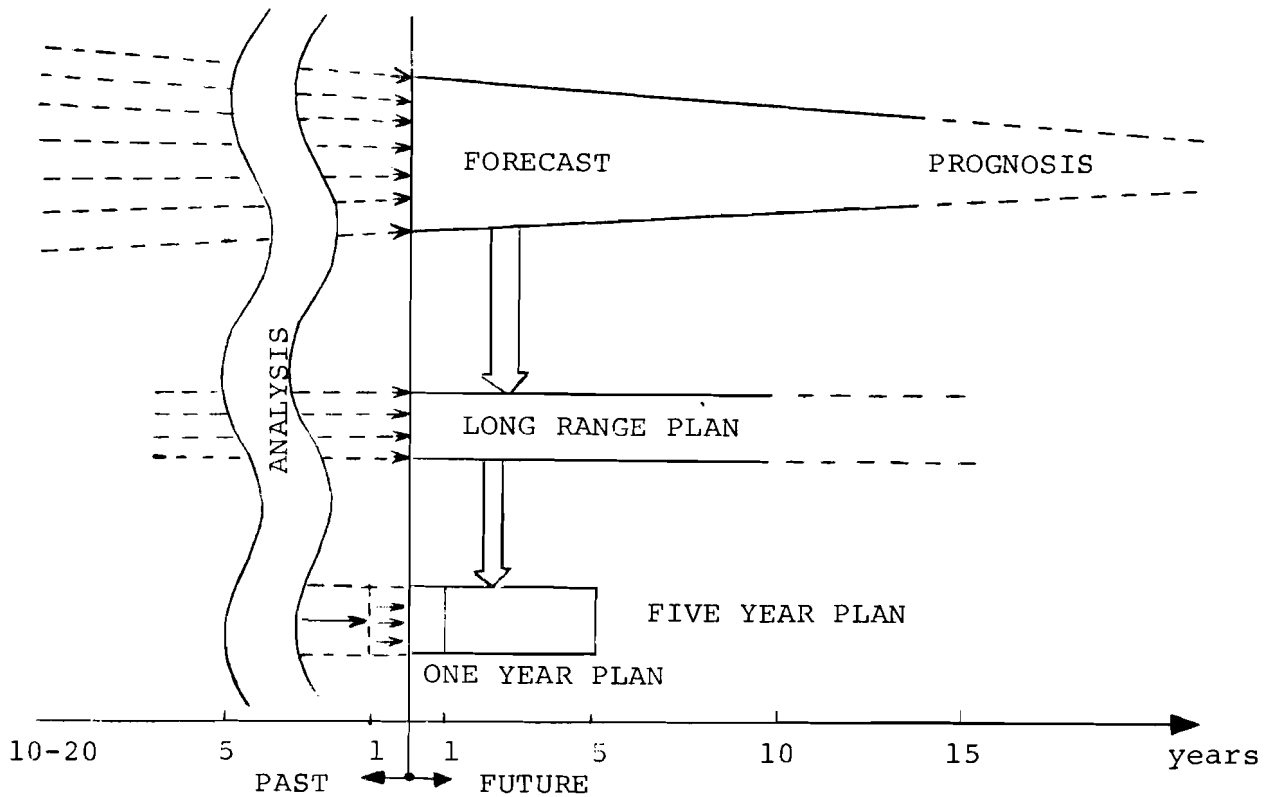


Figure 1 Time Scale for Different Types of Plans

The basic idea of conceptual planning involves a set of long-term plans which may influence the means of achieving the goals of the system, define and promote structural changes and prepare basic conditions for long-run development.

Operational plans determine in detail the content of a conceptual plan and the program of its realization in space and time. Operational plans are developed for the shorter time periods. In other words, they are the means by which conceptual management is transferred into the operational management. The instrument of operational planning is a system of operational standards, i.e. the standards valid in the given period of time and corresponding to the current state of controlled activity.



Use of operational plans in management involves the current control of their implementation. The efficiency of control increases if deviations from the plan are discussed instead of analyzing all the data about the given state of plan implementation. The control by exceptions in an enterprise uses a normative method of book-keeping and calculation.

The main objectives of operational planning are the following:

- to present actual goals, tools and methods for implementing conceptual plans.
- to maintain the continuity and harmony of the controlled activity.
- to introduce discipline.

## 2. Long-, medium- and short-term plans

The function of planning requires that the plans are elaborated for certain precisely defined intervals. Besides that, partial plans (short-term) must be included in the longer-run concepts on the basis of which it may be concluded if and how the long-term forecast tendencies are being implemented.

A set of time-bound plans must be built in such a way that it reflects continuity of economic development and the inside and outside dynamic connections of the objective system. Dynamic equilibrium must be established for two time levels:

- a) proportionality in a given, closed time period.
- b) correspondence of this proportionality to the demands of future development.

Classification of plans into long-, medium- and short-term plans is, of course, relative. The actual time interval for which the plan is developed must correspond to the nature of the planning system as well as planned activity according to the level of management and the nature of economic processes.

Long-term plans are used mostly by the higher (executive) level of management. Their purpose is to aim the development of the system at distant goals, define and promote innovations and structural changes and prepare basic conditions for the desired development in future. In other words, they are identical with conceptual plans. The time horizon at macro-economic level differs between 5 and 10 more years. Plans elaborated for a very long interval often have a character of a forecast as a number of relations cannot be well defined and only approximate estimates can be done.

Medium-term plans are linked to the long-term plans. Their objective is to realize the structural changes (construction or extension of a plant, liquidation of out-of-date plants, etc). This has to be done within the frame predetermined by the initial basis and the long-run concept of development. For example, a medium-term plan of an enterprise determines the targets for sales, production costs, profit, investments, etc. scheduled into the years of the long-term planning period. It deals with functional areas rather than with the detailed activities of individual planning bodies. The data used in these plans is more specific than that used in long-term plans, on the other hand, it has less liability than, for example, the factors of annual plan.

Short-term plans have an implementation character and involve a relatively short time period, for example, a year. Short-term plans determine how to utilize disposable factors of production and make a step forward to the realization of long-run structural changes. Liability of implementation plans is considerably great and it is usually assumed that the task will be implemented exactly according to the assumptions of the plan.

### 3. Time-fixed and Sliding Plans

Time fixation of plans, e.g. the determination of the fixed time intervals for which they are elaborated, is a necessary requirement from the aspect of their stability and liability.

Division of plans into the shorter intervals creates boundary transitions which cause unwanted interruptions (breakdowns) of continuity in the planning activity and in planned reality. These problems are especially noticeable in combining short-term and long-term plans. It is therefore desirable that the ends of planning intervals have uninterrupted transitions into the beginning of the following ones so that aggregation or disaggregation of factors of the plan are possible.

The requirement of continuity in planning assumes that each type of plan includes, in addition to the plan for the given interval, the forecast for the next phase of development. One suggested method is that 5-year plans be accompanied by a forecast for 1-2 years beyond.

#### 4. Material and Financial Plans

Material plans (plans reflecting material features of reproduction processes) define the objectives of a controlled system as combining different specific activities and assets (material and fixed and circulating assets) for the purpose of creating new assets.

Speaking in terms of practice, the planning of material features of reproduction processes in industry means to plan:

- production and sales
- structure and quantity of labor (manpower)
- structure and quantity of capital investments
- structure and quantity of consumption of stocks and supplies of material, raw materials and energy
- technological development of the system and increasing qualification of the laborers.

Financial plans (plans reflecting the value aspect of the reproduction processes) are based on the existence of production of goods and operation of the law of value in socialism. That makes it possible to measure all the economic processes by a

common unit, i.e. a monetary unit. The value feature of economic development and economic proportions becomes an object of planning. At the same time the financial planning is based on material processes and it directs and influences the planning of material aspects of reproduction.

The functioning of cost accounting is inseparably related to the value feature of economic proportions and therefore it is itself an object of planning.

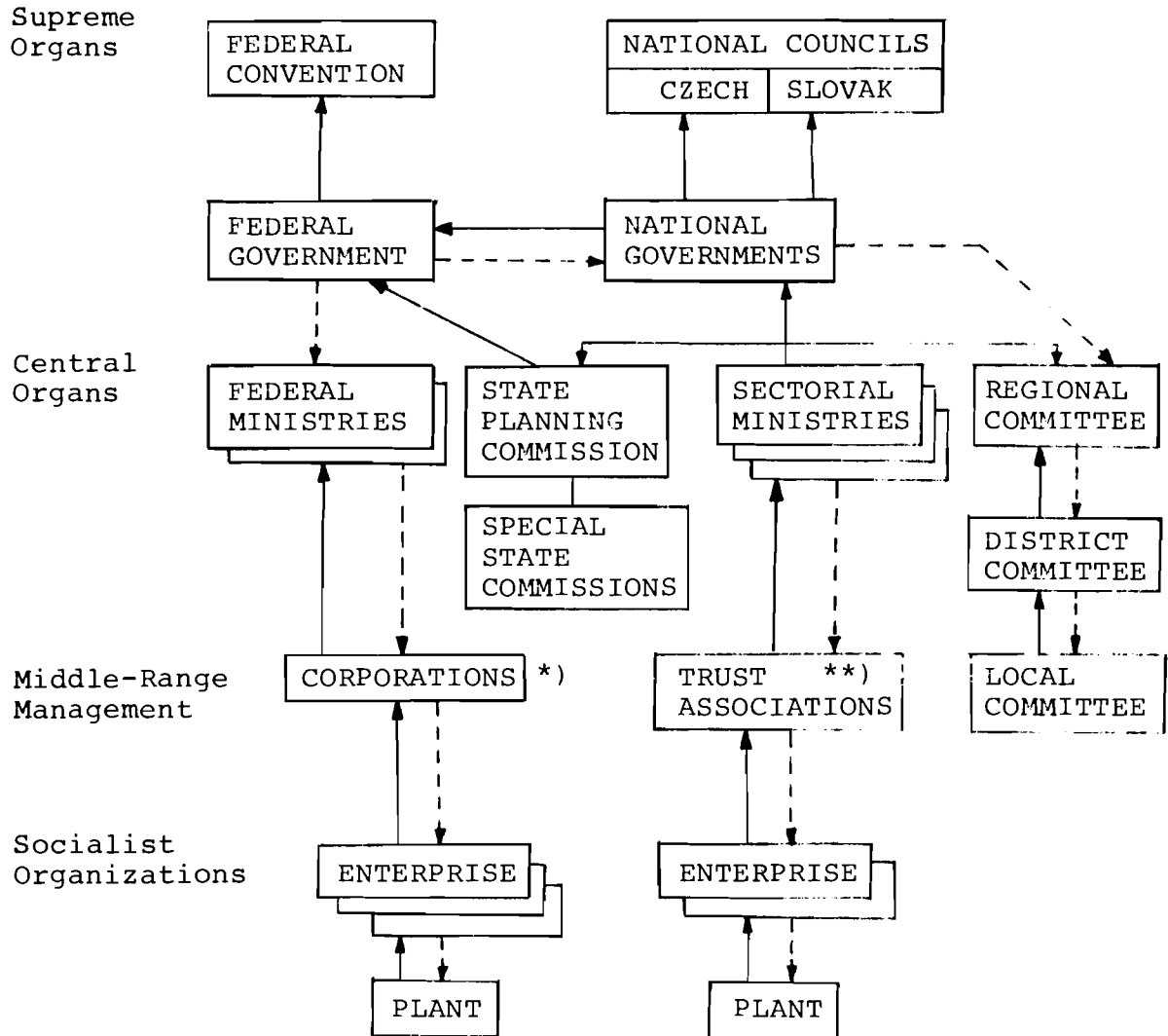
On the enterprise level the value feature of economic proportions is expressed in a complex and concentrate way by the financial plan and plan of costs. At the same time this feature is an inseparable part of other kinds of plans (plan of material-technical supply, plan of technological development etc.)

The value of categories which generalize the reproduction process on the basis of abstract studies, are an appropriate tool for inputing independence to controlled units. For example, a general task to decrease the consumption of social labor in an enterprise follows from planning the costs or profits. The decision of how to achieve this is left to the given system.

Such "decentralization" of planning of material proportions is limited if the system cannot solve certain problems from the aspect of national-economy proportionality and efficiency. The limits of decentralization are not fixed in time.

##### 5. National-Economy and Enterprise-Economy Plans

The object of national-economy planning is the national-economic processes, while the enterprise-economy planning is concerned with processes operating within the individual enterprises or their corporations. Both these are in a close relationship. Their special features follow from the different position and function of the national-economy and enterprise-economy spheres.



\*) vertical integration  
\*\*) horizontal integration  
— draft and data  
--- elaboration of the plan

Figure 2 Hierarchy of the National Economy Planning System

The integrity of an enterprise as a part of the complex of national economy is ensured by a system of planned economy which includes:

- (i) State plan of national economy development
- (ii) State budget
- (iii) Banking and credit planning system
- (iv) Economic organizations planning system

The state plan of national economy development has, for lower levels of management, a binding character. This aspect is derived from the harmony between the goals and policies of economic development in the sphere between a superior and subordinate socio-economic complex. The plan is seen for the production associations and all lower-level units like enterprises, plants, works as obligatory in the basic and general objectives, with a list of specialized targets, which have priority.

As a close link to this state plan system is a complex of economic organization's planning system, including technical-economic concepts and development studies, long-term plans, five-year plans and one-year plans.

#### Basic methods for economy development planning

Each scientific discipline uses general scientific methods on the one hand, but on the other hand very specific ones for the given area. The main and specific methods for the national-economy planning may be listed as follows:

- a) methods of balance
- b) method of analysis and synthesis
- c) method of the basic factor
- d) method of norms and coefficients
- e) comparactive studies
- f) statistical and mathematical methods

These methods are interrelated and interdependent. In the process of the planned control of national economy, preparation and realization of the state plan of development, neither of

them can exist independently and the whole complex is used. That means that the quality of one method depends on the quality of the others, and the quality of decision-making is greatly influenced by the quality of methods used. For example, the method of analysis and synthesis which is used to analyse the reproduction processes (the most synthetic description of them is the balance of national economy) depends on the quality of data (information system), on the quality of the system (comprising norms and economic indicators), as well as on the quality of mathematical and statistical methods.

The economy is developing under conditions with complicated and heterogeneous material and financial relations in the process of production, distribution, circulation and consumption. One of the basic methods of how to bring all these relations in accordance is the method of balances.

A. Method of Balances

The essence of this method is that it brings the economic quantities and the tasks and goals of the national-economy plan in accordance; it makes it possible to see the past, present and future relations in reproduction processes and coordinate the individual aspects and spheres of this process.

The result of the method of balances is a system of balances (input/output tables), the most important of which is the balance of the national economy. This table represents the most complex model of the production process.

B. Method of Analysis and Synthesis

The objectives of this method are as follows:

- to define the quantities and processes to be examined;
- to define the goal of the analysis and its criteria;
- to determine the main cause relationship and factors influencing the examined processes;
- to suggest provisions which would be in agreement with the goals of the analysis.

The most complex characteristics of the reproduction process which is the object of planning and managing activities, are the following:

rates of economic growth; rates of production growth; dynamics and degree of satisfaction of productive and non-productive demands of the society, development of the basic characteristics of the efficiency of growth.

These complex characteristics of the reproduction process are the basic object of the method of analysis and synthesis. That means that the method of macroeconomic analysis is used to analyse the basic economic boundaries and their dependencies.

Its objective is to present the development of national economy as a whole, and the development of the key sectors. The macroeconomic analysis must interpret the basic, causal relationship in the national economy, the tendencies and trends of this development, it must reveal the basic factors of the development, both positive and negative.

Next to the macroeconomic analysis in importance is the structural analysis which examines the inter-branches and inter-sectoral relationship. Its results serve to choose the most effective structure of national economy; factor analysis which analyses the factors of economic development which cause changes in the structure of national economy.

The important and starting point for the construction of the national plan is the retrospective analysis, based on the statistical balance of the national economy and dealing with the past economic development: rates of growth, proportions, structural changes and conditions under which the past production process operated.

Perspective analysis based on both planned and oriented balances of national economy represents the analysis of a future reproduction process, analysis of the complex development of relationships and proportions in the national economy.



An integral part of every analysis is to postulate the evaluating criteria. The use of analysis at any level of management, analysis of economic achievements of the country or of the enterprise, is based on assumptions and usage of comparisons. We can compare figures and data of international or inter-branches and inter-enterprises level of economy.

#### C. Comparative Method

At the national economy level the basic economic quantities are compared (national income, production, output, social product, factors characterizing the growth of the standard of living), at the enterprise level the basic measures of efficiency are compared; input of materials, labour productivity, etc. The technical aspects of individual products, the quality and the technical level of the production, as far as the technology of the processes are of interest to compare.

Analysis and synthesis of economic factors and their quantitative relations seems to be impossible without the usage of statistical and mathematical methods, the importance of which is increasing with

- the increasing complexity of reproduction processes which leads to increasing complexity and professionalism of decision processes;
- the request to have variant solutions and a choice of an optimal variant;
- the increasing influence of the time factor in decision processes mainly from the aspect of the future demand satisfaction of society.

#### D. Mathematical-economical models

A special position for building mathematical-economical models have disciplines like differential and integral calculus, possibility theory, correlation and regression analysis, methods of linear programming, etc.

Linear programming is suitable for finding an optimal production schedule when the constraints in sources exist, such as: the quality of materials, raw materials, labor, production capacity, etc. The optimization criteria are for example, achievement of the highest rentability, highest production output, requested quality. Linear programming is also suitable for solving the problems of planning the transport situations (i.e. example of distribution of goods while optimizing the transport costs), planning the construction investments etc.

A suitable method for actual planning and scheduling the construction works is the CPM, especially suitable for operations planning, solving very complicated situations occurring in for example, the building industry, scientific research, when a new technology is being introduced, in technical design and when manufacturing complicated equipment.

A basic presumption for the use of the optimization methods in planning is the reliability of data, namely of consumption demands, probable technological development, production capacity and its utilization, consumption of material and manpower, on stocks and inventory, costs, etc. In other words to optimize production programs or national-economy plans, a good knowledge of norms (standards) of material consumption and working time is necessary, and also their quality.

Use of mathematical methods together with today's computing facilities considerably increases the quality of information systems for planning. By introducing a broader range of newly formulated economic factors the manual calculations will not be as effective as those of computers. These methods together with computers frees management from the time-consuming routine work so that they can devote more time to the basic problems of economic policy.

At the present time "Automated Management Systems" (computer networks and data banks) are being introduced to be used for:

- a) share function in the management systems sphere. Persons who are in charge of collecting and updating data which is then processed by computer according to the request of the management people.
- b) to deliver information to planning and administrative bodies by means of data transmission (direct computer linkage) which in the past has been done by passing forms through administrative channels.

Usage of mathematical methods and computer facilities speeds up the planning process as an immediate reaction can be undertaken to respond to the changed conditions of the reproduction process such as, results of R & D progress, changes in international policy, foreign trade, etc. Further more, it makes it easier to develop the concepts of perspective development, complex programs, research and utilization of resources by removing a great deal of the subjective form of decision-making.

Nevertheless, it cannot be expected that in the near future a complex, universal mathematical-economic model would be developed, which would simultaneously solve both the complete planning problem and the planning problems in each of the planning intervals. This is impossible as one always has to take into account factors which cannot be expressed by mathematical functions and which are very significant for describing real life. Therefore, the usage of formalized methods will always go hand in hand with empirical decision-making for obtaining applicable results.

#### E. Methods of the Basic Factor

This is a specific case of the method of analysis and synthesis. The result of economic analysis, i.e. the analysis of changes taking place in the objective laws of socialism - must be the realization of the basic factor of the future production process. The objective basis for using this method is the close relationship between the individual moments of the reproduction process and the individual economic phenomena.

At present this basic factor can be recognized in managing the process of technical revolution which is a phenomenon recognized in the development all over the world.

As far as the improvement of the management and control system is concerned, the basic factor may be considered to put the content of the planning system on a more scientific base. A characteristic feature of the method of the basic factor, apart from the fact that it represents a certain moment in the reproduction process which is the most important for the achievement of political and economic goals, is its variability in time. Therefore the basic factor may change from one period of development of national economy to another.

#### Basic Sources of Information for Planning

The following list outlines the most essential sources of information and inspiration relevant to the elaboration of the plan:

- political and economic directives;
- directives issued by superior bodies;
- data concerning conceptions of development in organizations (suppliers);
- data concerning conceptions of development in consumer organizations;
- prospective needs of trade organizations;
- conceptions of development in subordinate organizations;
- information obtained from research organizations;
- data based on the results of team work specialists;
- data drawn from individual analysis;
- results of expertise conducted by external organizations.

One of the main problems in planning and management will probably be an adequate dovetailing of two types of data (vertical and horizontal). So far vertical data specifies what has to be done both in the form of binding assignment or

prospectively, while the specification of feasibility in terms of material, personnel, investments and other "inputs" and "outputs" - i.e. consumption, are largely the domain of horizontal data. The dovetailing of what is socially desirable (or perhaps generally desirable - and what can be attained within this framework by a specific organization) i.e. the supplier's potential versus the consumer's requirements (what is factually desirable) is still a major problem, one that gains in significance due to imperfect quality of horizontal data.

The comparison between the use of each group of data by enterprises and corporations shows that corporations dispose of a generally larger amount of data. Significantly, corporations make extensive use of primary data (political and economic directives, directives from superior bodies). Moreover, they carry out a large number of analyses and have access to a vast amount of relevant information. This is in harmony with their role and function in the sphere of long-term planning.

It is no doubt correct that corporations should dispose of more extensive information than enterprises and that enterprises should have access to more extensive information than that available to factories etc. The more superior the managerial body is, the more comprehensive outlook and the more varied type of information it requires.

Interestingly enough, enterprises have better access to data concerning supplier organizations than corporations. This is perhaps due to the fact that the need for data of this type is more urgent in the case of the enterprise as they exercise a limiting function with regard to development; and without a knowledge of prospects in the sphere of material the forecast itself is unreliable.

Enterprises evidently are more active than corporations for it is the enterprises and factories rather than the higher managerial links that have to bear the brunt of inadequate material provision.

The comparison between the frequency of use of planning data by technical and economic personnel shows that technicians use data of the decisive quality far more extensively. Similarly technicians use political and economic directives more extensively than economists.

Economists on the other hand, make more extensive use of directives issued by superior bodies. The operation of superior bodies is far more extensive and far more concrete in economic areas than in technical areas thus providing a wider scope for the technician's study of more general materials and for more extensive possibilities for comparing relevant developments outside of the planned area.

#### Superior Level Directives

A reliable directive approaching long-term planning both from the point of view of methodology and content, is one of the most essential types of information for the elaboration of a long-term plan involving different levels of management. Directives of this type specify what has to be elaborated and when it has to be elaborated. Unified methodology and temporal coordination of task are the most important prerequisites for an organic elaboration of future plans. Compared with political and economic directives, directives issued by superior bodies are more concrete in that they incorporate relations obtained between sources relevant to future development and the required potential including the personnel and the financial aspect of development.

Directives of this type are also significant in that they contain relevant decisions on production programs as well as decisions concerning a more efficient concentration and specialization.

Similar to political and economic directives, directives issued by superior bodies have a general validity and are binding. As a result they act as a stabilizing factor in the

enterprise sphere. Appropriately concrete and comprehensive, they are effective in stimulating further development in the desired direction. Directives issued by superior bodies specify the relevant quota for the development of individual production branches taking into account the specific possibilities of each enterprise in the sphere of technical and production facilities. They help to channel forecasting both methodologically and with regard to specialization. Sometimes directives of this type delimit the scope and form of planning. A great advantage of this type is their concreteness.

#### Organization of Planned Activity

In close relation to the construction of plans is the organization of planning activity for which it should create the optimal conditions. Organization represents the institutional aspect of the planning process (in contrast to the content of the plan), based on sharing the tasks in the different administrative units of the whole planning system. For example, the construction of the national-economy plan is accomplished by cooperation of the state central administrative bodies (the State Planning Commission, State Statistical Office, Ministry of Finance, branch ministries) and the bodies from the lower sphere (general and corporate top management, central management of cooperatives, independent enterprises etc.). The character of planning activity of these bodies and their interrelations vary greatly and depend on the organizational structure of the system.

The administrative bodies can be characterized in two groups:

- a) top managers, mostly executives
- b) professional "planners" (planning departments).

This differentiation explains the variety of planning activities which calls for the corresponding sharing of work according to:

- (i) subject specialization from different viewpoints
- (ii) functional specialization.

Generally, each administrative or functional unit of the system should elaborate its own plan. In order to maintain the unity of linkage of a process, the final elaboration of the plan must be coordinated by a special office (e.g. by a department or office of technical-economic planning) which usually also plays the role of a methodist of planning and a consultant to other planning units.

In the socialist system the vertical relationships are important in the process of planning because all the levels of management and control of the national economy are involved.

The importance of an efficient organization of planning activity is an informal organization. The following points (based on a practical experience) proved to be important for a right organizational approach to the planning process:

- 1) planning unit (department) should be organized as an independent unit supervised directly by the top management unit of the administered system (e.g. State Planning Commission to the government; planning department to the general director; planning unit to the enterprise director, etc.).
- 2) central planning unit coordinates the planning activities in the entire system and maintains its integrity.
- 3) planning should penetrate till the lowest levels of management.
- 4) planning should take into account the autonomy of the relatively independent components (units) of the system.

The actual planning on a decision-making level can be performed only by a body which is authorized to define tasks and responsibility for their implementation. This concerns all managers



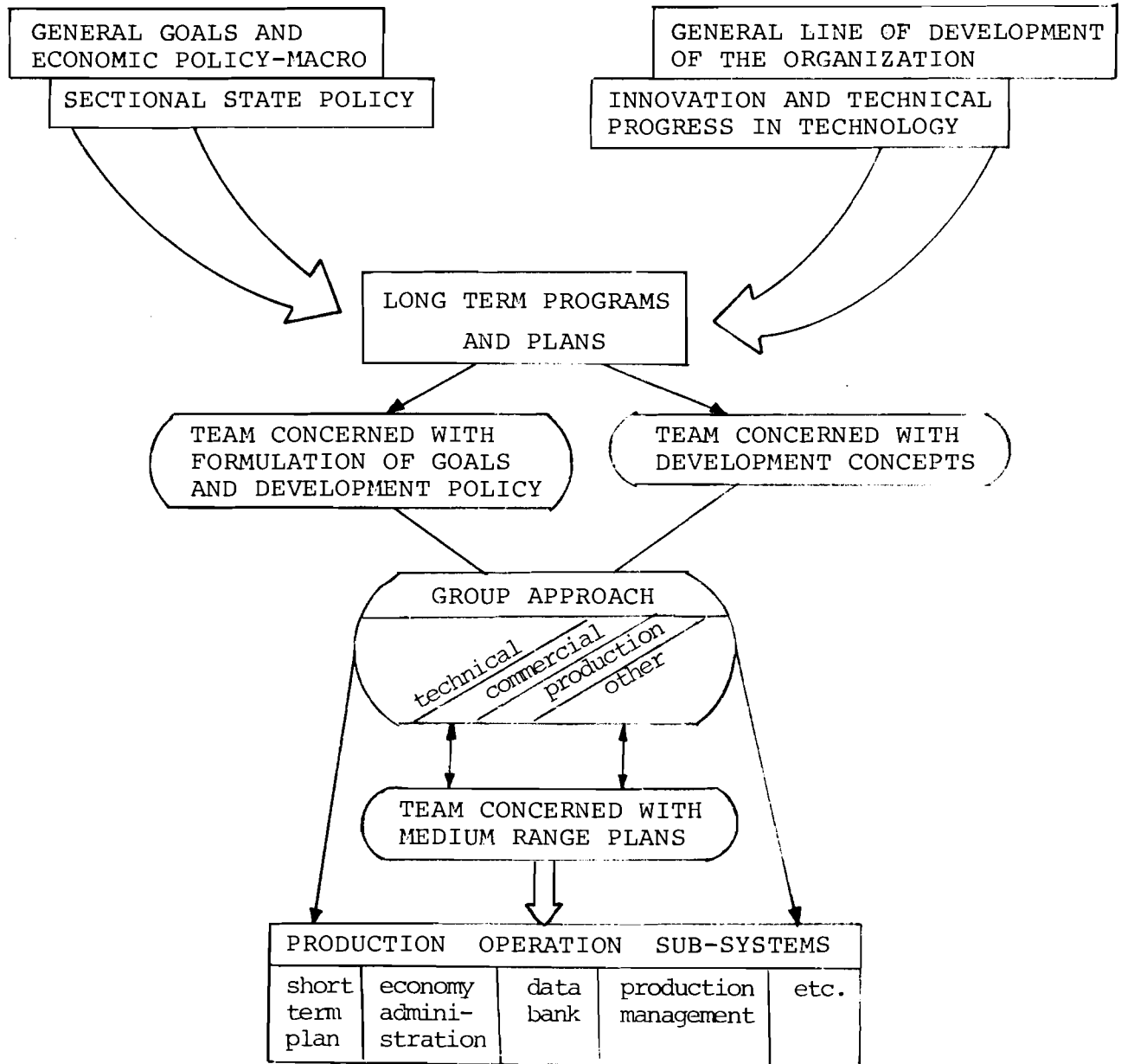


Figure 3 System of Planning Activity and Functional Specialization

of the planning departments. This concept should not be limited to a formal delegation but should include the objective fact that the responsible manager (social authority) is the one with the best understanding of the future activities of the unit supervised by him. It is expected that everybody concerned will contribute to the development of an administered system by his own experience and that of his own co-workers. Only application of integrated experience can lead to achieving the overall goals of the system. This cannot be achieved by one person or one group or even by the planning department itself.

Sharing of tasks is performed in the following way:

- 1) each unit contributes to the plan by its experience in the field of concerned activity (experience of working people),
- 2) planning unit performs the professional control and coordination of the planning activity (methodology, scientific approach, etc.)
- 3) decision-making and control functions of the planning process are carried out by managers responsible for the system (administrative area).

#### System of Standards

Both conceptual and operational planning is supported by a scientifically elaborated system of standards. The requirements for standards development follow from the essence of the planning of economic systems, from the basic principles of planning (first of all from the principle of progress and reality) and also from the given conditions and assumptions.

The development of standards makes it possible to disclose the capacity of systems and their components by use of testing the performance and/or results and the scientific analysis. So the volume of necessary or available resources (both material and labor) is established, on these grounds, the separate parts of the plan can be elaborated and put together. At the same time standards are the means for the control of the utilization

of disposable resources of the system and serve to stimulate their effective usage and to increase the productivity.

Standards can be classified according to different viewpoints: Besides the "current standards" which correspond to the existing level of technology, organization and qualification of labor there exist so called "planned standards" corresponding to the planned condition of these factors. Planned standards are the backbone of the planning activity while the current standards are used for operational control in the actual reproduction process. In the vertical structure of management the standards are classified as "aggregated standards" and "detailed standards." The higher the executive level the more aggregation of standards is used.

Similar is the classification of standards according to the length of planning period into the "global standards" and "detailed standards." The detailed standards are used in short-term planning while the long-term planning uses more the global standards in praxis.

According to the subject of standards, they are classified as follows:

1. standards of utilization of equipment (machines etc.) capacity which determine the volume of production output to be produced in a time unit;
2. standards of consumption of material determine, e.g. consumption of raw materials, materials and energy for a unit of production output.
3. performance standards which are subdivided into:
  - time standards, determining time needed to perform certain operations;
  - quantity standards, determining the volume of performance of a worker per time unit.
4. standards of stored reserve (called normatives) determining the state of production stock, semifinished

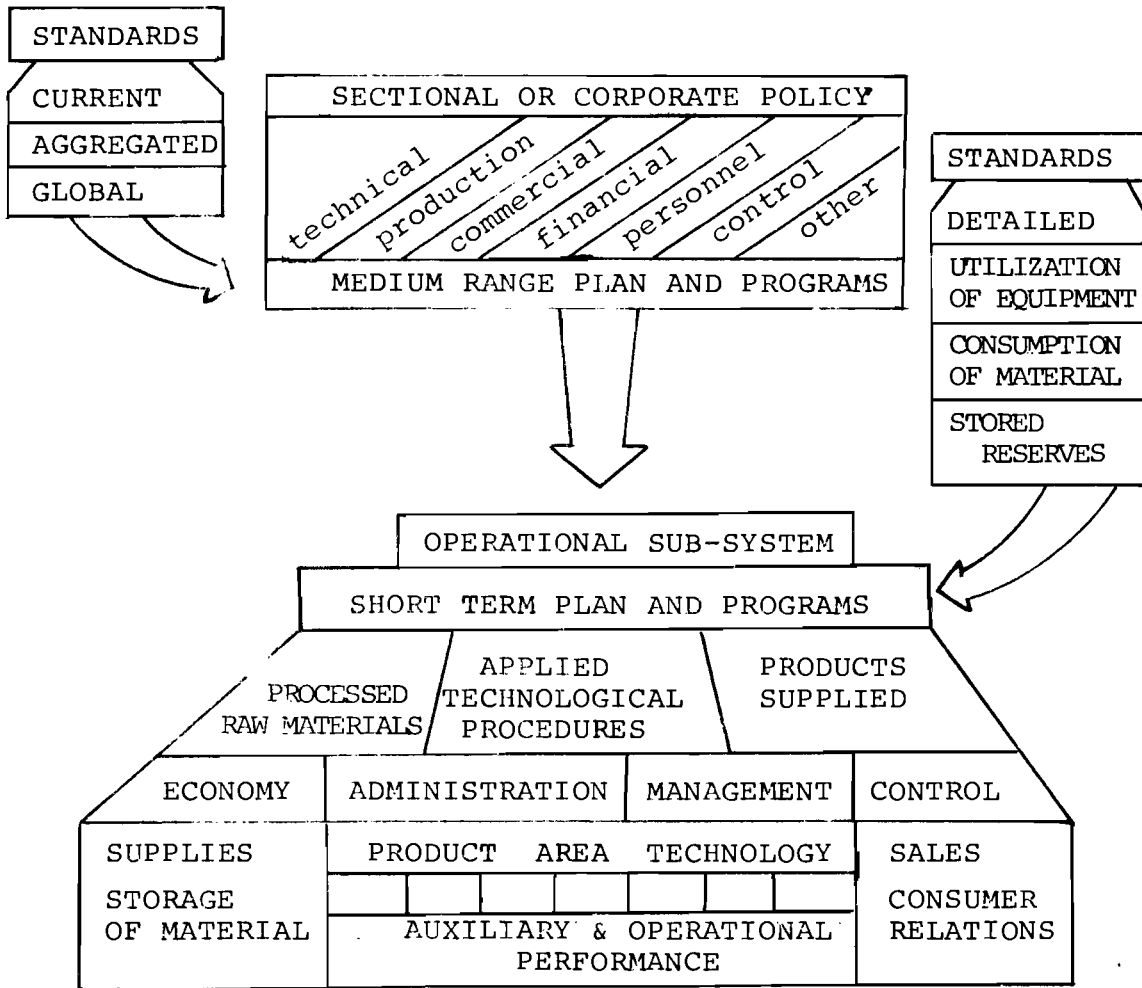


Figure 4 Planning Standard Structure

and finished products to be in the storehouse. Standards are assets on the basis of the period necessary for the supply, length of the production cycle, according to the volume of critical stock, etc.

5. technical standards specify the technological design of the product, equipment and technological flow from the point of view of economy, quantity and security of work.

#### Long-term Planning for Development of an Economic Organization

The basic function of the Long-term plan is to clarify the development trends in the main conception, orientation and strategic objectives in the development of the organization. According to the strategic character of the plan, it comprises long-term planning methodology in the sphere of higher-level management, i.e. production association (corporation).

The main function of the Long-term plan is to yield:

- long-term global production plans and cooperations;
- optimization of production capacity development;
- optimization of the necessary time for modernization and innovation of investment;
- evaluation and trade-offs of investment projects;
- long-term cost and financial plans;
- personnel and salary policy;
- stability analysis.

The political-economical directions formed by sectorial ministry requirements for output of products with determined quality and parameters, resources of national economy and long-term trends of technical-economical indicators (indices) are the basic factors for the construction of the plan.

The goals of the Long-term plan are expressed in terms of indicators as follows:

- identification of the rate of production development and make-up of the product structure;

- determination of the volume and time lay-out of new investments;
- growth of the manpower and changes in the structure;
- determination of the demand for export/import;
- special tasks concerning budgeting or prices policy;
- specification of the targets for the enterprise and form of fulfillment.

The long-term plans of development of an economic organization include both perspective plans (extending beyond one five-year plan) and a five-year plan. They are fundamental for the preparation of one-year plans too, and are leading factors for setting the basic targets of production and future orientation of the enterprise as a whole.

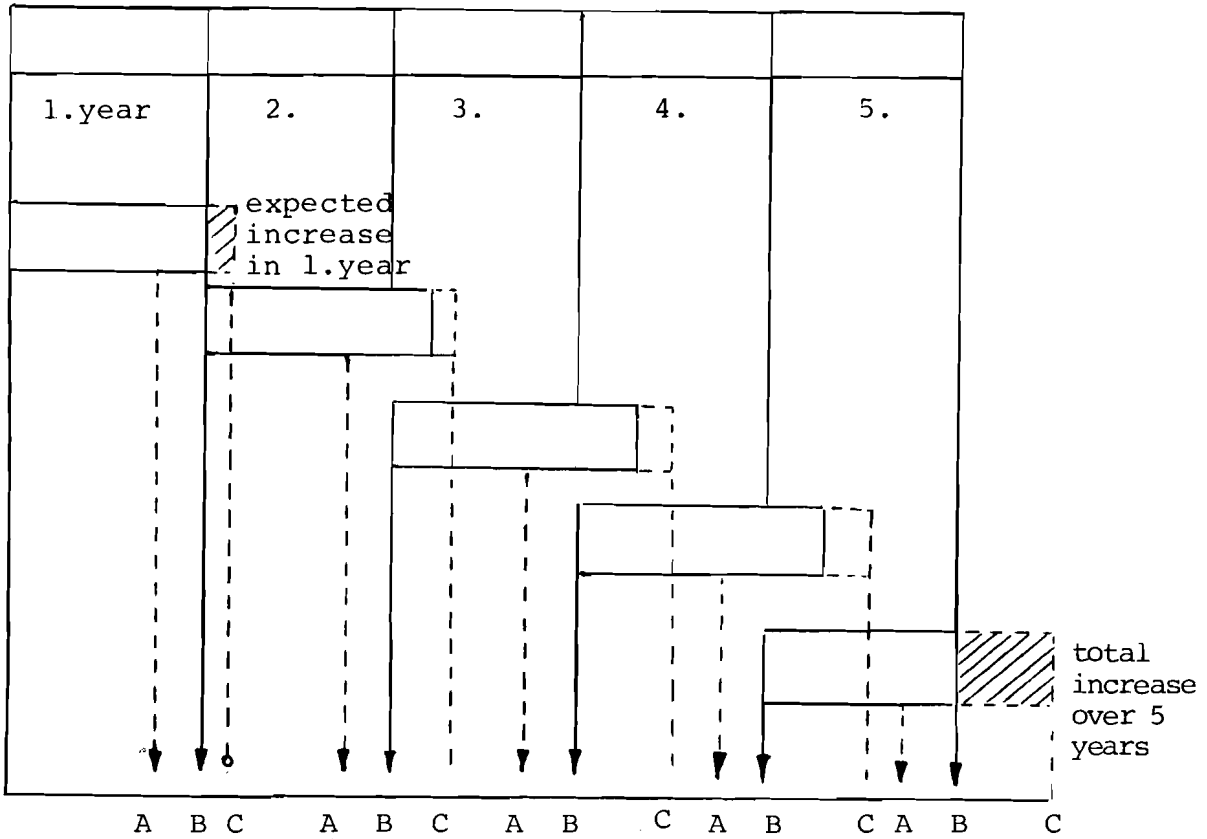
#### One-year plan

The one-year plan links very closely the long-term plan and specifies the detailed structure of targets to be fulfilled. There are some specific features to be respected by the constructing of the plan:

- supplier-consumer relationship;
- economical, technical and capacity requirements;
- specialization and concentration of production requirements;
- closing production loops in short-term plan periods.

The plan is prepared in close cooperation between the department for technical-economic planning and the sales department and production departments according to the basic targets.

Later on the production plan is broken down into quarters and according to the different departments, using these indicators: the volume of production, inventory limits for semifinished or in-process goods and of finished products in assortment or quality.



A = Term of Analyzing the Fulfillment of the Current One Year Plan  
 B = Previously Stated Term of Fulfillment  
 C = New Estimation of the Plan according to the Expected Increase and Development

Figure 5 Dynamic Function of the Sliding Improvement of the Five Year Plan Divided into One Year Plans (with Respect to Increase and Development)

The reality of the plan is tested by calculations, and mathematical or simulation techniques are used for capacity planning. The department for technical-economic planning is responsible for methodological coordination of all activity concerning plan setting, and for modifications or changes to be introduced later on into all parts of the plan, with respect to economical efficiency. The hierarchy of the planning activity is described on the diagram on the following page.

### Automated Management Systems (AMS)

Concept of AMS. Traditionally, industrial establishments have not been structured to utilize the system concept. In adjusting the typical production structure to fit within the framework of management by system, certain organizational changes may be required. It is obvious that no one organizational structure can meet operational requirements for every company. Each organization must be designed as a unique system. However, the illustrative model set forth would be generally operable for medium- to large-size companies which have a number of major products and a variety of management functions.

The primary purpose of this model is to illustrate the application of the system concept to industrial or business organizations and the possible impact upon the various management functions of planning, organizing, communication and control.

The results of the profound inner changes in the development of management, changes in the approach to the activities of economic organizations and their temporal orientation, are comprised in a new concept of Automated Management Systems (AMS) (or ASU in the original language) now being introduced in socialist countries. This conception defines both the problems of more efficient planning in all the relevant spheres and the corresponding ways and means of stimulating the implementation of computers.



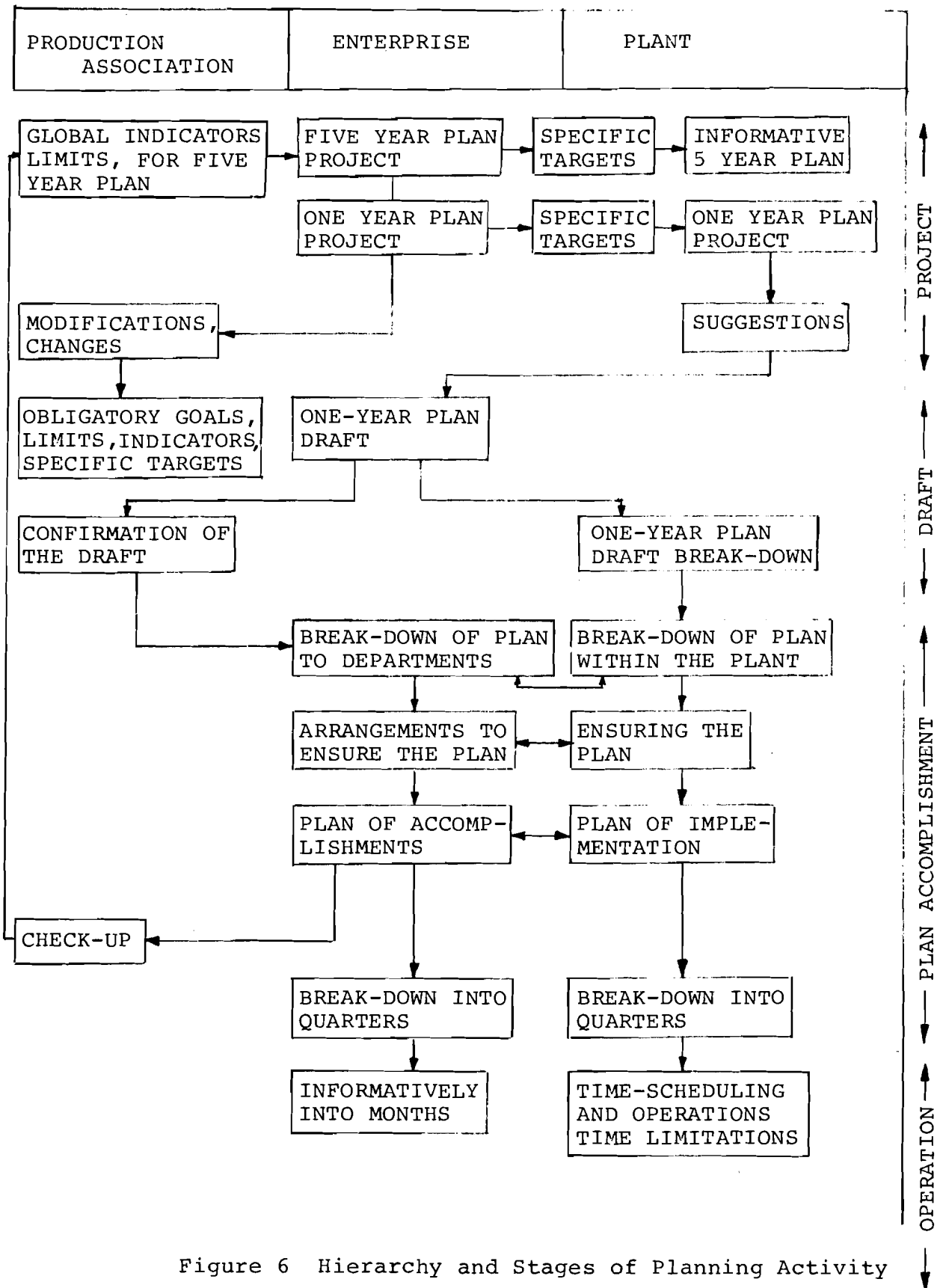


Figure 6 Hierarchy and Stages of Planning Activity

Necessary measures will need to be adopted in the sphere of personnel management and - most important of all - the training of managerial executives, as well as issues concerning the decentralization of management and the participation of the working people in management, the improvement of technical aspects of management etc.

The other aspect of the evolution of the managerial structure is the development of new forms of production associations. Even more surprising is the large number of new integration forms promptly offered by socialist practice, forms that can be regarded as a qualitative leap towards the organization of a system of socialist micro-economic management.

The basis and framework underlying their emergence are no doubt the requirements of scientific and technological progress calling forth profound structural changes in the economy of industrial countries. The process of economic integration is characterized not only by the growing size (concentration) of economic organizations due to the merging of economic organizations operating within the same branch but also by the integration of organizations operative in completely different branches and sectors.

The vertical integrated plants with production ranging from raw materials to the final product come into being within the framework of the same raw material branch, similarly trusts were formed within the corresponding branches. In the final analysis these two forms of production associations are representative of extensive growth whereas in the case of combined organizations and different branches this process involves a markedly intensive growth. This particular sphere witnesses the emergence of dynamic systems of growth, where it is precisely the new combination of components that creates conditions conducive to rapid development.

Objectives of AMS. The vast growth in size, complexity and diversity of operations of the modern manufacturing environment has made the managerial function exceedingly difficult, but even more essential to the success of the enterprise.

During the past few years there has been a new concept advanced for improving management: Automated Management Systems (AMS). An AMS could be defined as "a part of the complex management system of an enterprise, using modern EDP equipment and implementing mathematical methods for optimal decision-making in production, planning and accounting."

The main functions and objectives of AMS could reflect three basic tasks:

- (i) rationalization of internal and external information flows;
- (ii) design of an EDP system based on automated data preparation, data processing and usage of management of the enterprise as a whole and for decision-making in the main functions;
- (iii) incorporation in the EDP system of appropriate algorithms, modules and rules for the complex of projects and programs to analyze project and plan technological and technical-economical processes.

Goals of AMS. As a powerful instrument for rationalizing the management functions AMS must provide these goals to an extent economically justifiable and feasible:

1. intensify the quality of decision on all levels of the decision-making staff;
2. increase the consistency of objectives on the hierarchy of management, namely in relation to the top management (headquarters of the trust or concern, form of production associations, ministry, etc.);
3. make the decision-making process more detached and objective;

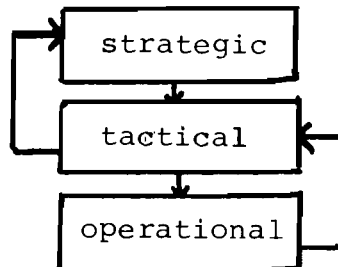
4. accelerate the decision-making process to shorten the response time;
5. to assure answers on inquiry based by managerial staff.

The realization of these objectives can be advanced through the application of modern computers instead of conventional key-punching machines and tabulators. Whereas such a system used to permit at best, the possibility of a one-day period for data processing, it now becomes possible, corresponding to the expected development of communications, equipment and electronics, to operate in an on-line mode with the advantage of using data-base information files for decision-making as part of a complex system.

The project concept is normally oriented according to the problem areas covering the basic functions of the management system of the enterprise.

As a problem area we understand a cluster of activities forming a relatively closed circle of problems. Such a system concept differs from the traditional batch-processing system. Particular problem areas or activities must be dealt with according to the level of management, so as to solve the problems of each level by means of individual subsystems which are interrelated in accordance with the scheme:

Levels of Management



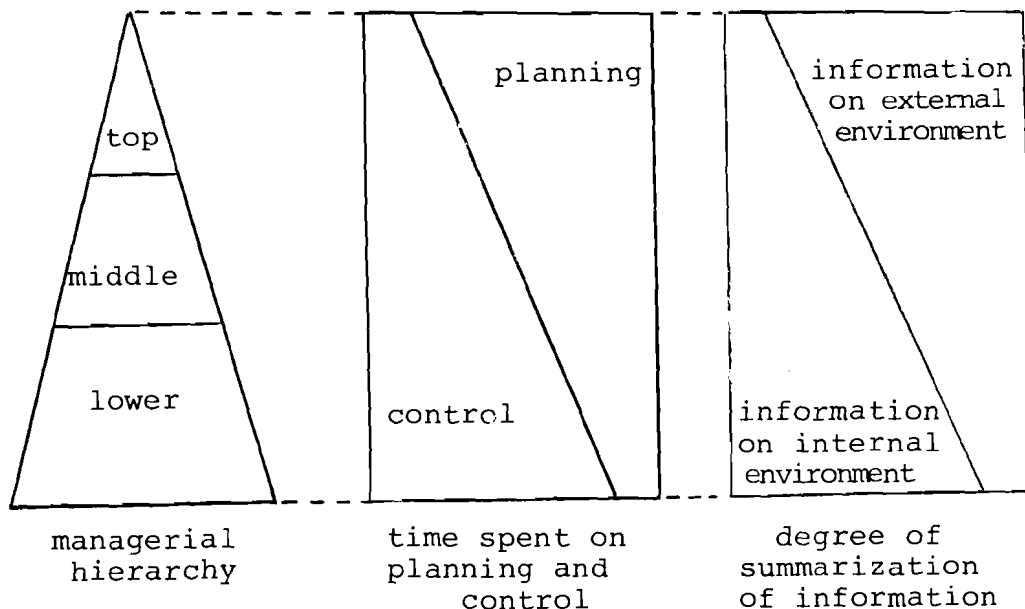
Requirements applied to AMS. The main aim expected from the implementation of an AMS is an increase in the effectiveness of the enterprise. AMS represents a flexible and straightforward system of achieving objectives which are:

- a) increase of production (in optimal structure);
- b) reduction of costs (achieve better economy) of:
  - the time of workpower and equipment
  - material and stock
  - financial resources

Besides the main effect, a successful AMS brings other side benefits, namely:

- \* in supplier-consumer relationship
  - cut the delivery time
  - better adaptation to the changes of consumer requirements
  - forecasting of future requirements and conditions on the market.

Figure 7 Management Levels related to Planning Control and Information:



- \* in research and development (R&D)
  - acceleration of new products development
  - intensification of standardization and all normatives
  - increasing the quality
  - better facilities and acceleration in the implementation of new technology
  
- \* in production area
  - optimization of operations scheduling in terms of time and space
  - better usage of equipment and manpower
  - optimal material flow
  - improved production-flow tracking with dispatching and handling of unexpected deviations
  
- \* in material supply and inventory
  - decrease of number of items
  - decrease of the stock
  - better manipulation with materials
  - reduction in space in warehouses
  
- \* in investment and equipment
  - rational maintenance (technical and economical aspects)
  - optimal structure of the used equipment (scrap and replace)
  
- \* in manpower
  - improve the whole information of personnel and individuals
  - better choice of people for specialized professions (reserves)
  - optimal number and ratio of manpower/production
  - limitation of time-consuming routines for the benefit of creative and inventive labor.

- \* in financial operations and accounting
  - systematical control of all kinds of financial operations
  - finding out all less effective operations and achieving an effective pressure to abandon these operations
  - improving the whole information and accounting system, product costing, summary reporting, balancing and purchase analysis.

#### Management System and Subsystems

A typical structure of the basic management system for a production enterprise can be described as a complex of subsystems with specific functions. The main subsystems forming the nucleus of an AMS are as follows:

Technical-economic planning  
Technical-production preparation  
Sales  
Material supply  
Operational control of production  
Economical informations and accounting

#### Technical Production Preparation (TPP)

One of the most important subsystems for production planning and control on the level of a plant is TPP. Here the necessary decisions for the pre-production is concentrated with a time lead.

The main features and functions of the subsystems are:

- creation of the data-base for the future production process, products specification, technological flow, management and control;
- designing the structure of the products according to the determined parameters, (reliability, cost/maintenance, efficiency);

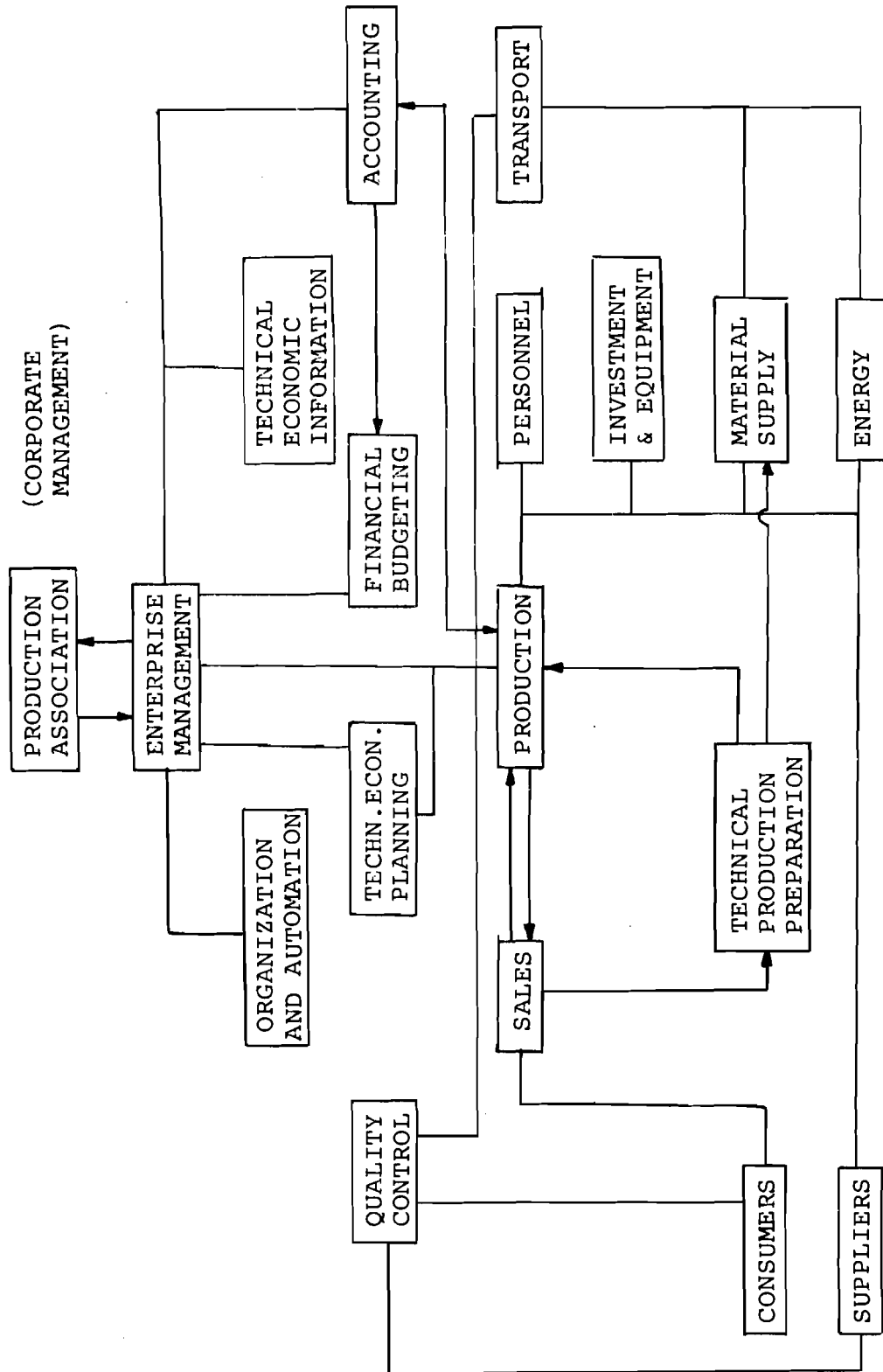


Figure 8 Structure of Basic Functions of a Manufacturing Enterprise



- inset all requirements into the plan of R & D, investment, manpower and other plans in close cooperation with concerned subsystems;
- concentrate all necessary information for fulfillment of goals, namely concerning sales, production, technical development, competition, environment, etc. by using appropriate methods of research: value regression analysis for increasing the quality of products, critical path method or simulation technique for analysis and improvement of the manufacturing process, for minimizing the needs and maximizing the effectiveness of resources.

Confirmed plans of TPP form the basic indicators for the construction and technological development of the plant. The organization of TPP inside of the AMS differs according to the type of production cycle, series production or job-shop production.

### Sales

The main objective of a socialist enterprise is to produce and ensure the market with products and with harmony to the demand of the national economy. The plan of final production represents the volume of capacity for a determined time period. To fulfill a planned capacity is a procedure not exactly fixed by the methodology and could be carried out in three ways:

1. the plant receives the tasks through the state plan;
2. the plant covers the production by customers orders;
3. the capacity is fixed by a combination of both.

The basic function of the sales department is as follows:

- demand forecasting based on historical sales data and analysis of demand, market analysis (marketing)
- setting own sales plan on order processing, consumer's demands and direct demands from the top management or authorities with higher priority (sales plan form the initial file for production planning and order processing)

- sales order confirmation, contract preparation
- orders delayed reporting, customer response to products
- shipping and invoicing
- statistics about sales operations and reporting to management.

According to the structure of orders (state preference, customers) the time-horizon of order planning and processing differs. A period from one to six months may be necessary from the moment of receiving a demand from a new customer or in case of irregular order.

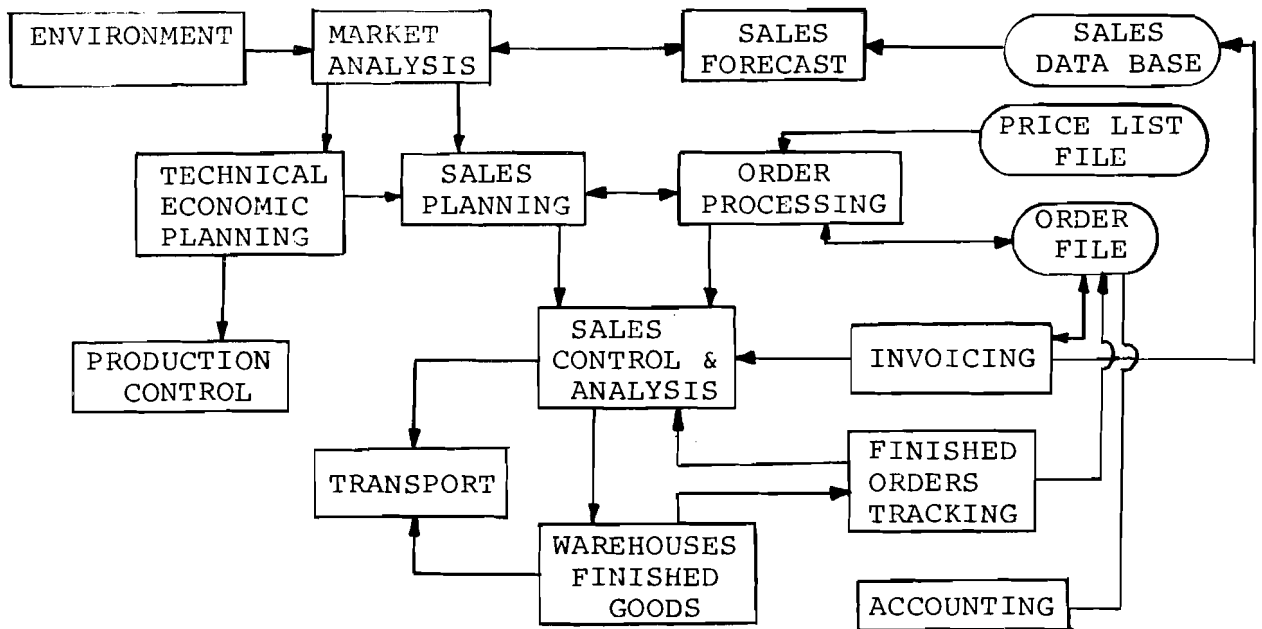


Figure 9 Scheme of Basic Information Flow of Sales Subsystem

### Material Supply Subsystem

The main function to cover the demand of all kinds of materials for production processes is the responsibility of the Material Supply subsystem. The basic goals fall into two tasks of the same importance for the harmony of the process:

- to supply the production departments with requisite materials (raw-material, basic material for process, accessories, equipment, machines, tools, spare-parts, instruments) in time, continually, fluently and in sufficient quantity (i.e. principle of maximum stock);
- to maintain stock-control and inventory of all kinds of materials and equipment, spare-parts etc. only in a minimum quantity, not to bind financial means and not exceeding the credit limits (i.e. principle of minimum stock).

The fulfillment of both antagonistic targets and principles in the optimum way is the main objective of this subsystem as a part of operational management and AMS.

For better understanding it is necessary to explain the function of the plan in relation to material supply of a manufacturing plant. The one-year plan has a character of balance of the basic assortment of material centrally planned or to be ordered from abroad. Thus summary of these items is provided on the level of sectorial ministry or production association and after checking the complete balance with respect to the national economy, the plan is confirmed as a limit for the enterprise or factory.

Methodologically, the one-year plan has importance for planning on the macro-level of management. For the lower level it is most important that the plan is broken down into quarters (months) periods, because the plan includes all demands from the production plan and material detailed structure corresponding with the

confirmed orders for that time period. The material supply planning must be very flexible because some items must be ordered (purchased) in a longer period before the planning period and in the other case the production must reflect on unexpected or irregular orders outstanding in the plan.

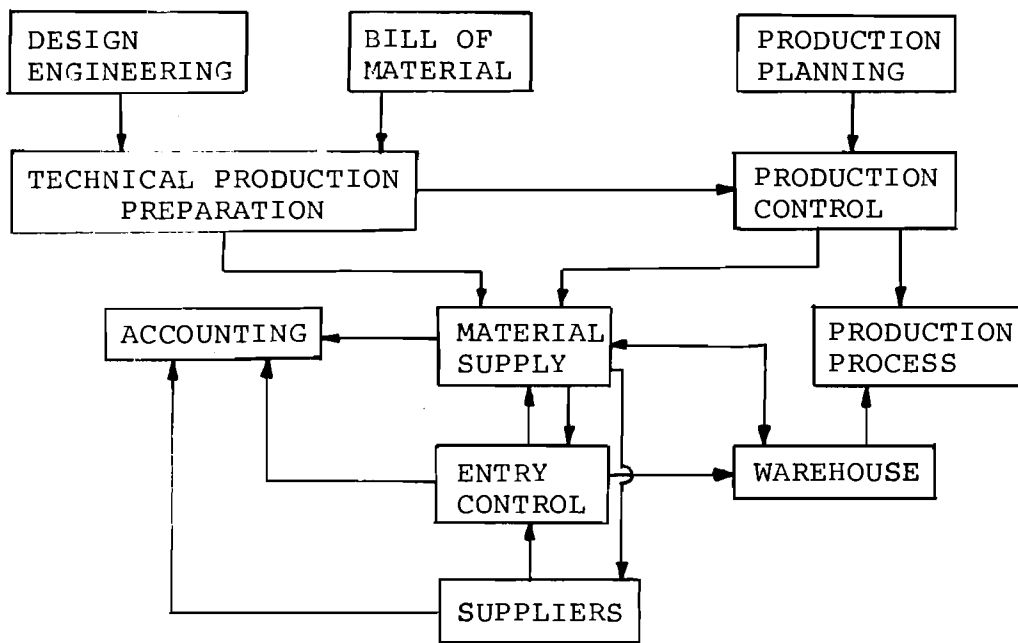


Figure 10 Basic Relations and Information Flow of the Material Supply Subsystem

### Operational Production Control

The design of the production control system needs to be adapted to the needs of the organization in which it is located and these needs are determined by a wide range of factors, historical, geographical or personal, as well as simply technical. Every organization is different and hence every system is different.

There are some basic aspects, common to all manufacturing plants, necessary to be included in the management and control system to meet the objectives:

- Scheduling of the final production and all needs expressed in units and components is specified as a detailed target for the production process. The loading as an act closely associated with the activity of preparing a schedule, is the assigning of work to an individual machine, operator, or work station for a shift, day or three-day period;
- Ascertain labor complexity of the defined target and comparison with real situation and arrangement of equipment and manpower, analyze the deficiency of capacity, etc.
- Propose and bring in to operation all necessary steps to resolve these differences by - increase of production capacity, new lay-out of technological arrangements, mobilize reserves and settle cooperation;
- Control of the process, following the performance and deviations from the plan, evaluation of deficiencies, despatching and intervention to secure the fulfillment of the plan.

Scheduling and loading still presents the greatest challenge to the computer-based systems. The computer can be of outstanding value in preparing the results for subsequent use. Not only will the computer prepare an output, often in a form which is immediately usable by the first-line supervisor, it will also sort this output

in any way desired, so that output can be reported by departments, by machines within departments, and by predetermined priorities.

Operational production control methods will be available in the near future as part of the production system where computers can ensure an integrated grid of operations fully automated. A perspective in this field is practical usage of operators research methods as well as simulation techniques.

Further listing of current methods for rationalization of the production and process flow as a significant part of CBMS will be the separate part of the comparative study.

#### Economical Information and Accounting

The system of economical information is obligatory and is the same for all business or production organizations in a socialist country. A full set of laws and regulations gives a unique methodological explanation of how to keep accounting files and what kind of statistics it is necessary to return.

The basic files are concentrated into ranges as follows:

- Accounting
- Budgeting
- Calculations
- Statistics
- Basic information files of production and inventory
- Special files

The objective of the information system is to represent the real state of all operations and a number of financial means of balancing budgeting and analysis of the complex condition of the organization.

#### Summary

Progress has been so great in the past decade that only those totally involved with computers are capable of keeping

track of the subtle changes in management. Most companies seriously concerned with putting computers to work already have a total computer based system in operation. First, goals were to shorten the intervals between receipt of an order and delivery of a product. The total AMS goal is to reduce inventory, improve schedule production - up to and including the actual running to secure the fulfillment of plan and targets specific to the organization.

Other goals of the system are to standardize nomenclature, keep personnel records, provide engineering information services, and give management a frequent picture of what is actually going on in the company, compared to plans and forecasts.

When talking about the total AMS, we are not necessarily using only one computer. It may be a whole network or hierarchy of computers linked together by communication lines. Experience with industrial organizations shows that system improvements may not result nearly as much from changing the type of information but the nature of the decision based on the information. A system model can be used to see how changed information flows will affect the management system.

The knowledge of the existing control theory, mathematical/simulation techniques, and the computer, now being applied to higher levels of control in the management hierarchy, can lead to vastly improved information for better decision-making.

BIBLIOGRAPHY

1. "Algoritmizacija v Automatizirovanyh Sistemach Upravlenija."  
(Kijev, 1972)
2. "Obsceotraslevyje Rukovodjascie Metodiceskoe Materialy Po  
Sozdaniu Asup."  
(Minsk, 1972)
3. BUKACEK, Z., MAZEL, B. "Methodology for Project and  
Development of Automated Management Systems."  
(Inorga, Praha, 1974) - in Czech.
4. KARFIK, P., MAZEL B. and Col. "Information and Management  
System for Production Industry."  
(Inorga, Praha, 1972) - in Czech.
5. MAZEL, B. "Automated Management Systems." (Methodology and  
Projecting.)  
(Charles University, Prague, 1976 - Manuscript in Czech.)
6. "Automatisierte Systeme für Leitung von Betrieben."  
Conference Proceedings, ASR-ASU, Praha, 1974.
7. SMRCKA, J. "An Analysis of the Ways and Means of Elaborating  
Long-Term Forecasts and the Role of Executives in this Process."  
(Institute of Management, Prague, 1974).
8. BOURA, J., KOVAR, V. et al. "Prognoses of Development  
of the System of Management of Socialist Economic  
Organizations."  
(Institute of Management, Prague, 1974).
9. HARTMAN, W. et al. "Management Information Systems Handbook."  
(Phillips, 1975).
10. MARTINO, J.P. "Technological Forecasting for Decision-  
Making."  
(Elsevier, 1972).
11. LANFORD, H.W. "Technological Forecasting Methodologies."  
(A Synthesis).  
(American Management Association, 1972).
12. HARRISON, E.F. "The Managerial Decision-Making Process."  
(Houghton Mifflin Co., Boston, 1975).