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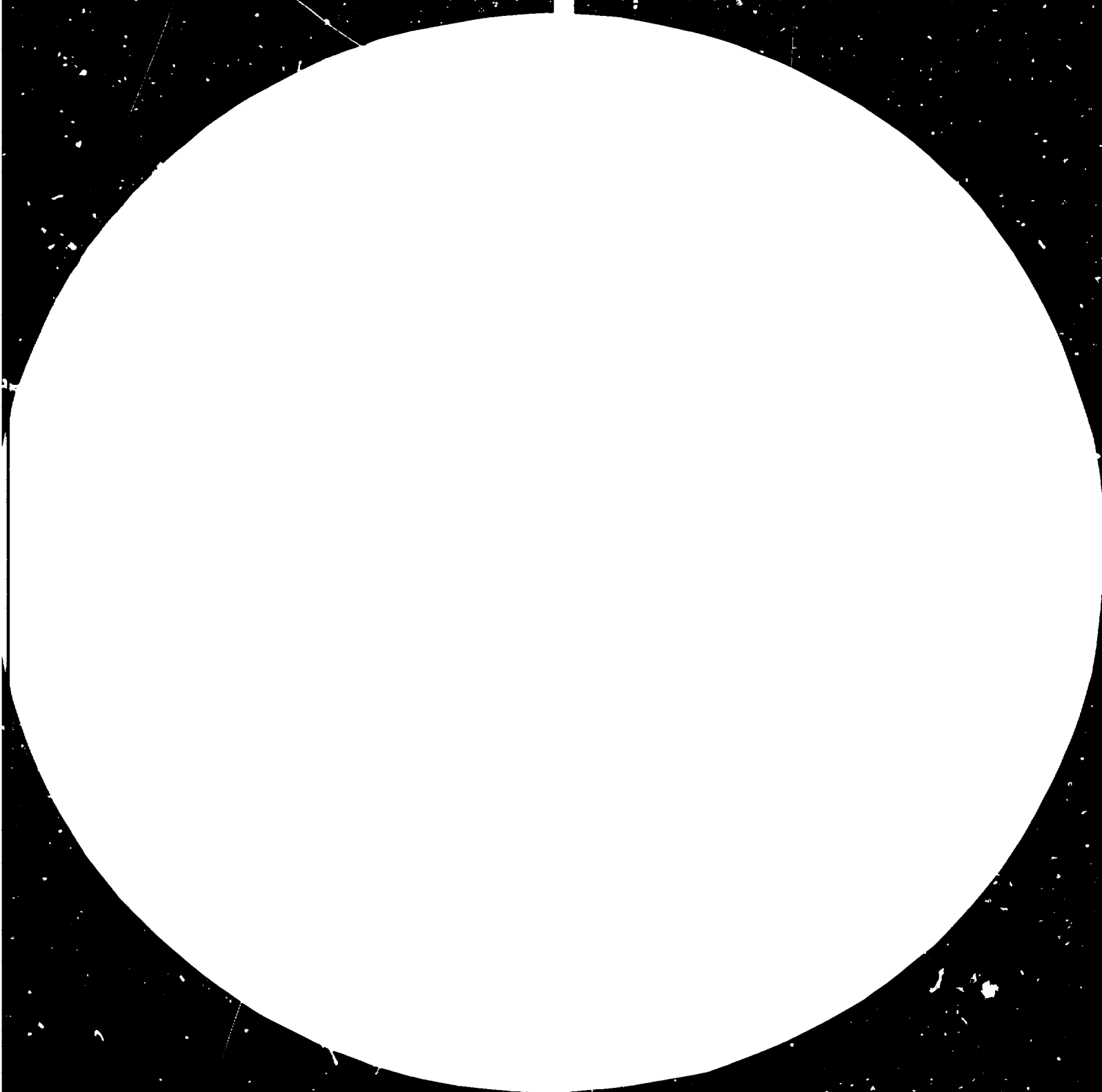

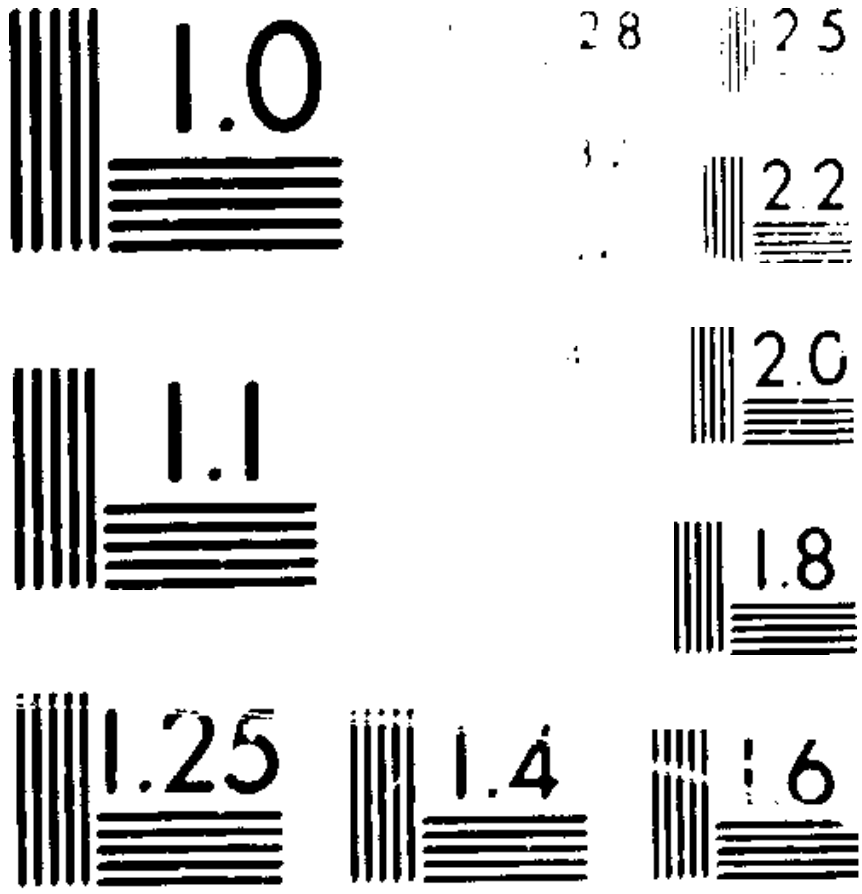
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METHODOLOGICAL PROBLEMS OF A COMPREHENSIVE PROGRAMME OF SCIENTIFIC AND TECHNOLOGICAL PROGRESS IN THE SOVIET UNION

A Preliminary Note*

by

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Contents

I. PURPOSE OF FORMULATING THE COMPREHENSIVE PROGRAMME

Background

1. In present conditions, scientific and technological progress exerts greater influence than ever before on the efficiency of the national economy. That is why a strong emphasis, especially in recent years, has been placed in the Union of Soviet Socialist Republics (USSR) on improving the techniques of managing technological change.

2. Planning provides the basis for a consistent scientific and technological policy, enhancing the co-ordinated development of science and technology, achieving the necessary balance between separate lines of technological advance and ensuring the optimal development of scientific potential with respect to the national resources. The Soviet Union, opening up new ways of historic development, has gained an extensive experience in the comprehensive solution of technological and socio-economic problems.

3. As was noted at the 26th Congress of the Communist Party of the Soviet Union (CPSU), "the Party approach, the political approach to the economy has invariably been based on the programmatic requirement - everything for the sake of man, for the benefit of man."

4. The major characteristic of the state economic function, aimed at the aforementioned goal, is the application of a systems approach to the formulation and accomplishment of economic policy. The economy of the USSR is an integral economic complex comprising all the elements of social production, distribution, and exchange on its territory. The economy is managed on the basis of state plans for economic and social development, with due account of sectoral and territorial considerations and by combining centralised direction with the managerial independence and initiative of individual and amalgamated enterprises and other organizations, for which active use is made of management accounting, profit, cost and other economic levers and incentives.

Objectives of the Comprehensive Programme

5. The Comprehensive Programme of Scientific and Technological Progress proceeds from the major objective of long-term socio-economic development of the USSR, i.e. to ensure improved well-being and much higher material and cultural living standards of the Soviet people through the advanced and intensive development of the national economy; more rational utilization of the country's production potential; conceivable economies in all kinds of resources;and higher quality of work.

6. A Comprehensive Programme must provide scientifically-based guidelines for:research activities; development of technological and educational potential of the nation; scientific and technological change in the national economy with regard to domestic and foreign technological advances; and socio-economic implications and effects of innovations,in luding regional and interregional aspects of scientific and technological progress.

7. It is worth pointing out that a programme of this kind is not an ordinary forecast predicting the development of uncontrolled events in some or other environment. It provides recommendations to be considered in the formulation of plans, and forecasts the country's development, should the recommendations be adhered to. Obviously, a forecast of this kind is worth formulating where the State is able to plan the country's development.

8. The Comprehensive Programme of Scientific and Technological Progress for 20 years, substantiating the major elements, results and techniques of a unified technological policy, must absorb the rich information provided by numerous scientific and technological and socio-economic forecasts formulated in the USSR. It is equally obvious that both the rationale of individual task-oriented programmes and their contents can be substantiated only on the basis of preformulated forecasts.

9. In 1979 the CPSU Central Committee and the USSR Council of Ministers passed a resolution "On further improving the economic mechanism and the planning system". The above resolution initiated many an important

improvement in the national economic planning. To name a few:

(a) greater orientation of the national economic units to ultimate results, in particular, through performance evaluation of a number of industries by the value-added indicator;

(b) greater role of five-year plans due to switching the planning and incentives system from the basis of level of attainments to a system of stable annual plans and respective standards within the five-year plan;

(c) mandatory formulation of comprehensive programmes of scientific and technological progress in the USSR for the next twenty years (broken down by five-year periods), two years prior to the next five-year plan.

10. The Comprehensive Programme is a pre-plan document integrating the major aspects relating to effective innovations and their practical implementation. It is the Comprehensive Programme that provides the basis for practical implementation of programme planning techniques, and formulation of major scientific and technological programmes (including task-oriented complex programmes) which considerably affect sectoral and regional development and the effectiveness of inter-industry programmes.

11. The notion of scientific and technological progress is defined rather broadly from a systems position: it involves both new technology and materials, progressive structural changes and improvements in the economic mechanism and management of the national economy. The activities relating to scientific and technological changes are ranked by their priority and their potential contribution to the accomplishment of objectives set by the current and long-term plans.

II. THE EXPERIENCE IN FORECASTING TECHNOLOGICAL CHANGE

Organizing the forecasting

12. The preceding Comprehensive Programme was formulated under the guidance of the Research Council on Scientific, Technological and Social Forecasting. The latter, under the auspices of the USSR Academy of Sciences and the USSR State Committee for Science and

Technology, directed the activities of special committees along 27 lines of research (of which 16 covered scientific and technological and 11 socio-economic problems). The Comprehensive Programme was contributed by nearly 2,000 researchers, experts and practitioners representing more than 500 R + D and design organizations of different ministries and agencies. The USSR State Planning Committee also participated in the formulation of the Programme.

13. The work was carried out on the basis of hundreds of technological forecasts and engineering economy studies performed by research organizations, groups of scientists and experts. The scientific and technological committees operating within the framework of the Council, systematized and generalized, corrected and specified the forecasts and studies to make them comprehensive. Besides, the committees made specific recommendations and evaluated all social and economic implications of their accomplishment. Simultaneously, the major socio-economic problems were studied. It should be noted that account was taken of both the expected results of scientific and technological change, and the trends and objectives of the country's socio-economic development.

14. The studies associated with the Comprehensive Programme revealed that the major perspective directions of science and technology development can be obtained by two approaches:

(a) identification of the established trends of scientific and technological advance, and available stock of scientific ideas and evaluation of benefits from their introduction in the national economy; and

(b) determination of objective requirements based on the directions and rates of scientific and technological change and their relations to the major objectives of the national economic development.

The two approaches can help substantiate the necessity of engineering drastically new solutions and the redistribution of scientific and technical resources.

Analysis of preceding programmes

15. Presently, the Third Comprehensive Programme of Scientific and Technological Progress is being drawn up in the USSR. The analysis of the preceding programmes indicates that for all the difficulties associated with forecasting, nearly every technological change of top priority and two-thirds of the measures envisaged by the Programme were taken into account in the respective plans.

16. The Comprehensive Programme activities prompted the necessity for additional research which resulted in the development of several task-oriented scientific and technological programmes. Thus, it was found necessary to elaborate a specific programme of mechanization of manual labour and production of special equipment. It turned out that yet another programme was needed, concerned with more intensive specialization in engineering industry, and setting up of intersectoral specialized production. Ferrous metallurgy required a programme for expanding the assortment and improving the use parameters of the end-products which called for reduction of product material intensity, improvement of equipment reliability, and reduction of material processing costs. This programme will also cover the metal users so as to make them ready to employ the more sophisticated products.

17. The Comprehensive Programme also identified the necessity for a special programme to improve the energy consumption pattern in all branches of production and other activities.

18. The preceding Comprehensive Programme specified priorities in different branches of research with special emphasis on:

- electronics (including computers) that must provide the national economy with new automation and data transmission facilities and in so doing promote substantial increase in labour productivity,

- power engineering, including research on thermonuclear fusion that will considerably facilitate solution of the energy problem, and studies relating to atomic power plants, and development of efficient

techniques for obtaining liquid fuels from coal. It is hardly possible to make up for the growing scarcity of oil unless the latter problem is solved;

- new technologies - laser processing, powder metallurgy, use of intensive catalysts;

- agriculture - its mechanization, raising new breeds of plant and cattle, development of effective microbiological techniques of protein production;

- forecasting the weather and climatic changes, including man-made ones;

- study of the earth's structure, improvement of minerals and fuels prospecting methods;

- medicine, especially regarding health care;

- continuation of intensive research into the processes of living matter at cellular and molecular levels, nuclear physics, elementary-particle physics, and space;

- studies on humanities, particularly the study of social processes in modern society;

- instrumentation development, particularly for R + D.

19. The integration of the two aspects - scientific and technological and socio-economic - was the most difficult part of work on the Comprehensive Programme. It was carried out with specially developed indicators, reflecting social and economic results in each line of scientific and technological progress, as well as on the basis of integrated economic calculations. The calculations revealed the necessity for additional research into some problems which will later take the form of task-oriented scientific and technological programmes.

20. The resulting conclusions indicate that the scientific and technological potential available in the USSR allows, given its proper utilization, the improvement of the dynamics of production efficiency, i.e.;

- increasing the growth rates of public labour productivity in the national economy;
- improving the dynamics of investment efficiency and capital productivity indicators;
- drastically reducing the metal intensity of production;
- raising the crop and animal yielding capacity within the next 10 years;
- increasing the end-product output per unit of raw materials in forest, wood-making, pulp and paper, light industries and others;
- increasing electric power generation per unit of fuel.

III. METHODOLOGICAL FRAMEWORK

Methodology

21. The general theoretical basis for forecasting the national economic development is provided by the Marxist-Leninist economic theory. The basic content of forecasting lies in the qualitative and quantitative analysis of real-life economic processes and identification of objective conditions, factors and trends of development. Embracing all major reproduction elements of productive forces and production relations, rates and factors of economic growth and criteria and mechanisms for balanced economic development, the theory of reproduction provides a methodological basis for the formulation of specific principles of national economic forecasting.

22. Forecasting of the national economic development has a complex nature: it covers all facets and levels of the national economic development and is interrelated with social, demographic, scientific

and technological forecasting. Each of the listed problems is significant in itself and to some degree can be studied independently from the others. This also holds true for the more specific problems, especially of a sectoral and regional nature. When studying the methodological problems of formulating a complex forecast of the national economic development all major lines and facets of forecasting should be treated in a systems approach.

23. There are primarily the following methodological problems relating to the formulation of the Comprehensive Programme:

(a) Since the Programme is based on the results of many scientific, technological and economic forecasts, all forecasts should be unified methodologically.

(b) One of the requirements of the Comprehensive Programme implies a sufficiently complete substantiation of recommendations for scientific, and technological and socio-economic actions.

(c) There are problems which require follow-up studies and, accordingly, separate programmes.

(d) Co-ordination of scientific and technological, and socio-economic aspects of the Comprehensive Programme. It involves primarily the elaboration of a system of indicators and calculation techniques which make it possible to pass from the indicators of technology development (characteristics of equipment, technological processes, material properties, etc.) first to technical and economic indices and then to socio-economic indices.

24. Development of a multifaceted and multiple parameter programme, such as a Comprehensive Programme of technological change, requires systems methodology and high-speed computers. The Comprehensive Programme covers the entire spectrum of branches with their horizontal relationships and vertical time dynamics for approximately two decades.

Systems modelling

25. Accomplishment of this objective requires systems analysis and systems modelling of socio-economic processes. Formulation of long-term programmes of technological change presupposes an all-round systems evaluation of advanced technologies or innovations. These are:

- manufacture of a new product (new material, substance, kind of fuel or energy, new commodity or machine, type of production or erection, new service, etc.);
- new mode of production of an established product;
- standard mode of production requiring a wider scale of application or redeployment.

26. An innovation can secure economies in labour or scarce material resources, in energy or fuel; be oriented at higher quality of products or more reliable production; at improved working conditions or ecological environment, etc. Systems methodology is helpful in:

- selection of efficient innovations out of potential ones;
- ranking the efficient innovations by their contributions to the final objectives of socio-economic development;
- defining the scale of useful innovation application;
- determining the earliest time of introduction of the innovation.

Evaluation techniques

27. All this must be done with due regard to interdepartmental and foreign economic relations, and time schedules. Rather helpful in this respect are the formalized evaluation techniques, particularly in countries with planned economies. The formalized evaluation requires:

(a) models of new technologies;
(b) models of earlier technologies;
(c) models of the remaining stock of earlier technologies.

Althogether, the three models make up an economic model. Besides, formalized evaluation requires a criterion reflecting, together with a number of additional (task-oriented) constraints, the socio-economic goals of development.

28. Formalized evaluation is based on the solution of the following optimization problem: it is necessary to define the model variables (including the model of the application intensity of new and replaced technologies which, on the one hand, would provide for the model balance relationships and inequalities and special constraints, and on the other, would provide for the highest value of the criterion.)

29. If the application intensity of any technology (new or replaced) equals zero then the technology is of no use. Otherwise, it is useful. In the latter case it is possible to determine its contribution to the criterion: to solve the optimization problem, with the technology included in the set of available ones; and with it excluded. Then compare the criteria values. Should the technology be useless, a number of additional calculations can be carried out to define the boundary values of technology performance characteristics beyond which it becomes efficient.

30. This is the principal idea of the approach developed. Naturally, its realization runs into problems of adapting the described procedure to the real life environment. Primarily, this is the problem of size and information support.

31. The larger the quantity of simultaneously evaluated technologies, and the more detailed the model is, the more reliable the evaluation results are, but the more difficult it is to collect relevant data and make the calculations. In order to solve this contradiction, it is proposed to divide the procedure into two consecutive stages and do separate calculations within each stage.

32. The first stage is confined primarily to preliminary reduction of the initial set of new technologies by ignoring the ones not ready for industrial application, and through aggregation of several technologies in an aggregate one. The reduction is done within groups of similar technologies by Delphi techniques in combination with other techniques of calculation of innovation efficiency. Also, there are the so-called impact coefficients of specific industrial, technological, and economic parameters on the national economic criterion.

33. The second stage involves a detailed evaluation and interdepartmental co-ordination of the separate technologies. As in the preceding case, each separate technology is evaluated and compared with the respective replaced one. The technologies compared and their economic environment are described in detail - in an aggregated fashion. This enhances broad interindustry co-ordination and allows the determination of the potential contribution of the new technology to the criterion. In order to improve consistency, a test is set up not for a single technology

but for a host of technologies either competing or related in production and consumption, or both.

34. At present, there is a software for such techniques and the results obtained from the calculations will be used for the formulation of the Comprehensive Programme of Scientific and Technological Progress in the USSR up to 2005.

IV. COMPREHENSIVE PROGRAMME OF SCIENTIFIC AND TECHNOLOGICAL PROGRESS OF THE USSR FOR THE PERIOD OF UP TO 2005

The perspective

35. At present work is under way to prepare a Comprehensive Programme for 1986-2005 that will be larger in scale and more detailed as compared to the preceding one. It has to identify the trends in social development, emergence of new demands, and capabilities of science and technology in solving the emerging problems; it must co-ordinate science, production and economic potential with a view to accomplishing the long-range goals; formulate the key national economic problems to which the scientists' efforts, resources and means should be directed; and provide the basis for large-scale task-oriented programmes.

36. The period up to 2005 is an important stage in further improvement of the develped socialist society for which the advance of science and technology is treated as the key lever.

37. The decisions of the 26th Congress of the CPSU envisage swinging the USSR national economy to an intensive path of development through considerable acceleration of scientific and technological change; its transformation into the major material source of expansion of production; more rapid introduction of advanced and sophisticated technologies accompanied by wide-ranging replacement of obsolete equipment; improvement of implements; drastic changes in numerous technological processes; and higher technical level and quality of products.

38. The 1980s and the future manifest a new stage in the national economic development distinguished by a number of characteristics of significance in a long-term perspective. These are primarily:

- switching over to predominatly intensive development of the national economy due to a growing scarcity of resources such as labour, minerals, fuels, energy;
- a new type of reproduction wherein the growth rates of the final social product and of national income exceed those of the investment potential;
- considerable restructuring of the national economy, geographical redeployment of national economic projects and productive forces, i.e. shifting the energy and minerals base to the east of the USSR, reduction of the share of the process industry in the central regions of the USSR;
- sharp increase of the scale and interindustry nature of production, its complexity, product mix, and intensity of national economic relationships;
- ever-growing impact of social, ecological, and other non-economic factors requiring a relative increase of expenditure in other than production spheres.

39. The reasons listed and others urge the formulation of a wide range of measures with a view to implementing long-term strategies for increasing the efficiency of public production, and improving the organization for planning and management of the national economy, and for development and introduction of innovations.

40. The Comprehensive Programme of Scientific and Technological Progress envisages a comprehensive analysis of the major sectoral and interindustry lines of change: accomplishment of advanced structural changes; innovations; creation and utilization of all kinds of products and services; improvement of management and organization; of production, etc.

Focus of the Programme

41. The programme focuses on a number of major lines of renovation of the national economy through the improvement of the existing processes, and introduction of new technological processes, materials, machines and equipment:

- raising the level of electrification, power and energy availability per worker accompanied by the all-round economies in energy resources;
- acceleration of technological processes, wider application of highly effective catalytic reactions in production, introduction of new process procedures including those in extreme or close to extreme conditions, as well as high energy processes;
- cutting short the duration of production processes by radical changes in production techniques; transition to simple-operation technologies; to combination of different technological operations in a single plant; replacement, where it is economically feasible, of periodic processes by continuous processes;
- further chemical development in the national economy necessitated by the growing output and wider application of chemical materials; further introduction of chemical processes in all branches of production and services;
- improving the quality of traditional materials and creation of new structural, composite, elastomeric, fibre, film-forming materials with fixed consumer and technological properties;
- reduction of material intensity or products through changes in raw material processing methods, reduction of direct losses and waste, and utilization of new processes;
- considerable reduction of demand for ores and organic raw materials through wide-scale collection and secondary processing of waste or out of use metals and polymers;
- complex utilization of raw material resources, and introduction of technologies involving little or no waste;

- introduction of technologies and equipment operating on local resources;
- maximum enlargement of unit capacities of technological plants;
- introduction of technological processes providing for continuous renewal of products, their higher technical level and quality with a view to meeting the existing and emerging demands of the national economy and population;
- automation of process control and their optimization through computerization, especially with microprocessors.

42. Attention is drawn to structural changes in the national economy as one of the most important lines of technological advance. These are:

- changes in the relative level of development of different industries, share of their products in the GNP and national income, in fixed assets and labour costs;
- emergence of new or rapid development of selected industries;
- changes in the structure of technical means of manufacture of selected types of products;
- changes in the output mix;
- changes in the structure of materials used;
- substantial changes in the reserves of certain kinds of products and production facilities.

43. In future, impetus will be given to the industries stimulating scientific and technological advance as well as to the ones lagging behind and thus hampering the growth rates of the national economy. In particular, rapid development is envisaged in information services, computer technology and control facilities, machine building complexes, power engineering, transport, communications, agro-industrial complexes, and production of commodities.

44. Considerable structural changes are expected in production of structural materials: sharp increase is envisaged in production of composites, polymers and plastics, large-scale replacement of steel with aluminium, etc.

45. Radical changes are also expected in the structure of facilities oriented at reduction of labour, energy-, and material intensity of production and lessening environmental pollution.