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JPRS L/8842
4 January 1980

USSR Report

ECONOMIC AFFAIRS

(FOUO 1/80)

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SPECIAL ASPECTS OF NONMECHANICAL TYPES OF TECHNOLOGY

Moscow VOPROSY EKONOMIKI in Russian No 8, Aug 79 pp 18-27

[Article by G. Danilin]

[Text] Under conditions of developed socialism, the process of organically combining the achievements of the scientific and technical revolution with the advantages of the socialist economic system ensures a qualitative transformation of productive forces and, on that basis, continued improvement in production relations. All the material and substantive elements of the productive forces system are undergoing profound changes: tools and means of labor, sources of energy, objects of labor, administrative apparatus. Recognition of the essence of these changes is a necessary requisite to planning and managing the renovation and retooling of production on qualitatively new technical and technological foundations. As is known, this problem was posed at the 25th CPSU Congress.

Revealing the objective laws of the technical and technological development of production in an era of scientific and technical revolution and consideration of them in practical management can serve as the methodological requisite for selecting and giving preferential development to the most important directions of scientific and technical progress, for developing and systematically implementing a unified state technical policy. These laws could also comprise the initial methodological basis for developing both the state new equipment plan and the branch technical development plans, on which the rates of economic development, production growth and social labor productivity growth depend in decisive measure. Finally, an awareness of the laws generated by the scientific and technical revolution in the productive forces system is of important significance to further developing socialist economic and scientific-technical integration.

By the mid-20th century, the use of the material and substantive elements of productive forces had begun to approach the maximum possible. In the sphere of the traditional tools of labor operating on principles of mechanical technology, the maximum productivity values, capacities, speeds, response times, and so on, had basically been reached. For example, average automatic lathe speeds have stablized at 300-700 spindle revolutions per minute and the productivity of mechanical weaving machines does not exceed 5 m of fabric per hour; the speed of the fastest sewing machines is 4,500 stitches per minute. In agriculture, the basic fieldwork is done at 4-5 km per hour; potato harvesters operate at 1.0 to 1.6 km/hr. The limits of intensification of grain combine operating speeds have been reached: even a slight increase in the speed of rotation of the threshing drum will destroy the grain.

In metallurgy, increasing temperatures in the smelting units enables us to increase production efficiency and improve steel quality, but neither wood nor coal nor coke nor electric arcs enabled us to exceed 3,600°C. It became possible to exceed that limit by using plasma in smelting units. The temperature reaches 15,000°C in a plasma furnace developed through the cooperation of scientific and industrial organizations of the Soviet Union and the GDR for smelting high-alloy steel. Such a concentration of thermal energy considerably accelerates and improves the production process and significantly reduces the electric power expended per ton of steel. Because the smelting is done in an inert atmosphere, the degree of utilization of the alloying metals (chromium, manganese, molybdenum, tungsten and nickel) is nearly 100 percent.

Practically all the potential for increasing the size, power, carrying capacity, speed, and so on, of traditional means of labor, among which means of transport play an important role, has been used. The limits of internal combustion engines were exhausted in aviation by approximately the mid-1940's. The theoretically achievable speed of electric locomotives, which replaced steam locomotives, is 250-300 km/hr, with a designed speed of mass-produced freight locomotives of less than 100-120 km/hr. The average-technical speed of trucks is over two-fold less than the [theoretical] maximum limit. The average speed of modern passenger and cargo ships is 30-33 km/hr. The power of ship power plants has increased to 300,000 h.p. and is practically at the limit. These limitations are being overcome through the development of means of transport which operate on qualitatively new technical principles (magnetic-suspension trains, air-cushion ships and platforms, pneumatic containerized pipelines, and so forth).

The maximum potential of traditional sources of energy lies foremost in the stabilization of their efficiency, which is less than 40 percent for thermal electric power plants, the basic producers of energy. This limit cannot be overcome on the basis of known methods of obtaining nuclear energy, since the production of electricity at nuclear power plants is based on the traditional technological scheme of "boiler - turbine - generator - transformer." The methods currently used to transmit electric power are also approaching the theoretical limit of their potential (the maximum possible power transmission line voltage is 2.2 to 2.5 million volts). Trunk power transmission lines of 1.15 million volts will be built in the 10th Five-Year Plan.

The maximum potential of traditional energy sources will be overcome on the basis of seeking out direct, nonmachine methods of converting primary types of energy into electrical energy by thermoelectric, thermoelectronic, magnitohydrodynamic, electromechanical and photoelectric methods. One promising method is magnetohydrodynamics (MHD) to obtain electric power without boilers, turbines or generators, which enables us to use temperatures of up to 2,200 to 2,700°C and achieve an efficiency of about 50-60 percent, instead of the 40 percent we get with the best thermal electric power plants. In our country, we propose to create an approximately one million kilowatt industrial MHD generator. Methods are being developed to convert solar radiation, wind, ocean waves and tides to electric power. Cryogenic superconductor cables with efficiencies of over 99 percent are being developed. They will enable us to ensure the underground transmission of large electric power currents with practically no losses.

The maximum potential of objects of labor is manifested not only in the limited number of natural types of such objects, but also in revealing the limits to improving their qualities and properties. This applies to traditional structural materials, and first of all to the primary objects of industrial labor, metals and alloys. Over the past 20-25 years, the strength of the basic structural materials widely used in machine building has increased insignificantly: aluminum alloys -- by 10-15 kgs/mm^2, structural steel -- by 30 kgs/mm^2. The rate of growth in the strength of titanium alloys has been roughly the same. The average increment in alloy high-temperature strength over the past 25 years did not exceed 8-10°C per year. The specific modulus of elasticity of aluminum, titanium, iron, molybdenum and other metals has not changed for the past quarter century.[1] Specialists think the opportunities for further improving the physical and chemical properties of traditional materials are very limited, since their production is based on the principle of using just the natural properties of objects of labor.

The quantitative and qualitative limits on the objects of labor are being overcome by developing a new class of materials with a complex of structural and special properties which are practically unattainable in the traditional metals and alloys. For example, to build nuclear reactors we need pure zirconium and superstrength radiation- and corrosion-resistant brands of stainless steel. A quarter of a century ago, such materials were unknown, and now they are being produced on an industrial scale. Fundamentally new materials with improved strength and heat resistance -- citalls [devitrified glass such as Pyroceram] and slag-citalls -- have been created based on the controlled submicroscopic crystallization of glass. Titanium alloys have become irreplaceable structural materials for space equipment and chemical machine building. The promising direction of creating various types of composite materials has arisen within the past decade.

The maximum psychophysiological potential of man as the chief element in the system of productive forces was revealed in the mid-20th century. In a converter shop, the flow of information steelmakers must process to control the technological process is approximately 4-5 times more than a person can normally handle. Modern continuous pipe-rolling mills operate at 18 m/sec (65

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1. See: A. T. Tumanov, "Composites, the Materials of the Future" in VESTNIK AKADEMII NAUK SSSR No 3, 1975, p 37.

km/hr). A man is not capable of visually monitoring the finished output and rejecting pipe with obvious defects. It has been established that the maximum reading speed approaches 100,000 characters per hour; human ability to perceive and process information is a maximum of 60-70 bits per second, and so forth.[1]

Revealing the maximum potential of individual elements of the productive forces system (tools and means of labor, sources of energy, objects of labor, man as the "natural unit" of processing data) testifies to the limited nature of this system as a whole under modern conditions. Economically, it is manifested in the inability of that system to ensure a level of social labor productivity adequate to economic and spiritual needs.

The natural-science basis of the process being examined here is exhaustion of the potential of laws of the mechanical way of moving matter which are materialized in the traditional tools and means of labor, energy sources and means of transport. K. Marx noted that machine tools of labor are based on "using the laws of mechanics, which occurs in that portion of the machine which is operating."[2] Their maximum potential is overcome based on the embodiment in various functional types of technical means of nonmechanical ways of moving matter which are based on intermolecular, intramolecular, atomic and subatomic energy bonds. This permits developing qualitatively new elements of the productive forces system which open up prospects for the qualitative transformation of the entire system as a whole.

The tools of labor form the pivot of production equipment. Scientists have noted correctly that "structural advances in tools of labor are the direct form in which scientific and technical progress is manifested, and planning and managing the structure of the tools of labor" is one of the primary objects of planning and managing scientific and technical progress."[3] Using the example of the leading material-substantive element of the productive forces system, let us examine in more detail several specific features of the qualitatively new tools of labor and types of technology. How are changes occurring in them?

New methods of obtaining metals are being developed in nonferrous metallurgy. For example, we now have microbiological metallurgy, which is used to obtain copper, zinc, nickel, arsenic, cobalt, cadmium, titanium, aluminum, selenium,

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1. The maximum psychophysiological potential of man (in a purely quantitative regard, not in the cognitive, heuristic sense) is being overcome by automating the control of technological (production) and nontechnological systems (planning and managing production, solving scientific-research and planning-design problems, optimizing transport flows, medical diagnostics, and so forth).

2. K. Marx and F. Engels, "Soch." [Works], Vol 47, p 355.

3. D. Palterovich, "Technical Progress and Planning the Structure of the Tools of Labor," in VOPROSY EKONOMIKI, No 2, 1979, p 36.

rhenium, tin and others. The use of microbes as "metallurgists" is extremely advantageous. Underground bacterial leaching enables us to reduce the prime cost of metals and mined chemical raw material three- to five-fold as compared with mining methods and to increase labor productivity three- to eight-fold. These methods provide an opportunity to work deep or worked-out deposits and dumps to great economic advantage and to reduce sharply the land area occupied by mining enterprises. It will no longer be necessary for people to work underground or to create mines. Such labor-intensive operations as transporting, crushing and melting the ore will become unnecessary.

The development of nuclear power engineering, space equipment, radio electronics, high-speed aviation and several other technical means has required the broad application of heat-resistant, stainless, magnetic, anticavitational and other high-alloy steels and solid alloys, as well as of such durable materials as silicon, germanium, ferrites, rubies, diamonds and others. In our country, we have developed a series of heat-resistant alloys based on titanium, have mastered alloys of many rare metals, and have developed effective methods of obtaining bimetals. Refractory inorganic compounds have been synthesized to produce high-strength, fireproof, corrosion-resistant and other materials.

A majority of such materials either cannot or can barely be worked by traditional mechanical methods. In this connection, it has become necessary to develop new methods of working these hard to process and "nontechnological" materials. Science is opening up more and more methods of nonmechanical treatment whose use replaces the cutting tool with electrons, laser beams, sound and water vibrations, plasma, ultrasound, magnetic fields, explosions, and so on.

In electromachining, one type of electroerosional metalworking method,[1] the shape of the part changes in response to an electrical spark which evaporates minute portions of a metal and fuses them by thermal explosion on the surface being treated. Local temperatures of 10,000 to 20,000°C are achieved and the energy density is on the order of several thousand million watts per square centimeter. For example, a very thin wire acts as the cutter on a machine to manufacture precision dies -- small metal plates with openings through which plastic is forced under pressure and divided into synthetic thread invisible to the naked eye. At the point where the wire meets the disc, electric sparks make an opening visible only under a microscope. In arc electromachining, the openings are bored to the needed dimensions with an accuracy of 1-2 microns and with class 10 smoothness of the inner surface. Both machines are automatically controlled.

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1. Depending on the type of electrical discharge (spark, arc), the magnitude of the impulse current, voltage, and other conditions, electroerosion processing includes four main varieties -- electricspark, electricimpulse, electriccontact and anode-mechanical. Each is distinguished by [different] technological characteristics and each has its own sphere of industrial application.

Electroerosional methods of working metal increase equipment productivity many-fold. Thus, a metal mold for manufacturing the tread of motor vehicle tires is worked 30 times faster on an electoerosion machine than on an ordinary milling machine. It takes 90 minutes to hatch grinder cylinders instead of the 1,000 to 1,500 minutes (2-3 shifts) needed with mechanical methods. The digital programmed-control units produced by the Kirovakan Precision Machine Tools Plant for electroerosion production of complex stamps increase labor productivity five-fold and ensure accuracies of up to 0.5 micron.

The necessity of working high-strength and heat-resistant alloys and of manufacturing parts of extremely complex or unusual shapes from super-strength materials has required the use of electrochemical methods. Their efficiencies reach more than 80-90 percent. On electrochemical machine tools, an electrolyte is fed under great pressure into the working zone between the positively charged part being worked and the negatively charged "tool." A high-frequency pulsating current causes thousands of minute discharges whose thermal energy shears particles of substance off the part being worked; the particles are washed off by the electrolyte. As the excess material is removed from the article, the mirror shape of the tool is accurately reproduced. Electrochemical methods enable us to work any metallic or nonmetallic conductive material regardless of mechanical properties. Characteristically, the tool does not wear and a high degree of precision is ensured with automatic control.

Supersonic aircraft fuselage parts, for example, are worked by electrochemical milling. We manage to obtain parts with greater precision and less weight than with mechanical processing, and the aerodynamic properties of the surfaces are improved. Equipment productivity is increased two- to 10-fold or more, since the parts are worked from both sides simultaneously.

When beams are used, excess material is removed not by a cutting tool, as with ordinary machine tools, but directly by concentrated light, electron or ion beams with high energy densities. Domestic industry has switched over completely to laser drilling of openings in rubies for watches.

Stamping by hydraulic impact, a magnetic field or explosion is emerging to replace mechanical stamping. The Sibir' impulse hydraulic press, with an energy of 200 ton-meters, enables us to stamp metal parts in a single blow. Costs drop from tens of rubles to kopecks. With the MIOM (magnetic impulse metalworking) installation, metal blanks are molded using a powerful electromagnetic field, without using molds or stamps. There are may advantages of such stamping: there is no need for expensive stamps, the tool does not contact the item being worked, and the magnetic field penetrates nonconductive materials, which can be given any shape.

Explosion stamping is being used successfully at the Novosibirsk Aviation Plant imeni V. P. Chkalov, for example. It increases labor productivity six- to seven-fold and ensures high-quality products: no subsequent finishing work is required. Parts of the most complex shapes are manufactured from metals which do not combine with one another by ordinary methods by using a momentary explosion. New welding methods are being born. The Patontsis/700 developed in our country for electron beam welding of automobile parts has increased labor productivity three-fold and reduced capital investment two-fold.

Powder metallurgy throws down a challenge to the mechanical working of metal parts. It enables us to manufacture parts of precise dimension and shape in a fraction of a second by caking and extruding metal powder to finished dimensions. An automatic press for manufacturing stamps makes hundreds of very precise stamps per minute. In this regard, material losses associated with casting, rolling and machining ingots are sharply reduced. Whereas shavings scrap comprises 20-80 percent for machining, there are practically no such scraps in powder metallurgy technology. Powder metallurgy equipment is simpler and less expensive than standard machine tools. According to data from the Institute of Problems of Materials Technology of the Ukrainian SSR Academy of Sciences, the lead organization in our country for powder metallurgy, the manufacture of 10,000 tons of items (the capacity of a large shop) caked from iron powder would free about 2,000 workers, 1,000 machine tools and provide a savings of 20,000 tons of rolled metal, with an economic impact of 15 million rubles per year.

Powder metallurgy enables us to obtain materials with unique properties (friction for heavy-duty operating conditions, heat-resistant, corrosion-resistant, and others), reduces the number of operations, uses smaller presses, the pressing is done at lower temperatures, less energy is spent on preheating the blanks, metal scrap is reduced since oxidation and machining losses are eliminated, output quality is improved, the overall weight of the output is reduced, defects are reduced, and so on.

In recent years, ultrasound has found increasing industrial application in the automatic joining of plastic parts. High-frequency vibrations enable us to create localized high temperatures needed to weld the parts. Ultrasound installations are used to join plastics in a fraction of a second, to press metal parts to plastic, to apply plastic coatings onto metal and nonmetallic parts.

A young textile industry branch, the production of nonwoven materials, is being developed. As compared with looms, the productivity of equipment for producing nonwoven materials by the knitting and trimming method increases 10- to 12-fold and by the sizing method by 60- to 70-fold. In our country, a method of obtaining nonwoven materials using radiation has been patented. These materials possess a number of valuable properties and are being used for sound and heat insulation, to manufacture filters, and for other purposes.

Highly efficient automated flow lines to produce napped nonwoven materials using an electrical field are in operation at the number of enterprises of light and chemical industry. They produce a variety of household and industrial materials to cover floors and the stitching on clothing and footwear made of artificial leather, and to manufacture parts and structures needed in radio industry, transport machine building, instrument making and other branches. When using technology for producing napped nonwoven materials, fibers of capron, nitron, lavsan [Dacron], viscose, fiberglass, and so on, are "sheared" into pieces 0.2 to 10 mm long, specially processed, put into a hopper under which is a base (fabric, knitwear, paper, metal, rubber and others) covered with glue, and electrified. The sticky layer is given a negative charge and the positively charged naps drop from the hopper onto the sticky layer. Under the influence of an electrical field, the nap fibers can be sunk into the glue to a prescribed depth, vertically or at a certain angle, with identical or different densities. After brief drying, the material is ready. The savings from introducing this technology were 34.2 million rubles per year. Automatic lines producing rug-type napped materials are tens of times more productive than ordinary rug-weaving machines. The cost of such rugs is considerably lower than that for woven rugs, and their durability is approximately 10-fold higher.

Mechanical sewing is beginning to be eclipsed by various nonmechanical methods of joining clothing parts. Ultrasound installations which enable us to sew articles with threadless seams twice as fast are being introduced into garment industry. Technology is being developed for manufacturing clothing by shaping directly from the fibers and synthetic materials, without spinning, weaving or sewing. The possibility of using high-frequency currents to join garment parts is being investigated.

The very latest types of technology are also invading other branches producing consumer goods. Chairs are cast out of durable plastic on automated lines at the Fanerodetal' Combine in Bendery. This saves thousands of cubic meters of wood. At the Novosibirsk Leather Haberdashery Factory, suitcases are manufactured using space welding by high-frequency currents. Labor productivity is two- to 2.5-fold higher. Quartz wristwatches and table clocks with no mechanically moving parts are being series produced. When exposed to an electrical field, the quartz plates in them oscillate at a very constant frequency. These oscillations are converted by an electrical circuit into impulses which are transmitted to a digital display. These watches are accurate to ±1 second per month.

Tools of labor which operate on the basis of nonmechanical types of technologs are characterized by a number of specific features which create an objective natural science basis for qualitative advances in the productivity of tools of labor, units and technological processes.

First, they are universal in application, that is, they are capable of acting on a variety of objects of labor and of performing the most diverse technological functions and operations. For example, industrial lasers can work plastics, metals, wood, paper and other materials. They can cut, drill, weld, solder, harden, deburr, mark, plate, and so on. A laser beam can weld metal to glass and ceramics, steel to copper, beryllium, titanium and various alloys. Control devices based on lasers are being developed.

Second, tools of labor for nonmechanical metalworking lack three links characteristic of mechanical tools of labor (engine, transmission, machine-tool). These three links are generally merged and thus eliminated in tools of labor operating on a base of nonmechanical types of technology. The clearest example is detonation technology. The "tool of labor" by which the explosion acts on the material being worked is a shock wave which combines a large amount of heat and high pressures. Their effects last some ten-thousandths of a second. The primary power effect is achieved thanks to the fact that the explosive combines the functions of a machine-engine supplying energy, a transmission, and a machine-tool producing a prescribed technological process. The combination of 1,000-degree temperatures and high pressures enables us to simultaneously both give the object of labor the needed shape and also to improve the properties of the substance comprising it. For example, detonation technology enabled us to revolutionize the vulcanization process by which natural rubber is cured. Under a shock-wave pressure of 100,000 N/m^2 for 0.00001 sec, the explosion "sews up" long rubber molecules, converting 100 percent of the raw material into the end product, vulcanized rubber.[1]

Third, the tools of labor being examined here materialize forms of movement of matter at the intermolecular, molecular, atomic and subatomic levels. As compared with mechanical movement, these processes are extremely brief. In stressing the fundamental difference between the mechanical form of movement of matter and nonmechanical forms, V. I. Lenin wrote: "The world is matter in motion...and the laws of motion of this matter reflect mechanics, relative to slow movement, and electromagnetic theory, relative to fast movement...."[2] Thus, whereas in micron areas the mechanical effect on a substance is tenths or hundredths of a second long in the best case, nonmechanical forms of movement of matter "operate" in time-space stages of 10^{-13} cm and 10^{-23} sec.

Fourth, with the introduction of nonmechanical types of technology, objective conditions for automating control processes are created. Nonmechanical forms of the movement of matter are not directly controllable by the human sense organs, and so transferring the functions they perform to technical means of control enables us to eliminate subjective errors in sensing information, issuing control instructions and executing them; it provides technical opportunities for rationalizing and optimizing the course of technological processes.

Thus, modern production is beginning to shift from traditional, mechanical technology to a qualitatively new, nonmechanical technology using forms of movement of matter at the intermolecular, molecular, atomic and subatomic levels. The advantages of the very latest types of technology include: a reduction in the number of technological operations; performing operations which cannot be performed by traditional technological methods; no wearing

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1. See: L. M. Geyman, "Vzryv" [Explosion], Izd-vo "Nauka", 1978, p 12.

2. V. I. Lenin, "Polnoye sobraniye sochineniy" [Complete Collected Works], Vol 18, p 298.

out of the tool, since in many cases it does not contact the object of labor; higher quality and fewer defects; high precision with automatic control; economy of materials and electricity; reduced prime cost; reduced specific capital investment per unit of useful impact; minimization or complete elimination of harmful discharges into the environment; possibility of achieving qualitatively new social labor productivity.

Of course, use of these advantages can produce results only on the condition that the latest types of technology are introduced extensively into industry. Machine-tools for nonmechanical working of materials currently account for only an insignificant proportion of the equipment. For example, specialists estimate that electrophysical, electrochemical and beam metalworking methods comprise about one percent of all technological operations being performed.

The replacement of mechanical by nonmechanical technology is an objective law of the development of production equipment, so the development of machine-tools and technological processes based on the use of forms of movement of matter on the molecular, atomic and subatomic levels is one of the most important principles of the unified state technical policy. Their production and introduction are the basis for developing the productive forces of developed socialist society at a qualitatively new level and the primary direction of retooling production. At the same time, this should not be understood as a conflict between the latest types of technology and traditional types. On the contrary, it is a matter of their simultaneous, mutually supplementing development to facilitate increasing the effectiveness of social production on the basis of the economical use of all production resources and social labor productivity growth. The use of all existing forms of moving matter, both those which arise naturally and also those which can be artificially created by man, is necessary and inevitable in the production of the future.

Machine building and its basis, machine tool manufacturing, are the material foundation for actualizing the achievements of the scientific and technical revolution. The creation of qualitatively new tools of labor occupies the most important place among the achievements of the scientific and technical revolution. Therefore, in order to successfully master the achievements of the scientific and technical revolution, we need first of all to ensure steady, high, outstripping rates of growth in the production of the latest tools of labor and introduction of new types of technology. In order to guide this process and to increase its dynamicity, it is appropriate to delineate in the summary results of machine building and machine tool manufacturing gross output their most important output for the retooling of production, tools of labor based on nonmechanical technology. This proportion must steadily grow. To maintain the priority of producing new-quality tools of labor, capital investment in this sphere must be increased.

In order to plan and direct the retooling of production on a qualitatively new technological basis, it is important to determine indicators which will enable us to measure the scope and rate of introduction and the degree of use of nonmechanical tools of labor in the national economy. The achieved level of introduction and use of the latest tools of labor should in the opinion of some be determined based on the indicator of proportion of enterprises which have introduced them. In this instance, both enterprises which are just beginning and those which have already or are now carrying out an extensive changeover to the latest tools of labor would fall into a single statistical category. The indicator of proportion of production personnel employed at servicing the latest tools of labor is also unsuitable for these purposes. For all its attractiveness, this indicator cannot be called satisfactory because it describes not the economic results of retooling production, but only certain of its social consequences. The indicator of proportion of output produced using the latest tools of labor seems to us to be more suitable. It can very effectively reflect the scope and rate of retooling production, since it is linked to end national economic results. Of course, the indicator of amount of nonmechanical tools of labor produced and introduced is also important in this regard.

The historical experience of USSR industrialization testifies to the fact that the retooling of production begins with heavy industry, machine building and machine tool manufacturing. Industry producing the means of production must concentrate its efforts on changing its own technical base over to nonmechanical technology, so as to accelerate the subsequent transition of all other branches and productions to the use of nonmechanical machine-tools. This changeover must be carried out in a certain sequence, which requires inclusion in the qualitative restructuring process of both traditional and new branches, those born of the scientific and technical revolution (as for example, radio electronics, microbiological industry, nuclear power machine building, and others), as well as agricultural production, transport, the services sphere, culture and personal services.

The universal nature of the latest tools of labor predetermines that they will belong to many ministries and departments, which serves as one of the objective reasons for the difficulties still being encountered en route to developing, producing and introducing them. The departmental position makes especially difficult the actualization of scientific and technical achievements of interbranch application. The latest tools of labor often do not become part of the products list of ministry basic production. As a result, it turns out that the most important direction of production retooling is left without a manager and without an adequate material base.

The necessity of improving the organizational structure and methods of management as an important link in improving management of the economy was noted at the 25th CPSU Congress. "...The question has arisen," L. I. Brezhnev said in the Accountability Report, "of perfecting methods of comprehensively solving major statewide, interbranch and territorial problems. In this we require unified, centralized programs encompassing all work stages, from planning to practical realization. It is important that in each instance there be specific agencies and specific people bearing full responsibility and coordinating all efforts within particular programs." Along these lines it is also appropriate, obviously, to solve organizational problems of creating and developing the latest tools of labor.

The replacement of technologies which is occurring during the course of the scientific and technical revolution marks the start of a new stage in the collectivization of socialist production. It promotes the intensification of the concentration of production and profound changes in its branch structure, in the forms of national economic planning and management in the direction of gradually departing from a one-sided, narrow, branch-oriented approach towards a significant strengthening of interbranch principles.

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CSO: 1820

BOOK ON ECONOMY OF SIBERIA REVIEWED

Moscow VOPROSY EKONOMIKI in Russian, No 9, Sep 79 pp 144-146

[Review by V. Kistanov of the book "Razvitiye narodnogo khozyaystva Sibiri" edited by Academician A. G. Aganbegyan, M. K. Bandman (responsible editor), B. S. Zarkhin, V. P. Mozhin, B. P. Orlov (responsible editor), B. E Popov, Z. R. Tsimdina (responsible editor), and R. I. Shniper, "Nauka" Publishing House, Siberian Branch, Novosibirsk, 1978, 376 pages]

[Text] A collective of scientists from the Institute of the Economics and Organization of Industrial Production of the Siberian Branch of the USSR Academy of Sciences has prepared a new major work which generalizes the results of studies connected with validating the directions, structure, and development rates of Siberia's economy. In contrast to a previous book "Economic Problems of the Development of Siberia" which was published in 1974 and was devoted chiefly to methodological and methods problems, the parameters and proportions of the long-term economic development of the region are primarily analyzed and forecast here.

The monograph is subdivided into three large sections in the first of which the general economic problems of Siberia are examined. The basic theoretical problems of overall territorial planning are treated here: the most important aspects of the formation of the conception of the overall development of the economy of the region, an analysis of the probable directions and a choice of the variants for its long-term development, and a comparison of expenditures against results in the regional reproduction process. The inclusion in this section of chapters on the principles and methods of territorial forecasting raises its scientific level.

Attention is called in the work to the necessity for a clear formulation of the conception of the development of an area which is regarded as "a system of theoretical views on the purpose and most acceptable directions of the long-term development of a regional economy, and also of the principles and methods of this development." (Page 15) In this connection, an analysis is made of the basic component parts of a regional economic conception and a definition of the goals and tasks of the social and economic development of a region is assigned a most important place among them.

Touching upon the problems of a study of the probable directions of and the selection of the variants of the long-term development of an area, the author of the chapter emphasizes the important role of a situational analysis which is regarded as the most acceptable method of determining an appropriate economic strategy. With respect to Siberia, the problems of an overall use of its fuel and energy and raw material potential and of following a labor-saving policy are put forward as the decisive ones. In accordance with this, the basic regional development variants have to provide different directions for the use of energy (fuel) and labor resources.

In the opinion of the author, the problem of regional efficiency has two aspects: a determination of the expediency of developing individual branches and an evaluation of the economical nature of the entire reproduction process. It is proposed that the efficiency of a regional economy be calculated (dynamically) through the indicator of the resource intensiveness of a unit of net output. (Page 70) The work considers the little studied problem of the influence of stocks (scientific, planning, construction, and others) and the resources connected with their creation on the relative weights of expenditures and results in a region.

However, we would like to take note in this chapter of a number of propositions which seem to us to be quite controversial. Thus, wide use is made in it of the term "regional economy" by which, in contrast to certain other known points of view, the concrete economy of an area is meant. However, no arguments are cited in the work in favor of this kind of interpretation.

Other questions which are touched upon in this chapter also are open to discussion. For example, in our opinion, there is an exaggeration of the importance for a regional economy of the relationship between accumulations and consumption (page 32) which, in its essence, is a state problem. It is debatable to explain the function of pre-planning research by the demand for "mastering" a large amount of primary information necessary for territorial planning (page 23), while in reality this is connected with the necessity for a deep scientific work-up of very important problems.

In the first section of the monograph a great deal of attention is devoted to the social and economic problems of Siberia, to scientific and technological progress and an intensification of the economy, and to the preservation and efficient use of natural resources. The principles of forecasting the needs of a region for labor resources are examined here. At the same time, emphasis is given to the necessity for satisfying the material and social needs of people at a level which is at least no lower than in other areas. (Page 91)

In our opinion, this kind of approach somewhat impoverishes the content of this problem. It is not sufficient to insure merely an inter-regional equalization of standards of living. It is important in areas which are being opened up not to permit large gaps in the living conditions of the workers of different branches (especially in the mass occupations). In connection with this, the book should have provided a more detailed analysis of the entire complex of problems which have to do with the expediency of branch wage differentiations in one or another region.

In determining the structure and amount of the consumption fund the author of the chapter based himself not only on normative rations, but also took account of the income level of the population of Siberia, and also the prospects for its growth. These premises are put at the basis of the calculations of the growth rates of wages and of total income. (Page 122)

With regard to Siberia, the task of a reorientation toward a primarily intensive development and a substantial increase in economic efficiency is an especially acute one. In the work production intensification indicators are proposed and calculated, the chief of which are "level of technology" (a derivative of labor productivity and yield from capital) and an increase in net output on the basis of scientific and technological progress. (Pages 128-129)

A separate chapter of the monograph is devoted to the problems of the preservation and efficient use of natural resources. However, this problem is considered in it from the theoretical and methodological point of view. As a result, the chapter appears to be unconnected with the rest of the book.

In the second section of the monograph (Chapters 5-13) there is an analysis of the development of the individual branches of Siberia's economy -- the fuel and energy, petroleum, chemical, and timber and timber processing industries, ferrous metallurgy, machine building and metal working, the construction industry, transportation, and the agro-industrial complex.

The most important directions of the development of the Siberian economy -- an accelerated growth of power engineering and of energy intensive productions -- are reflected in the directive documents of the party and government. Basing themselves on them, the authors treat a wide range of problems -- the role of a branch in the economy of an area, the state of and the prospects for expanding the raw material base, the influence of the labor factor and of the consumption of output on the overall nature of the development of a region's economy, an improvement of the technical base of a branch, its production and territorial structure, and an evaluation of the economic efficiency of its development and siting. In a number of chapters the problems of improving the economic mechanism of management are also dealt with. The chief emphasis here is put on a variant forecasting of the rates, amounts, and proportions of production (as a rule, two stages are distinguished -- the immediate and the remote perspective).

During the course of a detailed analysis of the most important problems the necessity for new approaches to their solution is validated. Around 80 variants of the use petroleum, gas, neuclear fuel, and coal obtained by the open-strip method are examined in order to optimize the country's future fuel and energy complex (including Siberia). It is established that the consumption of western Siberian fuel will be efficient even with a hypothetical increase in its cost: petroleum -- 2.5 to 2.7 times, gas -- 2 times, and Kansko-Achinsk coal (with partial processing) -- 2 to 3 times. (Pages 165, 172)

The authors have attempted to estimate the needs for the output of related branches in order to extract the various types of fuel in Siberia. According to their calculations, the extraction and distribution of gas requires three times as much ferrous metals and construction materials as the extraction and transportation of an equivalent amount of coal. In view of this and also of the reliability factor of fuel supplies, the conclusion is drawn that it is advisable to include additional coal in the fuel balance. As a result, it follows from the analysis which has been performed that Siberia is able to provide for the extraction of half of the energy resources produced in the country. (Page 173)

However, certain proposals which are formulated in the monograph, particularly with regard to increasing the proportion of mazut which is produced by Siberian petroleum refining plants (for its expanded use for technological purposes and by small consumers) require additional substantiation.

Considerations are cited in the book regarding the expediency of increasing the development rates in Siberia of highly efficient branches of industry -- petrochemistry, ferrous metallurgy, and timber processing -- and of the accelerated development of railroad transport. However, it seems to us that the program for the development of the labor intensive branches of machine building which is substantiated in the work is over stated. The author of the chapter proceeds here from a clearly exaggerated estimate of the consumption output factor.

The most difficult current problems in the development of Siberia are the relative shortage of labor resources and the necessity for using large amounts of capital investments for new construction. For this reason we need a relative analysis of the economic expediency of siting different branches in this region. In bringing about the accelerated development of effective branches of specialization and of the infrastructure we should not complicate the program for the development of Siberia and should make wider use of the possibilities of "old" areas for supplying certain means of production and consumer goods.

A number of branches of machine building have to be developed in Siberia, first of all, heavy machine building which is metal intensive and relatively energy intensive and this is demonstrated well in the book under review. However, in our view, machine tools, instruments, and certain electrical engineering products and other labor intensive and transportable output which is least efficient for production locally (some light industry goods are also in this group) should be supplied from the European part of the country and from Central Asia. Otherwise, it will be necessary to import and provide arrangements for additional labor power (in terms of location efficiency it should probably be evaluated as a "connected" and more expensive resource).

In this connection, we regard as controversial the position of the authors of the chapter on scientific and technological progress who believe that the small proportion in it of instrument making, experimental machine building, and the production of computer equipment is a shortcoming of the structure of Siberia's scientific and technical potential. Only in individual cases are such enterprises able to play the role here of supplementary (balancing) productions.

In general, the conception of a broad and frontal development of the productive forces of the region is clearly expressed in the monograph. It would probably also have been useful to evaluate a variant with a more limited composition of leading branches.

One other shortcoming of the work should be noted. In the agricultural forecast cited in the book there should have been a demonstration of its comparative efficiency as against other areas. Again, the use of scientific consumption norms in the calculations should have been preceeded by an analysis of when it will be possible to achieve them in our country.

In the concluding section of the work -- on the regional problems of the development of the economy of Siberia (Chapters 14-19) -- an examination is made of the problems of developing petroleum and gas resources of the West Siberian plain, the development of the southern zones of Western Siberia, the development of the Angaro-Yenisey area, the formation of the economic complex of Zabaykal'ye, the construction of the Baykal-Amur main line, and the exploitation of the resources of southern Yakutiya and the contiguous areas of the Siberian North (on the example of the Yakut ASSR). The basic attention here is devoted to an analysis of the chief problem of the development of each area and of the economic structure of its complex (including the infrastructure), of the need for labor resources, and of an intra-area territorial organization of production (separate industrial complexes and centers).

The ways of improving the branch structure of the economies of the individual areas of Siberia are characterized in the book and interesting recommendations are made. The authors are critical of the proposals of certain organizations to develop light industry extensively here. Facts are cited in the work which confirm that these organizations made miscalculations in deciding to build large textile combines in the Kuzbass which are now experiencing considerable difficulties with staffing and utilizing production capacities. (Page 321)

On the whole, the monograph is of unquestionable value both as a theoretical methodological and practical study of an important economic problem. The materials, conclusions, and recommendations contained in it merit the attention of planning agencies.

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MANAGEMENT OF SCIENTIFIC AND TECHNOLOGICAL PROGRESS DISCUSSED

Moscow VOPROSY EKONOMIKI in Russian No 10, Oct 79 pp 124-134

[Article by V. Ivanchenko and A. Sobrovin: "The Management of Scientific and Technological Progress"]

[Text] In developing its economic and social policy the party proceeds from the necessity for an overall approach to the solution of the problems of scientific and technological progress, for an organic unity between science and production, and for the accelerated use in the economy of the best scientific and technical achievements. "Communism," V. I. Lenin wrote, "represents a higher productivity than capitalist productivity of the labor of voluntary and conscious workers who are united and who make use of advanced equipment."* He also said: "...The upper hand is taken by the one who has the greatest equipment, organization, discipline, and the best machines...."** These Leninist propositions are decisive in the formation of scientific and technical policies at all of the stages of socialist construction. They become especially important under developed socialism.

The consistent realization of the course of the CPSU aimed at scientific and technological progress has been one of the most important ways of creating the material and technical base of developed socialism and of the country's single national economic complex which are based on a mightly socialist industry. An enormous scientific and technical and production potential has been created in our country in an historically brief period of time. In 1978 there were 1,314,000 scientific workers in the USSR -- one-fourth of the world's scientific workers. In the same year the expenditures for scientific and technical development reached 19.3 billion rubles and have been growing annually at rates which exceed the growth rates of the expenditures for these purposes in the USA and other developed capitalist countries.

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* V. I. Lenin, "Complete Works," Vol. 39, p 22.

** V. I. Lenin, "Complete Works," Vol. 36, p 116

USSR industry now has more than 155,000 mechanized, flow, and automated lines, around 80,000 overall mechanized and automated sectors, shops, and productions, and around 55,000 units of equipment with programmed controls. An increase in labor productivity is the most important result of the great changes in the labor equipment ratio. During the years 1928-1978 labor productivity in industry increased by 23 times, in agriculture by 5.8 times, and in construction by 15.5 times. Important changes are taking place every year in renewal of production, an improvement of output quality, and in reducing specific expenditures of resources.

One of the advantages of socialism consists in the fact that public ownership and the socialist economic system make it possible to subordinate the development of science and technology to the interests of the entire people. In the Summary Report of the CC CPSU to the 25th Party Congress it was emphasized that only under socialism does the scientific and technological revolution acquire a correct direction which accords with the interests of man and society and, in its turn, only on the basis of an accelerated development of science and technology can the final tasks of the social revolution be achieved -- the construction of a communist society.

The scientific and technological revolution is becoming one of the chief factors in the successful solution of the fundamental problems of the construction of communism in our country and in overcoming the differences between town and country and between intellectual and physical labor. Our task consists in making fuller use of scientific and technical achievements in combination with the advantages of the socialist system of management.

In socialist society scientific and technological progress is an object of planned management. Plans are based on the achievements of science and technology and create unlimited space for scientific and technological progress in the name of improving the wellbeing of Soviet people. The basic principles of the development of the planned management of scientific and technological progress at the stage of developed socialism have been formulated in the materials of the 24th and 25th CPSU congresses, the Plenums of the CC CPSU, and the works of L. I. Brezhnev.

The most important of them are: an increased role for the economic plan as a powerful lever for scientific and technological progress; a strengthening of the connections between science and production for the purpose of the accelerated practical realization of scientific achievements and their introduction into mass production and an improvement of the organizational forms of science and production; the composition of scientific and technical development plans with a view to the further economic integration of the socialist countries and the use in the production of these countries of the best achievements of world science and engineering; an improvement of scientific and technical information and the development of effective methods of control over the technical level and quality of the equipment which is created and produced; the concentration of the efforts of scientific organizations on the accomplishment of the most important tasks of production; and the production and use in all branches and productions of machinery systems which make it possible to achieve the overall mechanization and automation of production processes. The realization of these principles has the task of creating the conditions for increasing the interest of enterprises in the rapid mastery of the latest highly productive equipment and of increasing the reliability, service life, potential, and capacity of machinery and mechanisms, which, at the same time, makes it possible to effectively accomplish the tasks of a quantitative growth in production. It is also important to provide the most privileged positions for enterprises which constantly improve equipment and technology and which produce high quality output that accords with modern demands.

An improvement of the management of scientific and technological progress is inconceivable without an improvement of the planning and management of our economy as a whole. This is why when speaking about the management of scientific and technological progress it is important to have in mind that what is being discussed is a single system of the management of economic and social development and a single managerial mechanism. It is precisely such an approach which is contained in the decree of the CC CPSU "On a Further Improvement of the Managerial Mechanism and on the Tasks of Party and State Agencies" and in the decree of the CC CPSU and USSR Council of Ministers "On Improving Planning and Strengthening the Influence of the Managerial Mechanism on Increasing Production Efficiency and Improving the Quality of Work." It is determined in the decrees that when plans for the economic and social development of the USSR are worked out it is essential to ensure as one of the chief conditions an accelerated embodiment in practice of scientific discoveries and development work which are aimed at increasing the rates of the productivity of social labor and at improving output quality.

The general goals and tasks of the country's economic and social development and its single scientific and technical policy have to be thoroughly reflected in the planned management of scientific and technological progress. At the same time, this management has the task of satisfying the concrete demands of the effective management of all of the stages of the "science-production" cycle by creating the best conditions from the point of view of the realization of the laws of scientific and technological progress for the realization of possibilities of modern science, technology, and production and for a priority distribution of resources and, at the same time, of taking account of the economic and social consequences of various scientific and technical decisions.

Consequently, the management of scientific and technological progress is formed from the interaction of its economic planning, organizational, social, legal, and psychological aspects and includes: first, plans, programs, and the criteria for evaluating indicators, norms and normatives, financing, price setting, cost accounting and legal relations, wages and stimulation with a view toward the final results and effectiveness of scientific and technological progress, and the training of cadres; secondly, the organization of the management of the scientific and technological progress with respect to its cyclical nature, its stages, purpose, and relations with the "science-production" cycle, and the collection and processing information with regard to the integration of the different directions of the development of science. These blocks have to reflect the specific nature of the management of scientific and technological progress in a single system of planned economic management and have the task of ensuring a continual connection between scientific and technological progress and all of the sections of the economic and social development plans and the managerial mechanism.

On the basis of what has been said above, a systems approach to the management of the scientific and technological progress can be characterized as an approach in which, first, the tasks of this progress are looked upon in an overall manner, in the single system of planning and managing the economy, and, at the same time, are isolated -- as a result of the specific nature of the laws of the development of science and technology -- along the line of organizational forms, plans, economic levers and stimuli, legal regulation, information and material support, cadre training, and so forth; secondly, when a consideration of these factors in their interconnections and interactions is ensured at every level of the mechanism of economic management. In addition, special emphasis should be given to the fact that the systems approach to the planned management of scientific and technological progress demands its subordination to the goals of improving the entire managerial mechanism in keeping with the changing conditions and tasks with economic development.

The organic unity between the management of scientific and technological progress and the management of the economy as a whole, with the former subordinated to the later, is realized above all through national economic planning whose most important element is the planning of scientific and technical development. This planning serves as the point of departure for the composition of the country's economic and social development plans. An evaluation of the directions and consequences of scientific and technologic progress when planning decisions are worked out makes it possible to establish correct production proportions and to determine the dynamics of efficiency indicators. The basic directions for improving planning and the managerial mechanism as a whole which are stipulated by the decree of the CC CPSU and USSR Council of Ministers "On Improving Planning and Strengthening the Influence of the Managerial Mechanism on Increasing

Production Efficiency and Improving the Quality of Work" are directed toward an overall solution of the problems of scientific and technological progress.

The decree provides for an expanded horizon for planning, which will make it possible to take fuller account in plans of the results of scientific and technical development; for the reorganization on the basis of stable indicators and economic norms of cost accounting relations and economic levers and stimuli which are oriented toward an acceleration of scientific and technological progress; and for an increased role for scientific and technical programs. As has already been noted, the scientific and technological progress plans represent a central element in the system of the economic and social development plans of the USSR which includes an overall program for scientific and technological progress that is worked out by five-year periods for a period of twenty years.

At the present time work is being completed on an overall program for scientific and technological progress to the year 2000 -- an important stage in the substantiation of both our economic and social development plans and our plans for scientific and technical development. In this way, the overall program is acting in the role of a connecting link between the system of plans and all of its subsystems. It is determining the scientific and technical, economic, and social prospects for the development of our country and is providing long-term orientation points for our economic growth.

The very content of the overall program testifies to the organic unity of science and technology and economic and social issues. This program embraces all of the basic problems of the dynamic growth of the economy of developed socialism, its intensification, the accomplishment of major scientific and technical and social tasks, and an improvement of the organization and methods of management and of the managerial mechanism. The conception of economic and social development plans as plans of a single economic complex is revealed in it and, at the same time, it contains a consideration of the most important directions of scientific and technological progress which determine the structural changes in social production and an improvement of the technical level of production and of the quality of output.

As is stipulated by the decree of the CC CPSU and USSR Council of Ministers "On Improving Planning and Strengthening the Influence of the Managerial Mechanism on an Improvement of Production Efficiency and of the Quality of Work," the materials of the overall program for scientific and technological progress are being used in the development of a system of long-term and current plans for scientific and technical development, of basic directions for ten years broken down by five-year periods, of five-year plans broken down by years, and of annual plans for the development of science and technology and special-purpose overall scientific and technical programs. In these plans and programs the orientation points of the overall program for scientific and technological progress are filled out with detail and acquire the character of concrete assignments, are supplied with the resources necessary for their fulfillment, and so forth.

A distinction has to be made between the planned overall management of scientific and technological progress as an all-embracing process for raising the technical and economic level of production and the planning of scientific and technical development as the scientific and technical base of this process. The planned overall management of scientific and technological progress cannot be limited to any single section of the plan, no matter how many-sided it may be. This management embraces the entire system of indicators and balances, programs, and all of the sections and parts of the economic and social development plans which determine structural policy, a rise in the technical and economic level of production and of output, the formation of a scientific stock and of our production potential, and also the amounts of material, labor, and financial resources which are necessary for this; that is, all of the aspects of the development of science and technology and of the technical development of production.

The overall planning management of scientific and technological progress has to determine changes in the technical and economic level of production, including the technical level of the means of production, the technical level and quality of the output produced, the level of the development of production specialization and concentration, the equipment level of labor and its dynamics in comparison with the growth of labor productivity, the effectiveness of capital investments, and the overall effect from using new equipment and technology in the economy.

In addition to basic research on the most important scientific and technical problems, the scientific and technical development plan defines the most important aspects of applied research and of development work on new equipment, including the latter's mastery and use (introduction) in production. At the present time our basic attention is being devoted to the development, production, and use in the branches of the economy of machinery which makes it possible to achieve the overall mechanization and automation of production processes and also output transportation and other auxiliary operations. A great deal of importance is being attributed to new types of progressive materials and new advanced production processes. The plan also provides for a complex of measures to develop production and expand the use in the economy of computer equipment and automated control and planning calculation systems and also other matters. It also establishes the necessary financial resources for all of the stages of the "research-mastery-use of new equipment and technology" process. The time factor is taken account of in the development of the scientific and technical development plans in all of their aspects.

Five-year plans are the basic form of the planning of scientific and technical development. With the long-term prospect as a basis, these plans define the chief tasks of scientific and technological progress for a five-year period, of raising the technical level of production, and of creating a scientific and technical stock on the basis of an analysis of the research and development work in our country and abroad in all of the basic directions of scientific and technical development.

The five-year plan for the development of science and technology on the level of the economy embraces the major national economic problems and the issues of creating equipment and technologies which are of important inter-branch significance. On the level of the ministry additional tasks are defined for the technical and economic development of a branch and for raising the technical level of production and output in it. In associations and enterprises plans are made up for the mastery and use in production of new equipment, technologies, and automation and mechanization equipment which provides for the accomplishment of all of the technical and economic tasks facing an association (enterprise) as a whole.

Planning the solution of the basic scientific and technicl problems is of great importance in the development of the five-year plans for the development of science and technology. This planning is carried out by the USSR State Committee for Science and Engineering, Gosplan USSR, and the USSR Academy of Sciences on the basis of a special-purpose programmed approach.

As is recorded in the decree of the CC CPSU and the USSR Council of Ministers "On Improving Planning and Strengthening the Influence of the Managerial Mechanism on an Improvement of Production Efficiency and the Quality of Work," in order to bring about a thorough consideration of scientific and technical achievements in the economic and social development plans, the USSR State Committee for Science and Engineering and Gostroy USSR together with the USSR Academy of Sciences are supposed to work out programs for the solution of the most important scientific and technical problems and the problems of the overall use of natural resources with a view toward improving the results of basic and applied research. Final goals, technical and economic results, and work schedules and stages are clearly established in these programs.

In addition, in accordance with this decree, Gosplan USSR with the participation of interested USSR ministries and departments and of the councils of ministers of the union republics has been charged with defining and approving the list of special-purpose overall scientific and technical programs before the beginning of a regular five-year plan. At the concluding stages of these programs provision has to be made not only for the creation, but also for the mastery in production of the most important types of new equipment and technology. One can cite as an example of such programs programs for the creation and mastery in production of systems of machinery and technology for the overall mechanization and automation of production processes and programs for economizing fuel and metal.

The distinctive feature of the programs consists in the fact that they have the task of ensuring the realization of the entire complex of measures aimed at achieving the goals which have been set and at all stages -- from the solution of a problem to final results. Goal, resources, economic effect, work stages, the head client organization, the head executor organization, the subordination of co-executor organizations, the procedure for financing work, material incentives monies and conditions, and the coordination of work -- all of this is defined in such programs in an overall manner. The technical and economic aspect of the solution of a problem is closely coordinated in them with the organizational and managerial aspect. At the same time, they enter organically into the overall system of planned economic management and find a reflection in the system of balances and indicators of a plan at all of the levels of management.

Thus, the programs are not an alternative to plans. They are a lever by means of which the planned managerial influence on the solution of scientific and technial problems which are especially important at a given period is strengthened. For this reason the material, labor, and financial support for these programs is reflected in the long-term and current plans. However, in view of the importance of the problems for which the programs are worked out, all of the types of support for their realization which are provided for in the plans have to be allocated as a first priority.

A ministry which is responsible for the execution of one or another planned measure has to organize the formation of the corresponding draft plan or program, the overall and punctual accomplishment of the tasks connected with it, financial and material support, and also the acceptance from concrete executors of research and development work which has been performed. With regard to scientific and technical problems of state significance for which a head ministry cannot be determined, the USSR State Committee for Science and Engineering picks out the ministries and departments which are responsible for the fulfillment of a problem's assignments and for their financial and material support.

The management of scientific and technical development on the branch level, when the development of special programs is not required, is realized on the basis of the measures and indicators of a plan. In addition, the functions of the programs are replaced by a system of schedule orders in which, just as in the programs, the goals, resources, effect, and all of the other elements of the process of advancing scientific research into production are established.

It has already been noted above that in the scientific and technical development plans there is an organic coordination between basic research, the development and mastery of new equipment as the applied aspect of this research, and the practical realization of the best development work. The plans (programs) for the use of the latest equipment and technology and for supplying production with them are worked out in a somewhat more isolated manner. As a result of the fact that these processes are essentially connected with the formation of the production potential and with the reequipping and reconstruction of enterprises, these plans are at the junction between the scientific and technical development plans and of the plans for capital investments for the reequipping of production which are increasingly being transformed into a form of the realization of the technical policy. Today expanded reproduction is able to function effectively only on the basis of the latest scientific and technical achievements which, in essence, fuses the capital construction plan and the scientific and technical development plan into a single continuous scientific-reproduction complex.

During the Tenth Five-Year Plan a system of differentiated indicators which characterized the technical and economic level of production and of output has been used for the first time in the branches of industry in the planning of scientific and technological progress. They include: the technical level of the means of production and their structure and composition, the level of the mechanization and automation of production, the amount and proportion of output which is produced with the latest technology, the amount and proportion of highest quality category output; the degree of the intensification of production processes and of the use of the means of production (drilling speed, the productivity of equipment, machinery, and others); and the scientific level of production management and scientific labor organization.

A system for overall output quality control is an important element of the management of scientific and technological progress. An improvement of output quality makes it possible to more fully satisfy the economy's needs for the means of production and the needs of the population for consumer goods and to bring about an economy of material resources and an increase in the efficiency of social labor.

We know that the first steps in an overall approach to improving output quality on the basis of technological progress, a strengthening of production in labor principle, and a development of the creative intiative and qualifications of the workers were taken by the industrial enterprises of Sartov, Moscow, Leningrad, Sverdlovsk, and Gor'kiy. Overall output quality control received its most completed forms at the enterprises of L'vovskaya Oblast.

An overall system of output quality control is based on the coordinated management of all of the stages of the formation of quality -- from the designing of products to their use -- and of the entire cycle of work, all of their technological elements, and every individual job. This kind of approach makes it necessary to order and plan new types of output with parameters and characteristics which ensure its being classified in the highest quality category as early as the planning stage and the awarding to it of the Token of Quality at the stage of production mastery. Of especial importance here is the creation of the necessary technical and organizational conditions for the attainment of stable high output quality indicators during mass (series) production, and also for the full realization of the planned technical and economic parameters during use.

The stability of the quality parameters during the process of production is ensured by means of a combination of advanced equipment and technology, the organization of production and labor, strict compliance with production discipline, and measures to improve standardization and the certification of output quality. Effectiveness in use is achieved by means of increasing the reliability and service life of products and of creating a proper system of servicing new equipment at the consumers.

A further improvement of the methods of certifying the quality of scientific development work, plans, and products and also the development of a state system of standardization on the basis of the development of the appropriate indicators in the five-year plans and in special-purpose standardization programs is of great importance. In recent years work has become somewhat more active in the ministries on drawing up new plans for standards and on the approval and registration of all-union state standards. However, it has to be noted that the quality and renewal of standards and control over comliance with them still do not meet current demands. Work is not being done with sufficient speed on the standardization and normalization of parts and units for machinery and mechanisms and on the unification of technological processes. Greater attention has to be devoted to the creation of the base equipment for a planned shift to the development, production, and supplying of the branches of the economy with systems (series) of machines and mechanisms which would make it possible to modernize equipment on the level of the best achievements of domestic and foreign practice. Work on metrology is in need of substantial improvement. Today it is going forward to a certain extent spontaneously, without the necessary planning and direction.

The decisions which have been taken on the above question provide, in addition to strengthening the demands upon the planning and certification of output quality, for an evaluation of the technical level of the machinery, mechanisms, and equipment which is produced. The role of state expert appraisals is increased in order to prevent cases of the production of obsolete types of output. The creation of new production capacities and the reconstruction of enterprises is included in the plan only on condition that planning projects are oriented toward the most progressive equipment and technology.

Economic stimulation occupies an important place in the management of scientific and technological progress. As is noted in the decree of the CC CPSU "On a Further Improvement of the Managerial Mechanism and on the Tasks of Party and State Agencies," "it is necessary to substantially increase the effectiveness of economic levers and stimuli and to make material incentives directly dependent upon the efficiency and the quality of work, the fulfillment of planning assignments, and the results of production work."

Economic stimulation in the management of scientific and technological progress presupposes a cost accounting system of organizing the work of scientific research institutions in interaction with the cost accounting of all of the elements of the chain which unites science and production; bringing material incentives to the concrete performers of research and coordinating their amount with the actual effect which is obtained in the economy from the introduction of scientific development work; a shift from the multi-channel system of financing the scientific and technical development of production to financing it from a single scientific and technical development fund; an improvement of price setting for new equipment so that price will interest the development worker and the producer in the production of new equipment, and the consumer in its most rapid introduction and mastery; and an increased role for the indicators of scientific and technological progress and its consequences in the formation of stimulation funds.

In a number of branches of industry scientific, designing, and technological organizations, scientific production associations, and enterprises and associations are already operating on the basis of the above principles. The employment in them of a system of through planning for schedule orders has made it possible to reorganize the development of the work plans of organizations on the basis of concrete topics which are carefully selected with regard to the tasks of the single technical policy for the development of a branch and of evaluating the effectiveness of individual measures. The schedule orders make it possible to concentrate labor, financial and material resources more purposefully for the accomplishment of the main tasks of the technical development of a branch and of associations and enterprises.

An improvement of its organization is of fundamental importance for the effective management of scientific and technological progress. Experience shows that the planning of scientific and technological progress has to be solidly tied to an improvement of the structure of management. This is essential, first of all, in order for branch scientific research, production, planning, and designing organizations to be closely connected to production in the solution of both current and long-term scientific and technical problems.

Secondly, it is important to ensure the use and development of forms of the organization of the "research-production" cycle which have given a positive account of themselves, and also to search for new forms in order to create the kind of system which will promote the most rapid movement of a scientific and technical innovation from the idea to new output.

Thirdly, an acceleration of scientific and technological progress demands an improvement of the structure of the entire system of scientific and technical organizations and giving them the necessary flexibility and mobility which accords with the laws of scientific and technological progress. This acceleration also dictates the necessity for the planned interconnection and continuity of the various aspects of the management of scientific and technological progress with full account taken of the specific nature of the laws of the development of science and technology on the level of the economy, on interbranch and branch levels, and on the level of associations and enterprises. It is also necessary to achieve the kind of organization for production that will sensitively react to everything new which science and technology can offer. In this connection, it is important that there take place in the next two to three years the completion of the formation of production associations as the basic cost accounting element of industry, as is provided for by the decree of the CC CPSU and USSR Council of Ministers on the improvement of planning and of the managerial mechanism. Experience shows that associations are capable of accomplishing the difficult tasks which are connected with the realization of the achievements of scientific and technological progress in production.

A system of scientific and technical organizations which is aimed at accelerating all of the stages of the "research-production" cycle has now been basically created. The improvement of this cycle has been expressed in a search for forms of connection which would eliminate the barriers between the stages of scientific and technical work. For example, cooperation agreements between leading academic institutes and large enterprises and production associations have received a further development. However, not all of the problems connected with these agreements have been resolved as yet. The basic one consists in the fact that these agreements are still a matter of initiative. They do not have a clear legal status. Apparently, it is necessary to make some effort so that the conclusion of agreements enters as assignments into the scientific plans of academic institutes. It would also be advisable to work out a standard regulation which would regulate the most important aspects of the agreements on scientific and technical cooperation.

Another example of a progressive form of the organization of science and technology is the scientific-production associations where research, development, the introduction of new equipment, and its first series production are concentrated in a single complex. There are no barriers between the stages of the "research-production" cycle here and hence there is the result that the movement of a scientific and technical idea from its birth to its practical realization is accelerated by two to three times. Experience shows that the preconditions for the formation of scientific-production associations exist in many branches. For this reason, as the management of scientific and technological progress is improved it is important to define assignments for the development and creation of new scientific-production associations. From this point of view, an improvement of the management of scientific and technological progress in a branch has to be based on long-term plans for a further concentration and specialization of production, on the formation of large production and scientific-production associations, and on the development and realization of plans for the development and reequipping of associations in keeping with the general plans for improving the management of a branch.

As practice shows, good results can also be achieved by using another overall form of the organization of the "research-production" cycle. We are speaking about the inclusion within large production associations of a scientific and technical component in the form of scientific research institutes, designing bureaus, and so forth. The work experience of such associations as, for example, the "Elektrosila," "Uralelektrotyazhmash," "Svetlana," and a number of others bears witness to the large positive influence of this kind of inclusion on the rates of the scientific and technical development of production and on improving the quality of output.

However, here also there are problems. Thus, the integration of scientific and technical and production organizations, as a rule, means the subordination of the scientific interests of the former to the needs and concerns of a given concrete production. Whereas, for example, before their inclusion in associations scientific research organizations and designing bureaus performed work also for other production organizations in the branch, now this work will be made much more difficult. For this reason, the question of the expediency of including a scientific organization within a production association has to be decided above all in relation to the degree of the specialization and closeness of the relations of a given association with the scientific research institutes and designing bureaus which are being integrated.

When a scientific-production complex has already been formed it is very important to create the kind of system of management for it which takes account of the laws of scientific and technological progress and the requirements for the development for precisely this organization. In this connection, the realization in the scientific and technical complex of a system of planning, financing, economic stimulation, and cost accounting becomes a task of paramount importance. In addition, all of the elements of the system have to bring about an intercoordinated influence on the functioning of the organization. For example, the material interests of the scientific workers of an association is reduced by the kind of stimulation procedure for the introduction of new equipment in which the total bonuses which are paid to them for this item proved to be much less than the total bonuses paid to production workers whose work at the stage of introduction hardly differs from the work of the scientific workers along side whom they have been working. This kind of situation is characteristic for associations in which the system of economic stimulation is organized separately for the institute and for the enterprise. It is clear that a system of stimuli should be developed which would have an equal influence on the workers of both scientific and production subdivisions.

Many organizational issues in an acceleration of scientific and technological progress are connected with the structure of the management of scientific and technical organizations. The structure of a number of present scientific research organizations hardly differs from the structure of from 20 to 30 years ago which, of course, does not help to increase the rates of scientific and technological progress. Meanwhile, domestic and world experience shows that the shortcomings of a rigid structure for scientific research organizations can to a large extent be eliminated by means of employing special-purpose programs, matrix, and temporary structures. A clear orientation toward final scientific and technical results is the common feature of all of these structures. However, it is achieved when each structure is used differently.

With the special-purpose programmed structu all of the work is conducted within the framework of an assigned scientii.c and technical program which is headed by a leader who is subordinate only to the director of the organization. With the matrix structure which is a variety of the special-purpose programmed structure there is also a clear program headed by a leader. But a number of the jobs are performed by auxiliary scientific subdivisions which are common for the organization and are not subordinated to the program leader, but are assigned to him for the time needed to perform various research, tests, and so forth. The temporary structure is marked by the fact that after the accomplishment of an assigned task it ceases to exist, while the workers who have performed this task return to their ordinary duties or move on to work on a new topic within the framework of a new temporary structure. The use of such structures, as a rule, makes it possible to shorten the time involved from the origin of a scientific idea to the practical use of the product created on its basis by 1.5 to 2 times. Given the large-scale nature of many scientific development projects this yields an enormous gain.

With a systems management of scientific and technological progress all elements have to "operate" in a complex. From this point of view, it is necessary to take account of the social psychological aspects of management. This involves the psychological climate in a creative collective and moral stimulation, the creation of the conditions for the growth of cadres, the correct organization of work and payment for it with regard to the concrete contribution of each worker. An overall approach to educational work in the system of managing scientific and technological progress is an important element of this system which is aimed at the construction of the material and technical base of communism.

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