JPRS L/10247

11 January 1982

USSR Report

CONSTRUCTION AND EQUIPMENT

(FOUO 1/82)

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CONSTRUCTION

BOOK EXCERPTS: CONSTRUCTION TASKS OF 11th FIVE-YEAR PLAN

Moscow K NOVYM RUBEZHAM V STROITEL'STVE (ITOGI DESYATOY I ZADACHI ODINNADTSATOY PYATILETKI V SVETE RESHENIY XXVI S"YEZDA KPSS) in Russian 1981 (signed to press 29 Oct 81) pp 1, 9-19, 64

[Annotation, table of contents and one chapter of the book, "To New Frontiers in Construction (Results of the 10th and Tasks of the 11th Five-Year Plan in Light of the Decisions of the 26th CPSU Congress)" by Deputy Chairman of USSR Gosstroy Ivan Ivanovich Ishchenko, candidate of engineering sciences, RSFSR Distinguished Builder and USSR State Prize winner, Znaniye, 25,240 copies, 64 pages]

[Text] Raising the effectiveness and the technical level is one of the main tasks set for the builders by the 26th CPSU Congress during the 11th Five-Year Plan. The brochure examines the path of further development of the industrialization of construction--improvement of design solutions, expansion of the use of progressive structure and materials, and an increase in the mechanization of operations. Much attention has been given to reducing the material and labor resources used and to improving technology, organization and management in construction.

The brochure is intended for engineers and technicians of design and construction organizations and construction-industry enterprises, as well as for lecturers and propagandists.

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Tasks for Capital Construction During the 11th Five-Year Plan

"The Main Directions for Social and Economic Development of the USSR's National Economy During 1981-1985 and During the Period up to 1990," which was adopted by the 26th CPSU Congress, set the total amount of capital investment that will be aimed at developing and strengthening the country's economy during the 11th Five-Year Plan. This capital investment is aimed at speeding up the development of all types of transport and communications, at assimilating the natural resources of new regions, and at regularizing the siting of productive forces, and also at carrying out the program for further raising the material and cultural living conditions of the Soviet people, for improving the sanitary conditions of the environment, and for building housing and all other facilities of the nonproduction sphere. During the 11th Five-Year Plan capital investment will rise by 12-15 percent. Construction and installing work will be 350 billion rubles higher, which is much more than during the 10th Five-Year Plan.

A most important task of capital construction is that of using capital investment effectively--improving fixed capital qualitatively, introducing production capacity into operation quickly, and speeding up the rebuilding of existing enterprises.

The reconstruction and reequipping of existing enterprises is one of the main ways to further the progress of industry during the 11th Five-Year Plan. The "Main Directions" emphasize: "Direct capital investment primarily to the reconstruction and technical reequipping of enterprises and to completing previously started construction projects. Start the erection of new enterprises and the expansion of existing ones in cases where the national economy's requirements for a given type of product cannot be met by improving the use of production capacity, taking the reconstruction and reequipping thereof into account.

This trend was born back in the 1970's, in the Central Urals. During the five-year plan, 1.1 billion rubles' worth of industrial output was produced at Sverdlovskaya Oblast enterprises that had been subjected to modernization and reconstruction. In so doing, 600 million rubles of capital investment were saved over what would have been required for new construction. The annual economic benefit was 110 million rubles, and the average period for recouping the costs was less than 2 years. The experience of the Sverdlovskaya Oblast enterprises was approved by the CPSU Central Committee and recommended for dissemination.

Much was done in this field during the 10th Five-Year Plan. Thus, at the Magnitogorsk Metallurgical Combine blast furnace No 2 was completely renovated in a short time and annual pig-iron production here increased 200,000 tons. The production of automotive sheet steel rose by 300,000 tons, thanks to the rebuilding of the "2500" hot rolling mill. Modernization of the equipment at the slabbing mill and the second blooming mill brought still greater effectiveness. The updating of plants and factories in Moscow, Leningrad, Ivanovskaya, Zaporozhskaya, Vostochno-Kazakhstanskaya, Kemerovskaya, Kuybyshevskaya and other oblasts proved convincingly that reequipping existing enterprises with machinery is extraordinarily suitable, since it provides greater effectiveness per unit of expenditures for output and rapid recoupment of funds.

Technical reequipping and reconstruction will be developed further. Many enterprises of ferrous and nonferrous metallurgy, machinebuilding and the coal, chemical and petrochemical industries will be renovated on that basis. The Kolomna and Voroshilovgrad Diesel-Locomotivebuilding Plants, the Bryansk Machinebuilding Plant, the Penza Diesel-Engine Plant, the Pavlodar Tractor Plant and a number of other plants are to be rebuilt. Enterprises of light industry and the construction industry are to be subjected to reequipping. The Urals, the Ukraine, Belorussia and the industrialized Central Economic Region of the USSR will become the main regions where rebuilding will receive preferential development and new construction will be restricted.

It is planned to erect new enterprises primarily in branches of the economy and at production facilities that will support progressive shifts in the structure of social production and involvement of the fuel-and-power and mineral raw-material resources of the country's eastern and northern regions in the economic turnover. Based upon this, capital investment for new construction will be aimed, as a rule, at implementing huge national economic programs, such as establishing regional production complexes (Kansk-Achinsk, South Yakutia, Pavlodar-Ekibastuz, Sayany, West Siberia and Timan-Pechora), the creation of energy-intensive production facilities in Siberia and Kazakhstan and the erection of new hydraulic-engineering and thermal and nuclear electric-power stations. In particular, thermal electric-power stations that use the inexpensive coals of the Nyurengri, Ekibastuz and Kansk-Achinsk Coal Basins, as well as the natural gas and casing-head gas of West Siberia's fields, will be built at an accelerated pace. In order to transmit energy to the country's central zones, power transmission lines that are unique in length and voltage will be built: the first phase of the Ekibastuz-Central Economic Region power line of 1,500 kilovolts DC and the Ekibastuz-Urals power line of 1,150 kilovolts AC. The construction of nuclear power stations in the country's European portion will receive priority: 24-25 million kilowatts of new capacity will be introduced.

During the 11th Five-Year Plan production facilities will be built with an eye to improving the siting of productive forces and use of the productive potential and the natural and labor resources of the various economic regions in the country's unified national economic complex.

In the RSFSR's Nonchernozem Zone, new capacity will go into operation at the Cherepovets Metallurgical Plant, additional capacity for making paper will be created at the Syktyvkar Forestry Industry Complex, and capacity will go into operation at the Smolenskaya, Kalininskaya and Kurskaya AES's.

In the Central Chernozem Region, the forming of a regional production complex based on the Kursk Magnetic Anomaly will continue, and the first phase of the Oskol Electrometallurgy Combine will go into operation.

In the Volga region, the forming of an industrial cluster for recovering and processing gas and gas condensate and for producing sulfur based on the Astrakhan gas-condensate field, will be started. Capacity at the Cheboksarskaya and Nizhne-Kamskaya GES's and also at the Balakovskaya AES will be put into operation.

In the North Caucasus, capacity at the Atommash plant, the Novocherkassk Electric-Locomotivebuilding Plant and the Rostovskaya AES will go into operation.

In the Urals, as before, the main efforts of the builders will be aimed at rebuilding and reequipping industrial enterprises, and, in Siberia, at establishing regional production complexes. A new stage is beginning--the buildup of an entire complex of branches of industry and of production-servicing facilities. The introduction into operation of the first capacity at the Tobol'sk and Tomsk plants will lay the groundwork for the West-Siberian petrochemical base, which will become the country's largest. In this region, enterprises will be erected for processing casing-head gas and for producing equipment for the oil, gas and chemical industries and for other facilities.

In Krasnoyarskiy Kray the machinebuilding base will be strengthened thanks to the introduction into operation of large capacity at the Krasnoyarsk Heavy Excavator Plant, the Abakan Railroad-Carbuilding Plant and electrical-equipment enterprises of Minusinsk. New capacity at the Sayany Aluminum Plant will be introduced.

In the Far East the construction of production facilities will provide for further development of nonferrous metallurgy and the oil-refining, fishing, lumber, wood processing and pulp-and-paper industries. Erection of the Primorskaya GRES and the Kolymskaya GES will be completed, and a metallurgical conversion plant will be built.

In the Ukrainian SSR, along with the rebuilding and technical reequipping of enterprises of the coal industry, metallurgy, machinebuilding and other branches, new capacity will go into operation at by-product coke plants and enterprises that produce mineral fertilizer and automotive tires and at the electric-motor plant in Uzhgorod.

In the Belorussian SSR, expansion of the agricultural machinery plant in Gomel', the Brest carpet-and-cloth combine will be completed, and a metallurgical conversion plant will be built. New capacity will go into operation at Novopolotsk's Polimer production association.

In the Uzbek SSR, capacity for producing copper and for mining lead-and-zinc ores at the Almalyk Mining and Metallurgical Combine and for producing steel and rolled products at the Bekabad plant will rise. Capacity will be put into operation at the Tashkent Tractor Plant and the Angrenskaya GRES-2, at cotton combines in the cities of Andizhan and Nukus, and at knitwear and other enterprises of light industry and the food industry.

In the Kazakh SSR, a large amount of construction is to be done to strengthen the raw-materials base and to develop ferrous and nonferrous metallurgy and the coal, chemical and petrochemical industries. Capacity will go into operation at the Kachar Mining and Concentrating Combine for mining iron ore and in the Karatau Basin and in Aktyubinskaya Oblast for mining phosphate, and for the production of yellow phosphorus and mineral fertilizer. Construction of the Chimkent Oil Refinery will be completed.

In the Georgian SSR, a plant for making equipment for cableways will be built, and new capacity for processing tea leaves and wine and for bottling mineral water will be put into operation. Erection of the Zhinval'skiy hydraulic-engineering complex will be completed, construction of the Khudonskaya GES will continue, and construction of the Namakhvanskaya GES will start.

In the Azerbaijan SSR, plants of the Azerelektroterm Association, plants of specialized motor vehicles and deepwater foundations will go into operation, also the Shamkhorskaya GES and the Azerbaidzhanskaya GRES and new chemical-enterprise capacity in Sumgait.

In the Lithuanian SSR, construction of the second phase of the Mazheykyay Oil Refinery, the Vil'nyusskaya TETs and the first phase of the Ignalinskaya AES is to be completed, and enterprises for processing flax are to be rebuilt.

In the Moldavian SSR, construction of a plant for colored television sets and the Rezin Cement Plant will be completed, the erection of plants for producing machines for gathering tomatoes and for mechanizing work in orchards and vineyards will be promoted.

In the Latvian SSR, construction of the Daugavpilsskaya GES and the development of seaports will be promoted, and light industry will be reequipped with machinery.

In the Kirghiz SSR, a gold-ore combine and capacity at the Tash-Kumyrskaya GES will go into operation, erection of the Kurpsayskaya GES will be completed, and the construction of a tin-ore enterprise will be started.

In the Tajik SSR, the erection of the Yavan Electrochemical Plant will be continued, construction of the Rogunskaya GES will be promoted, the Baypazinskaya GES will be put into operation, and the cotton combine in Dushanbe and the silk combine in Leninabad will be reequipped with machinery.

In the Armenian SSR, capacity at the Razdan Machinebuilding Plant, the lift-truck plant and the perfume factory will be put into operation, and nonferrous-metallurgy and chemical-industry enterprises will be rebuilt.

In the Turkmen SSR, the construction of a carpet combine in Bezmein and of a factory for nonwoven materials in Chardzhou will be completed, and the cotton combine in Ashkhabad will be modernized.

In the Estonian SSR, the shale-processing industry will be reequipped, and the Krengol'mskaya Manufaktura cotton combine, as well as other light-industry and food-industry enterprises will be rebuilt.

As before, the construction of housing and facilities for cultural and personal-amenity purposes will be developed at a rapid pace. The social program calls for the introduction into use of new housing with a total area of 530-540 million square meters, improvement of the comfort and amenities of the apartments, and the construction of a substantial number of facilities for public health and cultural purposes. It is planned to complete conversion to the construction of housing built from standard designs with improved layout and finish work of the apartments.

Rural builders are to do a large amount of work. During the 11th Five-Year Plan the share of resources allocated to agricultural development will be no less than during the 10th Five-Year Plan, and capital investment for building housing, children's preschool institutions, clubs and so on will be increased by 39 percent. The erection of district-heating and centralized gas-supply grids and of water supply and sewerage systems, and also of on-farm roads, will be expanded. Systems for irrigating 3.4-3.6 million hectares of land, for draining 3.7-3.9 million hectares and for flooding 26-28 million hectares of pasture will be created through state funding. Work on land reclamation and the agricultural development of land will be continued in integrated fashion. Large water-resources construction is planned for the North Caucasus and the Kulunda, Dzhizak and Karshi steppes and also for development of the Dunay-Dniester and Kakhovka irrigation systems and the erection of the second phase of the Dnepr-Donbass [Donets Coal Basin] Canal, a third phase of the North Crimean canal and of the Azov irrigation system.

During the 11th Five-Year Plan branches of the production infrastructure will be further developed. Investment for strengthening rail transport will grow 1.3-fold. During this five-year plan the builders of the BAM [Baykal-Amur Mainline] will provide for through train traffic for the whole length of the mainline, and then the potential will be opened up for involving the most rich resources found in this zone in the economic turnover. It is planned to erect 112 kilometers of subway lines. To the existing 7 lines, subways in Minsk, Yerevan, Gor'kiy and Novosibirsk will be added. Almost 12,000 kilometers of petroleum-product pipeline will be built, 5-fold more than during the 10th Five-Year Plan. Construction of the hard-topped highway network will be continued, primarily in Siberia, the Far East and the Nonchernozem Zone of the RSFSR. In regions of Siberia and the Far East it is planned to strengthen river-fleet port activities. High goals have been established also for the development of communications.

Construction programs will be implemented during a continuous growth in the effectiveness of construction work itself. During the five-year plan labor productivity should rise 15-17 percent, and the entire amount of construction and installing work is planned to be carried out without an increase in the industry's worker manning. This task is lower than for the last five-year plan, but each percent of labor productivity has become substantially more meaningful.

The fact is that the main source of growth in labor productivity will, as in previous years, be a further rise in the level of industrialization and in the degree of factory preparation of constructional structure and building materials. Although the potential here has not decreased in comparison with the previous period, realizing it is becoming increasingly complicated. For example, it is hardly possible to solve the task of complete prefabrication of construction with reinforced-concrete structure alone, with which "boxes" of buildings are already being erected now at a high engineering level; the cost of such a box, as a rule, does not exceed 50 percent of the total cost of construction of that part of the building. The "stuffing" and decoration of a building (erection of the interior structure, the installation of utilities equipment, and so on) are still being carried out, as a rule, by traditional, nonindustrialized methods. In most cases even partitions are made out of piece-type materials and then plastered. Wet processes are still practically the only method for doing finishing work.

Further industrialization of construction means not only growth and improvement in the production of traditional prefabricated structure for the boxes of buildings, but primarily the conversion to progressive methods for all types of work, such as the installation of partitions, floors, suspended ceilings and roof coverings, thermal and sound insulation, the installation of the building's utility systems, surface finish work, and so on. All this should be carried out with materials and articles fully fabricated at the factory so that at the construction site, construction processes will be reduced down to the simplest operations of assembly, installation, glueing, spreading out, and so on. The essence of it consists, consequently, in further intensifying the integrated industrialization of construction, primarily in work with a high level of labor expenditure. In order to solve this problem, the variety of factory-made items produced for construction needs should be expanded, and they should be shipped to the construction sites in finished form and in complete sets, with all the necessary materials and articles.

During the 11th Five-Year Plan construction should be accomplished on a higher organizational and technical level than during the past five-year plan, with more effective use of supply, equipment, financial and labor resources. For this purpose it is necessary to concentrate capital investment and the efforts of construction and installing organizations at the most important construction projects and on a limited number of facilities being erected simultaneously and to develop and execute the practical measures for improving capital investment contemplated by the CPSU Central Committee and USSR Council of Ministers decree of 12 July 1979, "On the Improvement of Planning and Strengthening of the Influence of the Economic Mechanism on Increasing Production Efficiency and Work Quality." Active realization of the indicated measures will lead to a reduction in construction time, accelerate the introduction of facilities into operation and reduce the amounts of uncompleted construction (right now it is almost 90 percent of the annual capital investment volume).

One of the important tasks of construction during the 11th Five-Year Plan is a reduction in the amounts of material resources used. It is known that construction consumes enormous amounts of various types of material. Therefore, a reduction in the materials intensiveness of capital construction is, very likely, of paramount importance among measures for increasing its effectiveness. And this means not only a reduction in the amounts of resources consumed but also a reduction in the labor intensiveness, construction time and cost of erecting buildings and structures. Given the current amounts of construction, a reduction in consumption of material resources by an average of even 1 percent would yield a saving of 450 million rubles. That is why the "Main Directions" for the national economy's development during the 11th Five-Year Plan calls for a reduction in the consumption of rolled ferrous metal and of lumber by 7-9 percent and of cement by 5-7 percent during construction work as a most important task.

Persistent and universal improvement of construction on the basis of industrialization, the effective use of capital investment, improvement in the organization of construction work and of the labor of wage workers, the wide introduction of progressive technologies and construction methods, a rise in the level of the mechanization of construction and installing work, an improvement of design solutions and the economical use of material resources--these are the paths that should enable the fulfillment of the 11th Five-Year Plan capital-construction tasks at a high technical and economic level.

11409
CSO: 1821/031

CONSTRUCTION MACHINERY

PRINCIPLES FOR REVAMPING MACHINERY-OVERHAUL SYSTEM POSTULATED

Moscow VOPROSY EKONOMIKI in Russian No 9, Sep 81 (signed to press 2 Sep 81) pp 44-54

[Article by A. Nemchinskiy: "Overhaul of the Machinery Pool"]

[Text] The necessity for maintaining machinery, equipment and transport in operating readiness lends national economic importance to improvement of the system for repairing them. The disrepair of just 1 percent of the country's machinery pool freezes an active portion of fixed production capital that costs 5.5 billion rubles. Considering that the share of equipment out of commission in various branches of material production ranges from 3-5 percent to 10-15 percent or more, the yield on capital for the machinery pool is reduced considerably. However, the national economy's losses are not confined to this, since the normal operation of many industrial lines and of whole production facilities is disturbed because various units break down. The rapid equipping of the national economy with complicated and expensive equipment intensifies the urgency of the problem with each year, since a reduction of the operational readiness factor of the machinery pool increasingly affects the effectiveness level of social production.

Technical servicing and current overhaul are required for most equipment. Intermediate repair of certain types of equipment is, in essence, a variety of current repair. But, while the complex of repair work, which includes technical servicing and current repair, has been aimed mainly at maintaining the users' value of the machinery, overhaul is designed for partial restoration of it. As K. Marx pointed out: "Repair work is divided, further, into current repair and overhaul. The latter is partially a restoration of fixed capital in its natural form...."[1]

Consequently, overhaul occupies an important place in the process of reproduction of machines, and, in essence, is one of its forms. It is desirable to examine the machinery overhaul problem in integrated fashion, its interdependency with other forms of reproduction, as a function of the retirement of obsolete machines and the arrival of new ones, and the technical and economic indicators and the reliability and durability of the machines. It is apparent that only a systems approach to solving the problem will enable the path for raising overhaul effectiveness to be determined.

[1] Marx, K. and Engels, F., Soch. [Works], Vol 24, pages 198-199.

The Modern Status of Overhaul

For many types of equipment, expenditures for repairing machines exceed substantially the costs for producing them. Thus, according to USSR Minsel'khoz [Ministry of Agriculture], expenditures for repairing tractors used in agriculture is 2.5-fold that of the costs of manufacturing them. Total expenditures for keeping up the efficiency of the E-652 excavator, which is used in construction, have reached 22,000 rubles, or 250 percent of the original cost. In this case metal consumption during repair of the excavator during its service life is 21-22 tons, or more than 100 percent of its weight. Such a situation engenders extremely questionable opinions about the desirability of overhaul.

Meanwhile, the high cost of overhaul results from economically ineffective organization. Different ministries and agencies overhaul like types of equipment (motor vehicles, machine-tool equipment and construction and road machines, as well as certain other types), breeding a multitude of dwarf semicottage-industry repair enterprises that have the very same purpose and are often located next to each other. The quality of their repair work is low, and operating costs are intolerably high.

Motor-vehicle overhaul is performed, for example, at 2,000 enterprises which are subordinate to more than 40 ministries and agencies, and agricultural machinery is repaired at more than 2,000 enterprises, construction and road machinery at 369 plants and 1,850 departments and shops. Machine-tool equipment (metal-cutting and woodworking machines and so on) are repaired in the departments and shops of 70,000 industrial enterprises.

The degree of support of machinery with spare parts and articles is assessed at 30 to 75 percent, for construction and road machinery 40-50 percent, of the total requirement therefor. Under these circumstances, enterprises are compelled to manufacture parts independently, at higher cost and with lower quality. For example, a spur gear that costs 20 rubles and 40 kopecks, according to the price lists, costs 102 rubles and 22 kopecks when fabricated at Dneproekskavatsiya Trust plants, or 5 times as much. Moreover, the repair capacity is used to produce noncharacteristic output that should come from machinebuilding enterprises.

The lack of specialization of repair enterprises and the primitive repair technology promote the preservation of obsolete individual, or so-called sidetrack, repair. Technological specialization is practically absent and only for automotive transport is it evaluated at 5 percent of the total amount of repair work, and parts specialization does not exceed 10-11 percent, while object repair is 88-95 percent. For a number of reasons, progressive methods for machinery repair (component-and-assembly and periodic replacement of repair sets--PZRK) still occupy a small share in the overall repair-work volume, reducing the effectiveness of measures for maintaining machines in operating condition.

At the same time, overhaul of a major portion of the equipment remains an economically rational way for reproducing machines. This is occasioned by the nonuniformity of durability of equipment components and parts, and by the necessity for replacing them periodically to preserve the efficiency of the machine as a whole. Mainly material deterioration is eliminated during overhaul. However, it must be considered that "material deterioration of a machine is dual in nature. One kind arises from its use--as a coin is worn from being circulated--the other comes from nonuse of it--as a sword rusts in a scabbard from disuse....Deterioration of the first type is more or less directly proportional to the amount of use of the machine, while deterioration of the second kind is to a known degree inversely proportional to use."[2] This situation is of great importance when solving questions of the interdependence of the degree of use of equipment and the amount of overhaul. In order to increase overhaul effectiveness, it must be kept in mind that "in addition to material depreciation a machine is also subject, so to speak, to obsolescence. It loses exchange value to the extent that machines of the same design become cheaper to reproduce or better machines enter into competition with it. In both cases, regardless of how new and viable a machine may be, its value is determined no longer by the worktime that has actually been invested in its production, but by what is necessary now for reproduction of the very same machine or for the reproduction of a better machine."[3]

During overhaul it is possible to reduce somewhat a machine's obsolescence by replacing key components with ones that are better perfected or by combining overhaul with modernization as one of the forms of reproduction of the machine, the main task of which is to be a countermeasure to obsolescence.

Industry peculiarities and the specifics of the equipment (for example, maritime ships, agricultural machinery, railroad rolling stock and others) require a differentiated approach to solution of the overhaul problem. At the same time it is necessary to examine ways for raising effectiveness in supporting the life cycle of mechanization equipment and transport that are common to all (or to most) industries.

These include: the conduct of a unified technical policy for the creation and repair of machines; the determination of economically desirable service lives for equipment and the relationships of amortization deductions to renovation and overhaul; the establishment of economically rational limits to overhaul, taking into account industry and regional peculiarities of operation of the machines, as well as the potential for providing new equipment; optimization of the proportions between current repair and overhaul of the equipment; the selection of effective methods (in technological and economic plans) for overhaul; the industrialization of repair, based upon the specialization of enterprises and of technological repair lines; the organization of a unified interagency system of repair enterprises; and the creation of reserves for replacing equipment that is being repaired (an exchange inventory of machines).

Despite specific peculiarities in the repair of different machines, certain groups of them are close with respect to technology and organization of repair. These are, primarily, mobile equipment (the motor-vehicle fleet, agricultural machines, mechanized-construction, road and land-reclamation equipment) and stationary machine-tool equipment (metal-cutting tools, and the equipment of light industry and certain other branches of industry).

The economic essence of overhaul can be examined in terms of renewal of the user's value of the machines, if a reduction in their value precludes further functioning of them as implements of labor and interrupts the process of transferring a portion of their value into output. Repair is occasioned by the need for partial

[2] Marx, Karl and Engels, F., Soch., Vol 23, page 415.
[3] Marx, Karl and Engels, F., Soch., Vol 23, page 415.

replacement for deterioration of the machinery. Overhaul (as distinguished from restoration) does not restore completely the equipment's potential. Thus, the productivity of construction machinery after overhaul is 7-12 percent less, while maintenance expenditures are 8-12 percent higher than is the case with new machines.

Where there is economic justification for long-term repair volume, it should be considered that the overhaul requirement is reduced as a machine's various components approach each other in uniformity of durability. In the ideal case, when the service lives of the assemblies and components of a machine are equal or very nearly alike, the requirement for overhaul disappears, and it is desirable to replace the machine with a new one. Along with the common tendency to reduce the amount of repair for certain types of complicated and high-capacity machines (where an approximation of uniformity in component durability is difficult to achieve), overhaul remains an economically effective form of reproduction of fixed production capital for the foreseeable future.

Modeling of a Subsystem of Overhaul Within the System for Reproduction of the Machinery Pool

Increasing overhaul effectiveness has necessitated that it be modeled as a process for the reproduction of machinery. It is natural that the pace of delivery of new machines and the total requirement therefor will affect the amount of overhaul. If shipments of machines cannot provide for the replacement of those falling into disuse, then a definite and frequently unjustified increase in repair volume occurs. A dilemma therefore arises: either write off the worn machines or extend their service lives by one more overhaul or even a poorly effective restoration repair but save expenditures of live labor and support fulfillment of the production tasks.

The choice of a rational technology and organization for repair greatly affects the effectiveness of equipment overhaul and repair-enterprise capacity. The assembly-and-component method is effective at present in the planned preventive-maintenance system. However, its wide application is being held back by the lack of a reserve of assemblies and components for establishing an exchange inventory, and also by an insufficiency of high-capacity specialized plants for repairing these components. Introduction of the assembly-and-component method will enable a reduction of repair time to one-half to one-third, as well as of time and costs for transporting the machines to and from repair, since the overhaul is done directly at the mechanization center. With this method, the labor intensiveness of repair is reduced by 40-50 percent, operating costs by 8-12 percent, and transport expenses by an average of 30-40 percent.

The overhaul of machinery is transformed into a planned system of replacing assemblies and components that have short working lives where the residual value of the assemblies (or components) that have exhausted their service lives is minimal. In the long term it will be possible to convert to a system of diagnosing the operating condition of each machine in order to determine the degree of its actual material deterioriation and to regulate measures for repair of the equipment.

In determining the economically rational limits for overhauling equipment, the ratio of a machine's residual value and overhaul costs to the benefit of operating the equipment after the overhaul can be used. Obviously, economically rational limits for repair are established differentially for different machines.

The interdependence of the ways to reproduce machines with alternative solutions for the structure of the pool thereof can be presented in the form of a balance-sheet model for the reproduction of machines. When economically justifying a process for reproducing machines, it is desirable to consider the following factors: the cost of replacing machines that are falling into disuse, expansion of the machinery pool, depending upon growth in the amounts and change in the structure of operations, and the creation of a reserve of machines. The total value of the machinery pool will be determined by the total of the attributed-cost indicators, by model and by group of machines.

The total value of a pool of machines at a given period of their reproduction is characterized by the sum of the indicated constituents, taking into account correction factors for change in the structure of operation in the industry and regional plans, as well as the level of intensification of the use of mechanized equipment. A machine pool can be reproduced through overhaul, modernization or the arrival of new machines. Each of these forms of reproduction has its own share in the reproduction process at different stages, depending upon specific conditions.

A balance-sheet equality of requirements and reproduction of the machinery pool in accordance with a consolidated model is dynamic and that, in turn, requires a forecasting for each of the indicators, by period of anticipation, of the estimated requirements for machines and for amounts of overhaul. Since the replacement of old by new fixed capital does not result in equality of their production potential, it becomes necessary to make a comparative assessment.

It is desirable that the comparative analysis be made by set of indicators. Specific indicators (or indices) that refer to unit capacity can be used for this purpose. For instance, one progressive type of equipment is the new EO-3332 excavator-planer with replaceable equipment, which, in comparison with the E-4010 planing machine that it replaces, is characterized as follows per unit of power: a 41-percent reduction in capital intensiveness; a 40-percent reduction in metals intensiveness for manufacture of the machine, a 70-percent rise in the operator's labor productivity, and a 57-percent reduction in prime cost per 1,000 square meters of soil leveling.

A set of particular indices enables a comparative variant analysis of progressive and standardized equipment to be carried out. This approach to evaluating the effect of technical progress enables its quantitative characteristics to be established in terms of cost and physical factors. However, an analysis by indicator is difficult where there are substantial deviations. In such situations it is necessary to apply a multiple-criteria approach, examining not just one but several indices successively for a comparison of the progressive and the standard equipment. The indices will also enable different variants of progressive equipment to be compared with each other. In consolidated estimates the economic potential of fixed capital is determined by the ratio of capital intensiveness per unit of capacity or output of the standard progressive equipment. In the model of reproduction of the machinery fleet, the creation of a reserve for unforeseen circumstances and for replacing machines that are sent for repair is called for.

The dynamicity of the whole system for reproducing fixed capital exerts an influence, on the one hand, on the probable deviations in the influence of various factors, which can be mutually canceling, and the system as a whole maintains its equilibrium and consistency of direction, and, on the other hand, a potential for unidirectional deviations in the influence of the indicated factors is not excluded, which can lead to a stratification of errors in the forecast computations. Such deviations create a risky situation in economic forecasts. It is desirable to a certain extent to counter the risk with an equipment reserve. However, the creation of reserve fixed production capital not only requires large capital expenditures (with a relatively small return therefrom) but it also involves an increase in operating outlays even if the capital is not used.[4] Therefore, it becomes necessary to justify rational reserves (absolute and relative) of fixed capital, taking into account a minimization of expenditures for creating and maintaining them, with maximum benefit from using them during production-load peaks and under various unforeseen circumstances. It is desirable to classify the reserves that are established at various levels--from the construction and installing trust or enterprise reserve to ministry and state reserves, inclusive--by purpose: operational, repair and national-economic (in case of natural disaster, and so on).

It is important to solve the question of reserves in systems fashion. The fact is that the types of reserves examined can scarcely be used simultaneously. Consequently, they can be concentrated where needed for various concrete situation. This will enable the proportion of estimated reserves to be reduced and their effectiveness to be raised. The trend toward a reduction in the repair reserve as the technical level of machines is raised and maintenance and repair bases are improved must be considered.

Modeling also calls for a balance of fixed capital and the output capacity needed for repair work with optimization of the proportions among plants that overhaul machinery, assemblies and components, mechanization centers, and mobile facilities for the technical upkeep of machinery. It is considered, when the model is being constructed, that a portion of overhaul is accomplished (using assemblies and components that are repaired at the plants) at mechanization centers, motor pools, and so on. In turn, a portion of the technical servicing and current repair is performed by mobile facilities for technical servicing (truck-mounted repair shops). It is desirable, when modeling the reproduction of the fixed capital of enterprises of the maintenance and repair base for mechanization equipment, to start with the repair coefficients that characterize the cost of current repair and overhaul. The requirement for fixed capital at mechanization centers and plants as a function of the cost of the machinery pool can be established in accordance with the standards for capital intensiveness of technical servicing, current repair and overhaul.

The dynamics of the composition of the mechanization equipment by size, type and group of machines complicate justification efforts in which change in the structure of enterprises and facilities of the maintenance and repair base in industry and regional plans and the level of intensification of the use of fixed capital are considered. Reproduction of the fixed capital of the maintenance and repair base is performed at overhaul plants and centers for the technical servicing and repair of machinery through reequipping, rebuilding, expansion and new construction.

[4] This concerns expenditures connected with the necessity to keep the reserve machinery in working condition during preservation operations, removal from long-term storage, storage, technical servicing and upkeep of servicing personnel.

Taking into account the proportions of the various forms of reproduction and the corresponding indicators of the economic potential of the fixed production capital, a balance is reached of the requirements for and the reproduction of fixed capital for enterprises and facilities of the maintenance and repair base. During modeling, questions of siting the productive capacity of the repair enterprises are resolved.

Unified Policy for the Production and Repair of Machinery

The conduct of a unified technical and economic policy for creating and repairing equipment helps the rational redistribution of capital investment among the repair base and the machinebuilding branches of industry.

The volume of production of new machines and spare parts for them and the amounts of overhaul of these machines and their assemblies and components are closely interlinked and depend upon the overall life cycle of the given type of machine. However, existing practice, wherein machinery makers find themselves associated with only one portion of the machine's life cycle (engineering design, design development, production and the short maintenance guarantee period) and are completely isolated from the other portion (maintenance, overhaul and writeoff), does not meet modern requirements.

The potential for overhauling machines should be specified when they are designed and produced. The artificial gap between the production and the maintenance of machines leads to a lack of producer interest in the effective repair and servicing of machines, and it also inevitably engenders a shortage of spare parts and the necessity to produce them by semicottage-industry methods. A unified policy for producing and repairing machinery will enable a more rational technological scheme for overhauling the various groups of machines to be created, taking into account their construction characteristics, the system for diagnosing the degree of reliability of machines, assemblies and components, and unified norms and regulations for planned preventive maintenance that consider the industry's specifics.

The experience of developed capitalist countries testifies to a striving to reduce and even eliminate disruptions of a machine's life cycle. This has enabled the operational readiness factor of construction-machinery fleets in the USA, FRG and Japan to reach 0.9-0.91. Machinebuilding companies are motivated to see to it that the equipment they deliver does not stand idle because of a lack of spare parts, the manufacture of which in the USA, for example, amounts to about 30 percent of the output of new construction machinery, exceeding our output 2-fold to 3-fold. Technical servicing and repair are performed in accordance with a planned preventive maintenance system which in the USA is provided by dealer companies. The basic method of repair is the assembly-and-component method.

The dealers are the connecting link between machinebuilding enterprises and equipment users. They do technical servicing and repair, deliver spare parts (in 24 hours) and pick up machines that are unusable and require restoration. In Japan, for example, the servicing of Mitsubishi Jyukogyo excavators is entrusted to the dealer Simmitsu Jyuki, which has a ramified network of technical servicing centers. The Aburadani Jyukogyo and Kato Seysakusyo companies have organized their own technical servicing and repair centers, locating them in areas of the greatest concentration of machines (excavators) that have been purchased from these companies.

Much attention is devoted in the FRG to full-fledged, responsive technical servicing and repair. For these purposes, special subunits of the manufacturing companies and the dealers have been established. The Abbau company, for example, has huge spare-parts warehouses and technical servicing centers at which mechanics are constantly on duty and have facilities for the transport and repair of equipment. The company guarantees the delivery of spare parts to a machine's repair site in 24 hours. Weimar Mashinenfabrik services and repairs machines in centralized fashion and through intermediaries and representatives, also in a day.

In the USA the Caterpillar company's machines are serviced and repaired centrally and through dealers, with use of the newest facilities for cleaning and washing, automatic installations for the deposition buildup of the rollers and frame of the crawler undercarriage, and automated reporting of the repair operations by computer, as well as automated delivery of the required spare parts.[5] For diagnosing malfunctions of Caterpillar Tractor Company engines, a portable computer has been created which determines their effective power in a few seconds, by means of sensors.

Experience in the maintenance of machinery with company servicing and repair (by the manufacturer or dealers, or their representatives) has shown high responsiveness and the economic desirability of this form of organization for keeping machinery in constant operating readiness. A main factor in repair effectiveness is minimal duration; this enables a high level of operational readiness to be provided for and idle time of the machinery pool to be reduced to a minumum.

Idle equipment time for repair in our country reaches 40-61 days. Relative to the planned annual service time in construction, which is 256 days, machinery time spent in repair is more than 20 percent for excavators and bulldozers, about 24 percent for scrapers, and 15 percent for boom cranes. Thus, an average of almost 20 percent of construction's basic machinery is frozen because of the idle time spent in repair. It is obvious that a rise in their repairability and reliability and an increase in service time and of the time between repair cycles are basic principles of a unified technical policy for the production and repair of machinery.

An experimental calculation of comparable progressive (new) and standard (old) equipment as to labor and capital intensiveness and of attributable expenses per unit of work performed indicated that the labor-intensiveness indicators of the new machines demonstrate their growing effectiveness in the range of 1.5 (KS-5363 and K-255 cranes) to 4.3 (KB-674 and KB-300 tower cranes). Capital intensiveness indicators for comparable machines vary from 0.7 to 1.8, testifying to an increase in capital intensity (of a portion of the new machines).[6]

For many brands of machines, not only an overall increase in expensiveness but also an increase in cost per unit of capacity is characteristic at present. For example. the KS-6362 crane costs 2,080 rubles per unit of capacity, the standard E-2508

[5] CONTRACTOR METHODS AND EQUIPMENT, Nos 4 and 10, 1971.

[6] Computations were carried out for 17 pairs of machines of comparable size models, based upon the baseline indicators of VNIIstroydormash [All-Union Scientific Research Institute for Construction and Road Machine Building] of USSR Minstroydormash [Ministry of Construction, Road and Municipal Machine Building], relative to 1980.

machine 1,570 rubles. However, this can be justified in some cases by an improvement of other indicators, mainly reductions in labor intensiveness and prime costs per unit of work performed (as occurs with the KS-6362 crane). In economic justifications for the process of reproducing machinery, it is desirable to consider the increase in mobility, reliability and completeness of equipping of the machinery pool. Mobility of machinery enables a reduction in the time (and also in the labor and material resources) spent on redeploying the machinery, provides for better use of time, and enables the total requirement for the corresponding groups of machines to be reduced. The reliability of machinery is manifested in reduced technical servicing, current repair and overhaul and less labor intensiveness and time spent in performing them. Completeness in equipping the pool of machines results in mutual coordination of their parameters for the subsequent fulfillment of the technological production processes. All these present substantial reserves for reducing the cost of the machinery pool and expenditures on repair.

Unfortunately, an unfavorable trend toward growth in total expenditures for the operation and repair of comparable "new" and "old" equipment is observed. An analysis of the total expenditures on technical servicing, current repair and overhaul that are attributable to one year indicates a growth thereof for a number of newly produced machines. For example, expenditures for the technical servicing of the KS-6362 rubber-tired erecting boom crane is, over its service life, in comparison with the E-2508 crane, 42 percent greater ($\frac{14.9}{10.5}$ thousand rubles), for current repair it is 210 percent greater ($\frac{74.4}{35.2}$ thousand rubles), and for overhaul it is 196 percent greater ($\frac{75.6}{38.5}$ thousand rubles). Expenditures attributable for one year, taking service life into account, are, respectively, 5,600 rubles (E-2508) and 11,000 rubles (KS-6362), that is, 5,400 rubles more per year for the new machine.

The producers of machinery understate the repair-intensiveness indicators of equipment. At the same time, a reduction in repair-intensiveness of construction machinery is economically desirable in many cases, even despite an increase in costs in the sphere of mechanization equipment production.

In practice, the limits for equipment overhaul have to be expanded, because of failure to provide enterprises and organizations completely with mechanization and transport equipment. Because of shortfalls in deliveries of machinery to construction organizations, a portion of the equipment subject to writeoff has to be operated. Therefore, obsolete and physically worn machines make up as much as 20 percent of overhaul (relative to total overhaul volume).[7]

Increasing the Effectiveness of Machinery Overhaul by Industrializing It

The industrialization of machinery overhaul calls for reducing the repair process to the replacement of assemblies and components with new ones or with ones that have been overhauled at specialized enterprises. This will enable the effectiveness of overhauling equipment to be raised greatly.

[7] Computations show a definite (or arbitrary) effectiveness of this repair where it is impossible to replace the obsolete machinery with new machinery.

Concentrating construction-machinery repair, for example, will enable specific capital investment to be reduced by 12-15 percent, prime costs for repair by 8-10 percent, and labor intensiveness by 20-30 percent, and will enable repair time to be shortened. In turn, the specialization of repair enterprises will lead to a certain rise in specific capital investment (5-12 percent), but it will reduce, in so doing, labor intensiveness of repair work by 35-40 percent and prime operating costs for repairs by 3-7 percent, and it will cut repair time 20-25 percent.

However, the prevailing practice of organizing construction-machinery overhaul does not meet modern management requirements, and it is a brake on raising the effectiveness of repair-production facilities. The total number of enterprises engaged in overhauling basic construction machinery and their assemblies and components exceeds 2,200, and about 10-12 percent of them are specialized. In this case, the level of specialization by groups of machines is no more than 4-5 percent.

Right now the overhaul sphere is marked by bureaucratic isolation and lack of a unified system for subordinating plants. This does not permit concentration to be raised much, and, because of that, the specialization of repair facilities to be organized. In the construction field, the concentration of production facilities for the centralized repair of construction machinery has been characterized by an average capacity of about 1 million rubles' worth of repair output per year per enterprise. At the same time, there are some enterprises within the repair base with a capacity of 7 million rubles' worth. The low level of assembly-line operation in overhaul leads to an increase in the prime operating costs thereof,[8] and the time taken for repairs leads to above-standard idle time of machines in repair or awaiting repair (1.5-fold to 3-fold in comparison with the standards). Thus, serious contradictions have arisen between the high pace of development of the machinery pool and the potential of the existing repair base to maintain the efficiency of the machinery.

Studies conducted by NIIES [Scientific-Research Institute for Construction Economics] of USSR Gosstroy have indicated that in a number of regions the capacity of enterprises for overhauling construction and road machinery must be brought up to 8-10 million rubles' worth (taking into account the rational radius for haulage). With further expansion of the centralized repair of assemblies and components, it will be desirable to increase capacity to 15-17 million rubles. As yet, the development of specialization is being held back by bureaucratic isolation and the low level of assembly-line repair of like type items.

In the long term there is to be a conversion from specialization by groups of machinery to specialization by size models (or brands), which will enable industrialized repair lines to be used and repair effectiveness to be increased. The subcontracting of repair work operations among various production subdivisions and facilities of other construction-industry enterprises, especially for relatively small repair enterprises, is an important method of raising their effectiveness: a reduction of 2-3 percent in prime repair operating costs and of as much as 6-8 percent in the capital intensiveness of operations.

[8] The cost of repairing one E-302 excavator at the Uglezavodsk RMZ [Machinery Repair Plant] is 4,634 rubles, while for a series of 96 machines at Mariyskiy's Remstroydormash plant of USSR Minsel'stroy [Ministry of Rural Construction], it is 2,403 rubles, or little more than half as much.

Considering that construction machines are being operated not only in construction (where they comprise 45-60 percent of the total number of machines), but also in other branches of material production--the extractive branches of industry, agriculture, transport (for loading and unloading), and so on, it is desirable to solve the problem of creating a single system of overhaul enterprises for the whole national economy.

In order to increase the effectiveness of equipment overhaul at enterprises, the following are necessary: conversion to the organization of an interagency overhaul system, which will enable the level of concentration and specialization of repair work to be raised greatly and inefficient repair at nonspecialized enterprises of ministries and agencies to be eliminated; and organization of the repair of new, highly productive equipment within the system of machinebuilding enterprises. This will enable construction and other ministries to be gradually freed of functions not characteristic of them--management of the process of overhauling complicated machinery.[9] Repair by the manufacturer will provide for quality and increased effectiveness; the maximal possible and economically rational use of existing repair enterprises; the freeing of such enterprises from producing nonrepair output; and an appropriate specialization by type of repair. According to computations by NIIES of USSR Gosstroy, about one-third of the enterprises (of the 365 considered plants of the construction ministries and agencies) must be left in the base for centralized repair, after they are rebuilt and expanded. In so doing, it is proposed to increase the average level of concentration of their output about 5-fold to 7-fold, and also to raise greatly the level of their specialization. The plants must organize the overhaul of basic construction machinery that is used in all branches of the national economy, except for new, highly productive machines. Large specialized enterprises that are being built should be restricted to the new, developing regions or to a major concentration of the repair inventory where it is impossible or economically irrational for existing enterprises to cover a shortage of capacity, or it is desirable to take a portion of the existing repair plants from the repair complex so they can produce nonrepair output that is required by construction and other ministries and agencies.

Studies indicate that construction-equipment overhaul will remain a necessary form of reproduction of fixed capital for a long time yet. In this case, it is considered that, as machines increase in reliability and their assemblies and components come to approximate each other in durability, the share of overhaul will be reduced gradually and then intensely. At the same time, according to the forecast, the total overhaul volume will tend to stabilize during the next decade because of the growth of the equipment pool.

The effect of implementing a unified technical policy in the area of repair and of raising the assembly-line nature of it consists primarily in an improvement of the quality of machines that are repaired and an increase in service life between repairs from 50-60 percent to 80 percent of the corresponding service-life indicators established for new machines. At the same time, the machines will spend much less time in repair. This will make possible the use of at least an additional 1 billion

[9]Excavators with hydraulic drive of the operating implement; earthmoving machines of the continuous-action type; self-propelled scrapers; bulldozers of more than 200 horsepower, based upon industrial-type tractors; and rubber-tired cranes, truck cranes, and certain other machines.

rubles' worth of the active part of fixed capital in construction operations alone, and, correspondingly, a reduction in capital investment in development of the pool of new construction machinery.

It is desirable to use the experience in developing recommendations for creating a unified system of enterprises for overhauling construction and road machines also for certain other types of equipment. This concerns primarily automotive transport, since motor vehicles are being operated in practically all ministries and agencies throughout the whole Soviet Union. In so doing, the degree of concentration of motor vehicles in the economic regions exceeds considerably the concentration of other types of equipment, creating the prerequisites for high effectiveness in centralizing the overhaul of vehicles.

In accordance with the CPSU Central Committee and USSR Council of Ministers decree, "On Strengthening the Work to Save and to Make Rational Use of Raw-Material, Fuel-and-Power and Other Material Resources," it is necessary to use in every possible way the large reserve for savings that exist in overhauling the machinery pool. This refers primarily to the problem of the centralized output of spare parts and of items for vehicles, which will enable metal consumption to be reduced about 1.5-fold to 1.8-fold, fuel and power resources almost 2-fold, and labor expenditures 2-fold to 3-fold in comparison with the manufacture thereof by semicottage-industry methods at small repair enterprises.

Another area for saving material resources is, in our opinion, the restoration of worn parts of machines by the automatic deposition method; the strength of the working layer here is in no way inferior to that of new parts. This method will enable as much as 65-80 percent of the metal of old parts to be saved. It is being used widely abroad (by the Caterpillar company and others). Our country also has similar experience. In particular, at the Pankovskiy Experimental Machinery Repair Plant, where a small section restores expensive and rapidly wearing parts of S-80 and S-100 tractors and E-652 excavators, savings on the order of tens of thousands of rubles have been achieved. The restoration of parts does not exceed 50 percent of the cost of new ones. Obviously, it is desirable to create specialized enterprises and departments for the centralized restoration of machine parts by the deposition method, which will enable labor intensiveness and the prime costs of these operations to be greatly reduced.

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CSO: 1821/021

METALWORKING EQUIPMENT

MACHINEBUILDING EQUIPMENT REPAIR CENTRALIZATION EFFECTIVENESS SUBSTANTIATED

Kiev EKONOMIKA SOVETSKOY UKRAINY in Russian No 10, Oct 81 (signed to press 12 Oct 81) pp 34-38

[Article by Doctor of Economic Sciences T. Ben' (Dnepropetrovsk) and Candidate of Economic Sciences Yu. Kostin (Khar'kov): "Territorial Organization of Interbranch Repair Production"]

[Text] Among the tasks put forward by the 26th CPSU Congress is that of increasing the effectiveness of machinery and equipment repair. This task can be solved in several resolution stages.

1. Increase repair centralization, concentration and specialization, including the production of repair items[1] in branches of economic region specialization. This stage can be described as temporary (transitional), its implementation to be concluded in the 11th and 12th Five-Year Plans.

2. Inasmuch as about half of the equipment being repaired is for general industrial and interbranch application, it is appropriate to carry out within the framework of specific territories an organizational-economic restructuring whose purpose is to create regional repair organizations servicing all enterprises, independent of departmental affiliation.

3. Development of a system of regional interbranch repair production management and linking it to higher-level management systems.

Let us examine the type structure and distribution of production equipment in USSR metallurgical industry using data from the last interbranch balance (MOB) of fixed assets published by the USSR Central Statistical Administration.[2]

Technological equipment of metallurgical industry occupies the highest proportion in the type structure of production equipment (44.74 percent). The metallurgical industry

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[1]We examined the basic types of general machinebuilding items (casting blanks, forgings and stampings, welded metal components and machined items) as applicable to the requirements of metallurgical industry.

[2]"Narodnoye khozyaystvo SSSR v 1973 g." [USSR National Economy in 1973], Moscow, Izd-vo Statistika, 1974, pp 67-115.

technological equipment group includes: blast furnaces, steel smelters, mills for cold- and hot-rolling metal, including rolled steel and iron pipe and other equipment.

A significant portion (8.43 percent) is accounted for by mine-shaft, ore-mining and ore-enrichment equipment; 9.52 percent is accounted for by power engineering and electrical engineering equipment, 7.65 percent by lift-transport equipment, 6.74 percent by means of transport, and 5.85 percent by pump-compressor, refrigeration and oxygen equipment.

Total metallurgical industry equipment includes 3.32 percent construction and road-building equipment, 1.21 percent equipment for building materials industry, 0.16 percent tractors and agricultural machinery, 0.05 percent equipment for light, food, mixed feed, timber, pulp-paper and printing-publishing industry, 3.26 machine and wood-processing tools, 2.83 percent forging-pressing equipment, 0.69 percent foundry equipment and other types of equipment.

Metallurgical equipment is extremely metals-intensive. Its diversity, high cost and distribution by subbranch of metallurgical industry have a substantial influence on the organization of branch repair services.

It is expedient to divide the available production equipment of each branch into four classification groups (see Table 1, following page):

1. general industrial equipment;
2. interbranch equipment;
3. technological equipment of a corresponding (specific) branch;
4. technological equipment of other branches.

Let's note that any classification, including that being proposed here, is in a certain sense hypothetical. First, it is prompted by the goals of concrete research. Second, intensification of the social division of labor predetermined the process of production differentiation in the branches, which complicated interbranch ties and, consequently, a precise delimitation of production equipment classification groups. Third, its formation is influenced by the existing classification of USSR national economic branches.

We used the following criteria as the basis for setting up our production equipment classification groups:

1. how multipurpose the equipment application is (its breadth);
2. the role of the equipment in the production process;
3. the branch affiliation of the equipment.

Equipment in the first group includes power and electrical engineering equipment, pump-compressor equipment, production apparatus, lift-transport equipment, equipment for construction and roadbuilding, and other equipment. The second group could include machine tools, wood-processing tools, forging-pressing equipment, foundry equipment, refrigeration and oxygen equipment, means of transport and other types of equipment. The third group includes specific equipment of the appropriate (specific) branch being examined. The fourth group is equipment of other branches which is used to resolve technological tasks in the branch using the given types of equipment.

In metallurgical industry, general industrial equipment accounts for 23.52 percent of the total, interbranch equipment for 20.47 percent, equipment of a specific branch

Production Equipment Classification Groups and Dynamics of Their Relationships In Terms of Branch Affiliation (calculated from fixed assets interbranch balances data for 1966 and 1972 (see: "Narodnoye khozyaystvo SSSR v 1968 i 1973 gg." [USSR National Economy in 1968 and 1973], Moscow, Izd-vo Statistika, 1968, 1974))

	branches of material production	
	all USSR industry	metallurgical industry
all production equipment	100.0	100.0
including groups by affiliation branch:		
general industrial application		
1966 MOB	18.88	20.78
1972 MOB	22.05	23.52
interbranch application		
1966 MOB	6.07	13.43
1972 MOB	9.08	20.47
corresponding-branch technological		
1966 MOB	73.14	64.37
1972 MOB	67.44	54.39
technological equipment of other branches		
1966 MOB	1.91	1.41
1972 MOB	1.43	1.62

54.39 and equipment of other branches 1.62 percent. For USSR industry as a whole, however, these relationships are: 20.05, 9.08, 67.44 and 1.43 percent.[1] This means that, given the existing level of branch differentiation, the necessity arises for an interbranch criterial evaluation of the mechanism for shaping optimum relationships among these groups over the long range. It is that very knowledge of the indicators (levels) of the relationships of various equipment groups in a five-year plan cross-section that opens up a way to find optimum relationships of branch and interbranch ties and opportunities for improving the effectiveness of repairs and permits a correct distribution of capital investments.

Let's analyze the relationships given in Table 1 for various equipment groups for the period between the two interbranch fixed assets balances of 1966 and 1972 from the viewpoint of determining the status of the equipment being repaired. On the one hand, inasmuch as the proportion of production equipment of a specific branch remains relatively high (67.44 percent for industry), repair organization is consequently also of the branch type, including the manufacture of repair items. This level will probably be retained over the next two or three five-year plans, with slight changes towards a reduction. On the other hand, there is obvious growth in the first and second production equipment groups during the five-year period: 16.79 and 49.58 percent for industry as a whole and for metallurgical industry, respectively (13.18; 52.41 percent).

The presence of these two trends in the production equipment structure indicates a definite connection between the relationships of the various classification groups and the level of repair centralization and specialization. As the proportion of

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[1]Estimated from the 1972 interbranch balance.

special equipment (that for a specific branch) decreases and the proportion of general industrial and interbranch equipment increases, expenditures for these groups grow, which lowers the overall level of repair centralization and specialization by increasing their decentralization in the specific branch. This becomes possible in connection with the fact that branches producing general industrial and interbranch output do not ensure deliveries of the needed amount of repair items or the centralized repair of their own equipment.

Thus, given growth of 2.74 and 7.34 percent, respectively, in the first and second groups in USSR metallurgical industry (in 1966 relative to 1972) and a 10 percent reduction in the proportion of the third group, the proportion of expenditures on repairs for these groups of equipment has increased correspondingly: five percent for the first group, two percent for the second, and expenditures on repairs for specialized branch equipment have decreased by seven percent.

Actualization of the scientific-technical progress programs in industry over the next 20-30 years will make its own adjustments in the relationships of the various equipment groups. We can assume growth in the proportions of the first and second equipment groups. If that growth is 1-2 percent per year, given the existing repair organization, the increased decentralization will be 3-4 percent per year. This circumstance will naturally force the specific branch to divert even more considerable resources into repairing and servicing these groups of equipment, thus causing considerable harm to efforts to raise the level of technological equipment repair specialization and centralization in the corresponding branch, which will lead to losses in basic production.[1]

The data in Table 2 [following page] testify to the level of repair centralization in USSR industry. The highest proportion of centralized repair (interbranch balance data for 1966 and 1972) is for machine tools (index of 3.30; 3.15), forging-pressing equipment (2.13; 2.05), foundry equipment (2.53; 2.69) and others. We have adopted as the unit the USSR industry average level of repair centralization, which is currently less than 10 percent. This situation testifies to insufficient attention by the USSR Gosplan and the union republic planning organizations to repair problems in the country. The efforts of planning organizations have thus far been aimed at organizing centralized repairs in machinebuilding branches.

Machinebuilders are successfully developing the centralized repair of machine tools and wood-processing equipment, foundry and forging-pressing equipment. To these ends, specialized repair associations of the all-union "Soyuzstankoremont" association type have been created in machine and tool manufacturing industry. The association includes a number of specialized repair plants. It is the task of the association to specialize and centralize as much as possible the repair of widely used models of machine tools and to improve the quality and reduce the cost of repairs.

ENIMS calculations confirm the advantages of organizing plants specialized for overhauling machine tools as compared with existing methods of repair at industrial

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[1]PRAVDA, 1 October 1979, 13 November 1979 and 3 March 1980; EKONOMICHESKAYA GAZETA, No 45, 1979; VOPROSY EKONOMIKI, No 8, 1978, p 8; EKONOMIKA SOVETSKOY UKRAINY, No 8, 1979, pp 51-63, and others.

Table 2. Production Equipment Type Structure and Centralized Repair Production Indexes in Individual Branches (calculated using interbranch fixed assets balances data for 1966 and 1972 (see: "Narodnoye khozyaystvo SSSR v 1968 i 1972 gg."))

type of equipment	proportion of equipment of this type, in percent of total		proportion of corresponding specialized repair production branch, percent		repair production index, group 4 to group 2 and group 5 to group 3	
	1966 MOB	1972 MOB	1966 MOB	1972 MOB	1966 MOB	1972 MOB
machine tools and wood-processing equipment	11.64	11.22	38.42	35.36	3.30	3.15
forging-pressing equipment	3.07	2.75	6.54	7.70	2.13	2.05
foundry equipment	0.86	0.86	2.18	2.32	2.53	2.69
technological equipment for metallurgical industry	7.75	6.82	0.49	0.22	0.06	0.03
equipment and apparatus for chemical industry	5.10	5.50	0.47	0.26	0.09	0.04
technological equipment for light industry	4.98	4.23	0.03	0.05	0.006	0.01
⋮	⋮	⋮	⋮	⋮	⋮	⋮
total of 20 types of equipment	100.0	100.0	100.0	100.0	100.0	100.0

Note: The average level of centralized repair for USSR industry was adopted as the unit in columns 6 and 7. That is, if the level of repair centralization for industry as a whole equalled, let's say, 10 percent, but was 30 percent for machine tools, the index of repair centralization would be 1.0 in the first instance and 3.0 in the second.

enterprises. Thus, for example, the labor-intensiveness of overhauling one machine tool in a centralized manner is 2.5 times less than the labor-intensiveness of manufacturing a new machine of the same type.[1]

At the same time, the data in Table 2 testify to an inadequate level of repair centralization in metallurgical industry (indexes of 0.06; 0.03), chemical industry (0.09; 0.04), light industry (0.006; 0.01) and other branches. This situation is to be explained, on the one hand, by the actually low level of repair centralization and specialization in these branches and, on the other, by the fact that the USSR Central Statistical Administration defines a specialized branch as an aggregate of specialized enterprises performing a given type of work, which very much narrows the limits of the repair branch.

Obviously, not all equipment manufacturing branches (enterprises) can efficiently repair their own equipment. This is a complex task, both technically and organizationally. In our opinion, having recognized the equipment grouping described above, based

[1] A. I. Kostin and D. I. Polyakov, "Spetsializirovannyy remont metallorezhushchikh stankov" [Specialized Machine Tool Repair], Moscow, Izd-vo Mashinostroyeniye, 1978, p 117.

on classification criteria, we can recommend that work be intensified on centralizing and specializing repair in specialization branches of an economic region. Resolution of these problems could be done following the proposed plan for ferrous metallurgy.

Ferrous metallurgy enterprises use all three forms of repair organization: centralized, decentralized and mixed. The mixed form is used most, wherein all types of repairs are done by shop repair services, the repair-machine shops of the enterprise chief machinist, sponsoring installation-repair facilities and specialized repair organizations (trusts) of the "Domnaremont," "Metallurgremont" or "Energochermet" type. Major overhauls comprise 28-32 percent of the total work volumes of these organizations, and 68-72 percent is accounted for by routine repairs.[1] However, the departmental nature of the subordination of these organizations to the Ministry of Ferrous Metallurgy leads to enormous unjustified expenditures. A metallurgical plant is totally uninterested in lowering the cost of repairs done by contractor organizations, since such reduction is not reflected in any way in the metallurgical plant's balance. On the other hand, a repair trust has no practical interest in reducing repair time, inasmuch as an increase in profit is not always expressed in lower repair costs. Evaluating the activity of repair trusts in terms of volume indicators and the formation of incentive funds based on them does not ensure a proper combination of contractor and client interests. Departmentally subordinated, the trusts are not in a position to create a strong material-technical base. The level of machinery availability per worker at "Energochermet" trust is one-third lower than for power repair organizations of the USSR Ministry of Power Engineering and Electrification.[2]

It has become necessary to improve the branch equipment repair system in ferrous metallurgy. In our opinion, it is appropriate in the 11th and 12th Five-Year Plans to transfer repair trusts to the subordination of machinebuilding ministries producing technological equipment for ferrous metallurgy. Such a reorganization will permit a maximum concentration of the efforts of these ministries at all stages of production, beginning with designing, planning and producing the machines and ending with their operation and repair. Under such a system, the equipment producer takes on all repair obligations. Our calculations show that the use of sponsorship installation-repair by Elektrostal'skiy Heavy Machinebuilding Plant (EZTM)[3] at Ukrainian SSR plants provides an opportunity for eliminating bottlenecks in equipment operation by improving equipment design and increasing durability, which as a whole permitted an 11-percent reduction in repair expenditures in pipe industry in the 10th Five-Year Plan.

It is appropriate for repairs to be done on equipment groups 1, 2 and 4 (general industrial, interbranch and other branches) by specialized rayon repair associations formed on the principle of territorial-branch affiliation.

The problem of producing commonly used repair items has been discussed repeatedly in the economic and special literature. The ineffectiveness of producing items in shops

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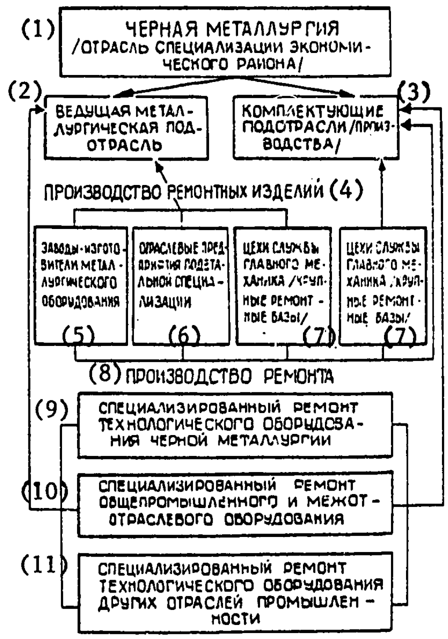
[1] S. S. Aptekar', "Sovershenstvovaniye khozrascheta v chernoy metallurgii" [Perfecting Cost Accounting in Ferrous Metallurgy], Moscow, Izd-vo Metallurgiya, 1978, p 119.

[2] "Razvitiye form upravleniya ekonomikoy" [Development Forms of Economic Management], Moscow, Izd-vo Mysl', 1978, p 126.

[3] EZTM produces pipe-rolling equipment.

Territorial-Branch Repair Organization Plan for A Specialization Branch (using ferrous metallurgy as an example)



Key:

1. Ferrous metallurgy (economic region specialization branch)
2. Leading metallurgical subbranch
3. Subbranches (production facilities) producing complete sets of items
4. Production of repair items
5. Plants manufacturing metallurgical equipment
6. Parts-specialized branch enterprises
7. Shops of the chief machinist's service/large repair centers
8. Repair production
9. Specialized repair of ferrous metallurgy technological equipment
10. Specialized repair of general industrial and interbranch equipment
11. Specialized repair of technological equipment for other branches of industry

of the chief machinist's service (SGM) at metallurgical enterprises as compared with parts-specialized machinebuilding enterprises has been noted every time.[1] However, the demand for repair items is currently being 90-percent met by SGM shops, about

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[1] "Organizatsiya i planirovaniye remontnogo khozyaystva metallurgicheskogo zavoda" [Organizing and Planning A Metallurgical Plant Repair Service], Moscow, Izd-vo Metallurgiya, 1969; Kh. P. Zaytsev et al., "Ekonomika remontnogo khozyaystva metallurgicheskikh zavodov" [Metallurgical Plant Repair Service Economy], Kiev, Izd-vo Tekhnika, 1974; I. M. Denisenko and K. K. Kapustin, "Ekonomika, organizatsiya i planirovaniye remonta metallurgicheskikh pechey" [Economy, Organization and Planning Repairs on Metallurgical Furnaces], Moscow, Izd-vo Metallurgiya, 1977; "Proizvoditel'nost' truda v chernoy metallurgii" [Labor Productivity in Ferrous Metallurgy], Kiev, Izd-vo Tekhnika, 1977, pp 73-88; "Razvitiye form upravleniya ekonomikoy," pp 116-130 and others.

seven percent by parts-specialized branch enterprises and only slightly more than two percent by plants manufacturing technological equipment.

It is apparently time to re-examine the ineffective system of providing rayon metallurgical complexes with repair items. In accordance with the plan presented above, repair items are being produced by plants manufacturing metallurgical equipment, by parts-specialized branch enterprises and by shops of the chief machinist's service at metallurgical enterprises (large repair centers). Under the given structure for producing repair items in the transition period, plants manufacturing metallurgical equipment should be instructed to manufacture large, unique and specific base parts.

Parts-specialized machinebuilding enterprises must serve as the basis of the branch production of repair items, with the rights of affiliates of machinebuilding complexes, whose number continues to grow in ferrous metallurgy, the large repair centers of metallurgical enterprises and, in part, the enterprises of multipurpose subbranches, which correspond to average-sized machinebuilding enterprises in terms of level of organization and volume of output produced.

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METALWORKING EQUIPMENT

OPTIMIZING EFFECTIVENESS OF MACHINERY AND EQUIPMENT OVERHAUL SCHEDULES

Kiev EKONOMIKA SOVETSKOY UKRAINY in Russian No 10, Oct 81 (signed to press 12 Oct 81) pp 39-42

[Article by Candidate of Economic Sciences M. Il'yenchenko: "Methods Questions of Determining the Economic Effectiveness of Equipment Overhaul and Modernization"]

[Text] The large and ever-increasing expenditures on machinery and equipment repair demand that their economic limits be established. A comparison of minimally possible major overhaul expenditures and the established economically expedient size of those expenditures enables us to reveal the degree of effectiveness of the repairs.

A number of economists have proposed various methods whose advantages and shortcomings have been analyzed by Ye. K. Smirnitskiy and R. Z. Akberdin.[1] Based on that analysis, the authors worked out a method which most fully takes into account the influence of various factors on the economic effectiveness of machinery and equipment overhaul. However, in spite of the great advantages of the latter, it cannot be used in practice due to a lack of needed information and to the great labor-intensiveness of the calculations, which the authors themselves note.[2]

The problem of scientifically determining the economic effectiveness of major overhauls must be solved with a view towards optimizing the annual machinery and equipment major overhaul plan at the production association and enterprise level in accord with the following method: planned major overhaul expenditures for a particular machine should be compared with the carry-over depreciation fund available for major overhaul of that machine.

Equipment major overhaul annual plan optimization must reduce the amount of ineffective major overhaul and expenditures on this type of work by establishing the limits of appropriate expenditures on overhauling and modernizing worn-out equipment.

The question of the appropriateness of a major overhaul must be resolved in the course of working out the association and enterprise annual equipment overhaul plans.

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[1]Ye. K. Smirnitskiy and R. Z. Ak rdin, "Povysheniye effektivnosti remotnogo proizvodstva" [Increasing the Effectiveness of Repair Production], Izd-vo Mashinostroyeniye, Moscow, 1970, pp 13-18.

[2]Op. cit., pp 18-27.

A major overhaul should be considered effective when expenditures planned for it will be less than or equal to the carry-over depreciation fund available for overhauling that machine, that is, when an adequate source of own financing is available for doing this work. This method of determining the economic effectiveness of equipment overhaul flows from the existing method of financing it, so its practical introduction does not cause any difficulties.

The legitimacy of this method results from the fact that major overhaul depreciation funds become socially necessary and economically permissible, that is, an appropriate amount of expenditure for this type of machinery and equipment repair service; moreover, that amount is always known.

If this condition is not met, that is, when carry-over depreciation funds are absent or less than actual expenditures when it is time to do the overhaul, it will consequently be ineffective, since such repairs will lead to additional expenditures.

This method is very simple to use, since the accounting section of each enterprise records the movement of fixed assets, calculating for them the amortization of actual expenditures on both renovation and major overhauls, which will be added to carry-over value. There is for each stocked item a stock card, on which this is recorded. Using these documents, we can analyze the dynamics of depreciation fund use for overhauling a particular item, that is, we can trace how our own major overhaul depreciation fund is used for each year of operation of a machine. Carry-over major overhaul depreciation fund should be taken to mean the difference between the calculated depreciation for major overhaul for all preceding years of machine operation and actual outlays on major overhauls and modernization done during that period.

Using PPR [planned preventive maintenance] system normatives and depreciation norms, as well as actual equipment stock cards, the Kiev Relays and Automatic Machines Plant has worked out descriptions of the value rotation process for 10 of the most common models of machinebuilding equipment. The results of their analysis of the characteristics of value rotation of the machinebuilding equipment studied are given in the table [following page].

The proposed method demonstrates that major overhauls are economically effective for the 3171 surface grinder only up to the eighth year of operation. It is economically ineffective to overhaul this machine after the eighth year of its operation since the carry-over major overhaul depreciation fund will only be 178 + 184 = 362 rubles by the end of that year, and major overhaul expenditures will be 1,100 rubles. For that same reason, it would be economically ineffective to overhaul the model 6N81 universal milling machine in the 11th year of operation, the model K116G eccentric presses in the seventh year of operation and the model PD-476 hydraulic presses in the seventh year of operation (see table).

At the same time, the calculations show that a comprehensive form of repair services organization ensures a reduction of major overhaul expenditures to a level at which the economic effectiveness of major overhauls on all equipment is ensured and a savings in depreciation funds is even achieved, which represents net income and confirms the legitimacy of the proposed method of determining the economic effectiveness of machinery overhaul.

According to this method, overhauling a specific machine will become ineffective at a given level of outlays in the l-th year of operation. In this instance, Economic Effectiveness of Overhauling Machinebuilding Equipment Over the Course of the Depreciation Period (calculated using the proposed method and based on 1975 depreciation norms)

1 Наименование типовых машин	2 Модель	3 Амортизационный период, лет	4 Амортизационный фонд на капитальный ремонт, руб.	5 Суммарные затраты на капитальный ремонт, руб.: 6 по системе ППР**	5: 7 по К. Ф.***	8 Экономический эффект (+), остаток амортизационного фонда или потери (−): 6 по системе ППР, 9 руб.	6 по системе ППР, %	7 по К. Ф., 9 руб.	7 по К. Ф., %	10 Экономически эффективный срок эксплуатации, лет: 6 по системе ППР	10: 7 по К. Ф.
screw-cutting lathe	1К62	14,9	2415	2229	1690	+186	+7,7	+723	+29,9	15	15
turret lathe	1341	14,9	3362	2571	1827	+79	+23,5	+1535	+45,6	15	15
automatic turret lathe	1Б118	14,9	2875	2748	2079	+127	+4,4	+796	+27,7	15	15
vertical drill	2А135	14,9	1275	1185	882	+80	+7,1	+393	+30,8	15	15
cylinder-and-cone grinder	3Б161	14,1	5055	3753	2727	+1302	+25,7	+2328	+46,0	15	15
internal grinder	3А227	14,1	5655	2979	2151	+2676	+47,3	+3504	+62,0	15	15
surface grinder											
universal milling machine	3Г71	14,1	2760	3330	2328	−570	−20,65	+432	+15,6	7	15
eccentric press	6И81	14,9	2250	2346	1776	−96	−4,3	+474	+21,1	10	15
hydraulic press	К116Г	15,6	1648	2068	1144	−420	−25,5	+504	+30,6	6	16
	ПД476	15,6	3008	4260	2332	−1252	−41,62	+676	+22,5	6	16

Key:
1. Standard machines
2. Model
3. Depreciation period, in years
4. Depreciation fund for major overhauls, in rubles
5. Total major overhaul expenditures, in rubles
6. PPR system (based on PPR labor- and materials-intensiveness normatives)
7. KF (based on comprehensive-form (KF) repair organization labor expenditure normatives and material resources expenditures)
8. Economic impact (+), carry-over depreciation fund or losses (−)
9. Rubles
10. Economically effective operating life, in years

the enterprise administration must take the steps necessary to organize equipment repair more efficiently, resulting in a decrease in outlays on it. But it is not always correct to think that, inasmuch as it is ineffective to overhaul a machine in the i-th year (prior to expiration of the normal service life), the machine should be written off and scrapped. Thus, for example, if a surface grinder model 3171 is written off and scrapped in the eighth year of its operation due to the ineffectiveness of overhauling it and is replaced with a new one, given an initial machine cost of 3,400 rubles and expenditures of 1,100 rubles on routine major overhaul in the eighth year of its operation, society incurs losses of 2,300 rubles. This cannot be permitted, of course, but at the same time, the national economy need not incur 570 rubles of the losses resulting from a major overhaul, since it is precisely this sum which we are short in financing a major overhaul of this machine from our own major overhaul depreciation fund. To this sum, we need to add the growth (or subtract the reduction) in operating expenses.

One condition of the economic necessity for a major overhaul and permissible maximum expenditures on it is that the difference between the cost of a new machine and expenditures on the planned overhaul be greater than the total depreciation funds deficit for overhauling the old machine and the growth or reduction in operating expenditures after that overhaul, that is,

$$C_n^н - [C_к^н + И_{ij}] > H_к^i \pm П^э \quad (1,000 \text{ rubles})$$

where $C_n^н$ is the initial cost of a new machine; $C_к^н$ is the normative cost of the planned major overhaul or midpoint repair whose effectiveness we are verifying; $И_{ij}$ are expenditures on transporting equipment from the i-th customer to the j-th overhauler and back (if the major overhaul is being done at the enterprise operating the machine, then $И_{ij} = 0$); $H_к^*$ is the shortfall in funds from the enterprise's own major overhaul depreciation fund for overhauling this machine in this year of operation; $П^э$ is the growth or reduction in operating expenses and the resultant profits after overhauling the old machine as compared with the operating expenses for a new machine for the duration of the repair cycle.

It must be noted here that there is general acknowledgement in our economic literature that operating expenses will increase after overhauling an old machine as compared with a new machine of the exact same type. This growth in operating expenses is a consequence of objective factors of scientific and technical progress in creating tools of labor. However, along with objective factors, subjective ones also influence the development of new machines. It therefore happens that operating expenses for existing machines are higher than the same expenses for new machines.

Thus, for example, the Odessa Forging-Pressing Equipment Plant imeni 16th Party Congress began series-producing the A-1216 automatic cold upsetter in 1970. The old AB 120 model was withdrawn from production. A simple comparison of the technical-economic characteristics of these two models testifies to a significant reduction in productivity and growth in operating expenses for the new machine, but not for the old one. Output in the very same shops decreased 27 percent, repair expenditures increased 11 percent and other operating expenditures also increased. Unfortunately, such examples are not isolated and we cannot fail to take them into account.

Possible losses from change in machinery productivity and in their operating expenses ($\pm П^э$)have therefore been introduced into the mathematical formulas reflecting the quantitative evaluations of major overhaul effectiveness. If they are positive (+), these losses represent a decrease in profit if we continue operating the old machine as compared with the profit which could be ensured by operating a new one. But if this value is negative (-), it represents a decrease in profit, but now when operating a new machine as compared with the profit ensured by operating the old one.

The following restrictions testify to the economic effectiveness of major overhaul: the carry-over major overhaul depreciation fund for a given machine will be greater than the total normative cost of a routine major overhaul and transport expenses (if the repairs are done by the direct-labor method, then $И_{ii} = 0$), that is:

$$O_{к}^{в} > C_{к}^{н} + И_{ii}.$$

However, the economic effectiveness of equipment major overhaul can be compared and determined using the above function only if this equipment (each specific machine) is not obsolescent. If a machine is obsolescent, it must be modernized. The only natural source of modernization funds is the major overhaul depreciation fund, inasmuch as a certain portion of this fund is planned for eliminating obsolescence by the depreciation deductions norms.

A sufficient condition of the economic effectiveness of major overhaul with needed modernization will have the form:

$$A_{к}^{г} \cdot Г_{э} - \sum_{i=1}^{г-1} (C_{кi} + C_{i}^{м} + И_{iii}) > C_{к}^{н} + C_{н}^{м} + И_{ii},$$

where $C_{i}^{м}$ is the actual net cost of previous general technical modernization of this machine, in rubles, whose costs were covered by the major overhaul depreciation fund;

$C_{н}^{м}$ is the normative net cost of a planned modernization being done simultaneously with a routine overhaul, in rubles.

It should be noted that if a sufficient condition exists when calculating the economic effectiveness of a major overhaul, it means the overhaul is actually effective with or without (in the absence of obsolescence) modernization, inasmuch as in this instance, expenditures are fully covered by the enterprise's own sources of financing. In this instance, there is no necessity of checking the economic necessity of the repairs. But if a sufficient condition is absent, such a comparison is mandatory.

If modernization is necessary, the condition of economic necessity for repair and modernization will be expressed by the following functions: first variant, when the modernization eliminates only some of the obsolescence, that is, when the productivity achieved is still less than the productivity of a new model of the machine:

$$C_{п}^{н} - (C_{к}^{н} + C_{н}^{м} + И_{ii}) > \sum_{i=1}^{г} (C_{кi} + C_{i}^{м} + И_{iii}) - A_{к}^{г} Г_{э} \pm П^{э};$$

second variant, when the planned modernization eliminates the obsolescence completely:

$$C_{п}^{н} - (C_{к}^{н} + C_{н}^{м} + И_{ii}) > \sum_{i=1}^{г} (C_{кi} + C_{i}^{м} + И_{iii}) - A_{к}^{г} \cdot Г_{э} + 0{,}1 \sum_{i=10}^{г} C_{тi},$$

where $Г > 10$ years.

Having solved both of the above conditions, we have objective indicators of the effectiveness of major overhauls and the appropriate limits of expenditures on them and optimum periods for the machinery to operate. The sufficient condition is an objective criterion of the actual effectiveness of a major overhaul. The necessary condition is an objective criterion of the limit on economically expedient major overhaul expenditures. Both conditions also determine the optimum service life of the machine.

It should be added that a sufficient condition is a criterion of the effectiveness of a major overhaul (including modernization, when necessary) foremost because additional expenditures are not required to finance it and, given appropriate repair organization, we even ensure a savings in depreciation funds which represents a net income.

It goes without saying that, given a sufficient condition, the depreciation period will serve as the limit of machine operation and normative outlays on major overhaul for that period will always be less than the depreciation fund for that particular type of repair and will generally be less than the cost of a new machine in those instances when the depreciation norm for major overhaul is less that the depreciation norm for renovation, which testifies to rather rigid, but nonetheless entirely feasible, restrictions.

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METALWORKING EQUIPMENT

IMPROVING METALWORKING-EQUIPMENT INVENTORY STRUCTURE IN MACHINE BUILDING

Moscow STANKI I INSTRUMENT in Russian No 8, Aug 81 (signed to press 21 Aug 81) pp 1-2

[Text] An important role in the resolutions adopted by the 26th CPSU Congress regarding acceleration of scientific-technical progress and improvement of the efficiency of consumer-goods production is assigned to the various branches of the machine-building industry, which provide the basis for technical re-equipping of the national economy.

"Basic Directions to Be Taken By the Economic and Social Development of the USSR in 1981-1985 and over the Period Through 1990," a document approved by the 26th CPSU Congress, calls for the output of machine-building and metalworking products to increase by a factor of no less than 1.4 during the 11th Five-Year Plan. The machine-building industry is to improve production efficiency by development of advanced technology, increased specialization, improvement of the structure of the metalworking-machine inventory, an increase in labor productivity, and rational utilization of basic manufacturing stocks and other material resources.

Any further increase in labor productivity in machine building will in large measure be determined by the level of mechanization and the qualitative and quantitative indices of the metalworking-equipment inventory. Systematic renovation of the equipment inventory and its supplementation with modern automated and precision metalworking machine tools and machinery is an important governmental goal in whose achievement all organizations and enterprises concerned with various aspects of the technical re-equipping of the national economy should take an active part.

"Basic Directions to Be Taken by the Economic and Social Development of the USSR in 1981-1985 and over the Period Through 1990" sets the following goals: "To improve the structure of the metalworking-equipment inventory in machine building by increasing the output of heavy-duty special and multifunction machine tools, advanced forging and pressing equipment, and automated production lines and machine groups. To provide for the priority refitting of machine-building enterprises with new metalworking equipment."

Producers' associations, enterprises, and organizations in the machine-tool industry achieved definite results in outfitting machine-building facilities with modern equipment during the 10th Five-Year Plan. The output of single-purpose, specialized, and multifunction machine tools (in terms of market value) rose by 76%, while that of machine tools with digital process control increased by a factor of 2.4.

More than 80(automated production lines were manufactured for factories in the automobile, tractor, and agricultural-machinery industries. A total of 550 automated and semiautomated lines were built for machine-building plants.

Over the last five-year plan, 2140 new equipment models were manufactured and tested and 590 obsolete models were taken out of production. The proportion of products of the highest quality grade (with respect to total commercial output) rose from 7.6% in 1975 to 41.2% in 1980; for metal-cutting machines, this index amounted to 49.8% in 1980, as against 11.5% in 1975. This made it possible to outfit new machine-building plants with modern metal-cutting equipment and to overhaul existing plants.

Improvement of production efficiency in machine building requires a substantial increase in the output of automated equipment, primarily automated and semiautomated metal-cutting machines and automated production lines for machine building and metalworking (including reorganizable lines), special and single-function equipment, machine tools with DPC (especially multifunctional machines with automatic tool exchange), equipment complexes controlled from a central computer, and equipment fitted with automatic program-controlled manipulators.

The 11th Five-Year Plan provides for an increase in the proportion (in terms of market value) of automated machine tools to 75% of total machine-tool output. The output (in terms of market value) of automatic and semiautomatic metal-cutting machines will be increased by a factor of approximately 2, that of automated and semiautomated machine-tool lines for machine building and metalworking by a factor of 1.5, and that of metal-cutting machines with DPC by a factor of 3. The proportion of special, single-function, and multifunction machine tools will amount to 24.1% of total machine-tool production.

The most important goal to be achieved in the manufacture of this equipment is a substantial improvement in its technical level and quality. The 11th Five-Year Plan calls for raising the throughput of metal-cutting, forging, and pressing machines and of casting and woodworking equipment by a factor of 1.5-1.6, improving their reliability and service life, and increasing the precision of metal-cutting machines by no less than 20-30%.

In accordance with the scientific-technical and production goals that have been set, the Ministry of the Machine-Tool Industry has worked out the variety of equipment models to be available for the period 1981-1985. Among machine tools that will be produced over this period, automated and semiautomated machines belonging to all technological groups will account for more than 60% of the total number of models. During the current five-year plan, 300 machine-tool models are to be introduced (replacing models manufactured earlier) and 305 models are to be taken out of production. Production is to be begun for 427 machine-tool models (not previously manufactured), including 297 models of automated machines. The new machine tools are to be characterized by a high degree of automation and higher precision levels; it will be possible to use them for implementation of new technological processes. New machine tools will be designed so as to provide standardized model-size series.

Design of more than 200 machine-tool models with DPC, including 55 models of multifunction machines with automatic tool exchange, is planned for the 11th Five-Year Plan. The technological level of precision machine tools is to be improved by automation, enhancement of machining precision, and expansion of the range of high-precision and extra-high-precision available. There is to be a qualitative change in the variety of heavy and custom-designed machine tools produced.

The following technical solutions must be implemented in order to achieve the planned increase in the throughput of metal-cutting machines: an increase in drive power, use of new types of tools and intensified cutting regimes, performance of a greater number of technological operations by a single machine, an increase in the degree of automation of machine-mechanism control, use of automatic manipulators, outfitting of machines with devices and attachments that give them greater technological capabilities, etc.

The output structure for machine tools will see an increase in the proportion of precision machines, particularly high-precision and extra-high-precision units (grinding, jig-boring, and fine-boring machines). It is proposed to bring 155 models of high-precision machine tools into production over the course of the five-year plan. New DPC systems (built-in and adaptive) are to be developed for this group of machine tools. Precision norms for machine tools are to be made more stringent by improving the quality of bearings and ball-bearing screw couples and employing real-time monitoring and fine-adjustment systems. Wider use will be made of tools fabricated from cermets and new synthetic materials in the finish machining of components.

The production of automatic machine-tool lines for branches of the machine-building industry engaged in mass and large-scale serial production will be increased and multipurpose lines and line groups will dominate total output.

Together with improvement of line throughput and reliability, reduction of the number of personnel required for equipment operation is also of great importance. Machine-tool fabricators in Minsk have taken effective steps in this direction. The Minsk Special Design Bureau for Automated Production Lines has developed automated machine clusters that combine individual equipment types, including automated lines.

All the machine tools and machines within a cluster are linked by asynchronous transport and storage systems that make it possible to virtually eliminate manual labor in loading, unloading, transporting, and storing articles to be machined. For example, the complex for machining of connecting rods and rod covers built by the Minsk Industrial Association for Manufacture of Automated Lines imeni 60-Letiya Velikogo Oktyabrya includes five automated lines, seven continuous surface-broaching machines, six rotary grinders, six fine-boring machines, five honing machines, an electrochemical unit, and other types of equipment. Use of this complex freed 375 workers and permitted an annual savings of 800 thousand rubles.

The Moscow Machine-Tool Plant imeni Sergo Ordzhonikidze manufactures a fast-switchover automated line with DPC intended for machining of shafts having different configurations (more than ten types). The line switchover time is 1.5 h).

Automatic manipulators are an important tool for raising the automation level in the machine-building industry. The 11th Five-Year Plan provides for accelerated expansion of the production of metalworking-equipment groups fitted with automatic manipulators.

The automated line designed by the Experimental Scientific-Research Institute of Metal-Cutting Machines for machining of electric-motor shafts, which consists of three machine tools with DPC and an automatic manipulator with a lifting capacity of 160 kg, makes it possible to increase labor productivity by a factor of 3 (with two-shift operation). Scientific-technical work conducted at the Institute will provide the basis for the future range of automatic manipulators to be produced.

Forty organizations and enterprises subsumed by the Ministry of the Machine-Tool Industry are participating in work on further expansion of the manufacture of automatic manipulators. Special attention must therefore be paid to the creation of standard types, units, and specifications in designing manipulators and auxiliary components for them. About 140 models of metal-cutting machines have now been selected for outfitting with automatic manipulators. Research and design on the new generation of manipulators, which will have better technical-economic indices, must be expanded.

A great deal of work is to be done in improving the effectiveness of development work at production facilities with a view to introduction of new metalworking equipment.

Current organizational practices pertaining to development and introduction of new technology must be reviewed and modified, with different stages (design, development of technology, fabrication of equipment and special tools, etc.) being carried out in sequence. Interesting experience in this area has been amassed by the Ivanovo Machine-Building Industrial Association imeni 50-Letiya SSSR, which switched to a parallel flowscheme for development work and introduction of new technology; this made it possible to reduce the time required for introduction of multifunction machine tools with automatic tool exchange by a factor of 3-4.

The experience of Odessa machine builders in the design and commercial introduction of a series of multifunction machine tools with DPC and automatic tool exchange is noteworthy; their throughput is 3-4 times that of the analogous machine tools produced previously and 8-10 times that of general-purpose machine tools. The horizontal and vertical machines in this series consist of standardized units and are constructed on the modular principle. In order to reduce development time, special engineering-technical groups were set up and carried out all the various phases of their work in parallel with the designing of the machine tools. Planning of the new series was begun in 1978 and two prototypes, models 2204VMF4 and 2254VMF4, were built and tested under industrial conditions in the first quarter of 1979.

Improvement of the industry's technical level will in large measure be associated with technical re-equipping of existing plants, an increase in the extent to which labor is mechanized, and improvement of inventory structure for metalworking equipment. Some work on outfitting of new and existing plants with the latest machine tools and machines, technological support equipment, and nonstandard equipment was conducted during the 10th Five-Year Plan. Any further increase in production efficiency in the machine tool and tool industry will to a great extent be the result of purposive work directed at improvement of inventory structure for metal-cutting machines and other types of equipment.

APPROVED FOR RELEASE: 2007/02/09: CIA-RDP82-00850R000500020016-7

All industrial associations and enterprises must fulfill their assigned quotas for elimination of obsolete equipment. The large amounts of funds allocated to technical re-equipping of plants must be used for acquisition of heavy-duty automated equipment. By the end of the 11th Five-Year Plan, the inventory structure of metal-cutting machine tools is to include 10-11% machine tools with DPC, up to 24% specialized, single-purpose, and modular machine tools, up to 9.3% high- and extra-high-precision machine tools, and up to 18.2% automatic and semiautomatic equipment belonging to all technological groups.

Special attention must be paid to rational utilization technological equipment. Reduction of idle time, improvement of the interchangeability factor, and rational utilization of equipment resources will provide the basis for a further rise in production efficiency.

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CSO: 1821/012

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