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MACHINE TOOLS AND METALWORKING EQUIPMENT

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## INDUSTRY PLANNING AND ECONOMICS

### MACHINE BUILDING AND INVESTMENT PROCESS

Novosibirsk EKONOMIKA I ORGANIZATSIYA PROMYSHLENNOGO PROIZVODSTVA in Russian No 3, Mar 82 (signed to press 4 Feb 82) pp 66-84

[Article by G.Ya. Kurbatova, candidate of economic sciences, head of machine-building sector, Institute of Economics and Organization of Industrial Production, Siberian Department of the USSR Academy of Sciences, Novosibirsk: "Machine Building and Investment Processes"]

[Text] The problem of intensification and boosting of the efficiency of public production presupposes a detailed program of reequipment of all spheres of economic activity. Growth of the technical level of the production apparatus requires large investment, and first of all a massive flow of tools of labor--machinery, equipment, instruments and so on. In the investment complex, about half of the gross production, size of production personnel and volume of capital investment belongs to machine building and metalworking; furthermore, with conversion to the intensive type of reproduction, this share displays a tendency for further growth.

The place and role of the machine-building industry are primarily determined by its capital forming function. An increase in the quantity of fixed capital, its technical and economical quality serve as the material basis of development and improvement of all public production.

#### The Machine-Building Industry and Capital Formation

Since 1960, the national economy's fixed capital has quadrupled, including a 5.5-fold increase for industrial-production capital.

We know that the level of the capital-labor ratio, its productivity and the prospects of the sector for production output are determined by the active part of fixed capital: power and working machinery and equipment, measuring and regulating instruments and devices. This part of them has grown 6.4-fold since 1960, that is, the growth rate of the active part of capital for sectors of industry (with the exception of electric power) exceeded only slightly the growth rate of industrial-production fixed capital. As a result the relative share of power, working, machinery, equipment and means of transport does not exceed 39-40 percent in the structure of fixed capital.<sup>1</sup> The share of measuring and regulating instruments and devices is small: it changed on the whole for industry

from 0.75 in 1960 to 1.4 in 1980. The share of this type of capital, determining to a certain extent the automation level of production, does not exceed 1 percent (with the exception of machine building and metalworking where its relative share was 2.6 percent in 1980).

In addition to the quantitative growth of the active part of the capital, its qualitative makeup changes, and renewal proceeds constantly. Thus during 1966-1979, 17,205 designations of obsolete designs of machines, equipment, apparatus and instruments were removed from production; during the four years of the 10th Five-Year Plan 7,255 of them were so removed.<sup>2</sup>

Two methods of fixed-capital renewal exist--addition of new tools of labor to the existing park and replacement of obsolete and written-off such tools with new ones. In the national economy, the first method still predominates, that is, reproduction of capital has mainly proceeded through an increase of the park, due attention has not been given to the replacement of that which has been written off. In investment deliveries, 82-88 percent of the equipment was sent for growth of the park and only 12-18 percent for its renewal. In industry, the share of equipment in 1966 serving as replacement amounted to 19.5 percent and about 25 percent in 1975.<sup>3</sup> As a result, the existing equipment with the onset of obsolescence and physical wear has not been replaced with new, more productive equipment, repeatedly undergoing 3-4 and sometimes even more capital repairs. According to calculations of specialists,<sup>4</sup> economy compared to the acquisition of new equipment exists only for the first capital repair; with subsequent ones, the efficiency of use of the old equipment drops steadily. Such a means of reproduction of fixed capital has become with time one of the causes of its aging and lowering of the growth rate of industrial production and slowing down of technical progress.

Slow renewal of the equipment park results in the accumulation of obsolete equipment in a number of sectors. Thus in ferrous metallurgy, more than half of the rolling mills at the present time consist of obsolete nonmechanized units; their labor productivity is one-tenth that of the new. The new mills provide only 45 percent of rolled metal. According to calculations of specialists, the replacement of only one-tenth of the mills with modern ones could produce approximately an additional 14 million tons of rolled metal.

Similar examples could be cited for other sectors. It is now necessary to raise the level of domestic machine building to an essentially new level.

#### Present Domestic Machine Building

USSR machine-building and metalworking industry is developing at a stable pace. From 1950 to 1980, the sector's gross production increased 33.7 fold. At the present time, the national economy has multisectorial machine building whose relative share amounts to 28.7 percent of total industrial production.

Major qualitative changes are taking place in domestic machine building. During 1961-1980, its structure changed significantly. First, there was an increase in the relative share of sectors providing technical progress,

mechanization and automation of production processes; these included instrument making, machine-tool manufacture, production of chemical equipment, construction, road and municipal machine building. Second, there has been a growth in the importance of sectors serving in the final analysis material well-being and the satisfaction of the cultural and everyday needs of workers: automotive industry, production of equipment for light and food, timber, pulp-and-paper and woodworking industry.

In addition to this a certain reduction is observed of the relative share of such sectors as heavy, power and transport machine building, electrical equipment industry, tractor and agricultural machine building. The changes in the sectorial structure of machine building on the whole should be considered progressive, being directed at intensification and increased efficiency of production, although the dynamics of the changes is so far inadequate.

Despite serious successes, the technical-economic level of the machine-building industry is inadequate, does not correspond to the tasks of reequipment of production and does not provide a high rate of development for the economy. The November (1978) Plenum of the CPSU Central Committee pointed to the lag of machine building behind the needs of the national economy. This thought was also heard at the 26th CPSU Congress.

The dynamics of the growth rate of machine-building and metalworking production during 1966-1980 attests to their systematic reduction. Whereas in the years of the 7th Five-Year Plan, annual production growth was stably maintained at a level of 12.4 percent, in the 8th the average annual rate of development of machine building amounted to 11.7 percent; in the 9th it dropped to 11.6 percent and in the 10th it fell to 8.2 percent.

Such a lowering of the rate resulted in weakening of the role of machine building in industrial production as a whole. The lead of production output of machine building compared to industrial production as a whole began to be reduced. Thus, whereas in prewar years the relation of the tempo of their growth equaled 2.0, in 1959-1960, it dropped to 1.43, in 1971-1975--to 1.20 and in 1976-1980--to 1.19. If we take into consideration the distorting influence of repeated reckoning of material expenditures and the cost factor, the actual growth rate of machine-building and metalworking production would be close to the rate of all industrial production, while the output rate of completed machines and equipment should be even smaller. Thus in 1966-1975 the average annual growth rate of gross production of machine building was about 12 percent and that of the production of machinery and equipment--8-9 percent.<sup>5</sup> As a result, the requirements of the national economy for equipment are not being satisfied.

#### Machine Building and Requirements of the National Economy

The special role of machine building in the national economy dictates the need of a leading production of tools of labor while adhering to rational proportions between machine building, on the one hand and industry and construction, on the other.

But the dynamics of correlation of sectors is such that by the end of the '60s the lead of deliveries of equipment had not only been reduced, but there was also to be observed their lag behind industrial production. There was also no lead of deliveries of equipment with respect to construction. In the 9th Five-Year plan, the situation changed somewhat. The lead of deliveries of machinery and equipment with respect to growth of industry and construction increased and the correlation of their tempi reached respectively 1.05 and 1.08. But such a correlation could not radically improve the technological structure of capital investment and ensure the creation of a technical base for the national economy meeting present-day requirements. Growth of the output of tools of labor lags significantly behind the needs of user sectors. The lack of correspondence between production of needed equipment, instruments and devices and the requirement for them hinders, for example, the solution of the burning problem of reduction of manual labor.

Although exerting a significant influence on reproduction of the gross national product, machine-building sectors themselves depend on this process. The dependence is expressed in manufacturing use of products of other sectors. A disproportion has come into existence between the volumes and rates of development of machine building and metalworking, on the one hand, and those sectors of industry that provide machine building with tools of labor, on the other.

This applies first and foremost to ferrous metallurgy as the chief supplier of materials for machine building and metalworking. The machine-building and metalworking industry uses two-fifths of all rolled ferrous metals. Consequently, the low and decreasing growth rate of ferrous metallurgy cannot but help affect the development of machine building. Besides, the assortment and quality of ferrous metals produced by domestic metallurgy does not fully meet the requirements of machine building, which also holds back its progress and restricts production efficiency.

Such a situation is to be explained to a significant degree by a lack of balance between ferrous metallurgy and machine building, especially metallurgical, whose level does not at all correspond to the tasks of reequipment of metallurgical production. The fact is there practically is no specialized metallurgical machine building today in the national economy. It is primarily represented by broad profile plants, which produce in addition to metallurgical equipment a broad range of other equipment for tens of sectors of production.

The share of investment in metallurgical machine building with respect to the sum of capital investment in ferrous metallurgy is low and has shown a tendency in recent five-year plans toward reduction. If there be taken into consideration the fact that the sector has to also provide equipment for nonferrous metallurgy and export shipments, the relative share of capital investment in the production of machines and units for ferrous metallurgy will be found to be even smaller.

Existent production capacities of metallurgical machine building cannot ensure the development of new progressive production processes in the metallurgical industry. Reference is made first of all to steel casting on continuous casting machines (MNLs). The amount of steel cast on MNLs in 1980 in our country

reached 16.6 million tons, that is, comprised 11.2 percent of all cast steel (in Japan, the FRG and Italy in 1979, forty to fifty percent of steel cast was with MNLS). The country where this progressive technology was first developed and applied in the world does not occupy today the leading position in regard to the amount of continuously cast steel.

One of the chief reasons for machine building's lag is a shortage of capital investment. Although it concentrates about one-third of the country's industrial potential, the share of the sector in industrial capital investment during 1966-1970 amounted to 18.8 percent, during 1971-1975--22,4 percent and only during 1976-1980 did it rise to 24.6 percent.

Higher efficiency and intensification of public production, equipping spheres of economic activity with high-production equipment require changes in national economic and sectorial proportions of production and distribution of products. This applies first of all to advanced development of production and deliveries of equipment for reequipment of machine building and metalworking and the complex sectors producing construction materials.

The leading role of the machine building industry in reequipment of the national economy presupposes a well-developed and progressive technical base first of all for machine building.

#### The Technical Base of Machine Building and Metalworking

Production capital of the machine-building and metalworking industry increased 4.5-fold from 1961 to 1980. As a result the share of the sector in the amount of production capital in industry grew from 18.6 to 21.5 percent (and of machine building only from 15.6 to 18.7 percent, respectively).

The growth of machine building's fixed capital was accompanied by a qualitative change in its composition because of receipt of high-production machine tools, automatic and semiautomatic units, automatic and flow lines. The number of installed mechanized flow lines in only 14 years increased from 9,862 in 1965 to 40,260 in 1979, that is, more than fourfold and of automatic lines from 2,965 to 12,912, or 4.3-fold. But many kinds of machines and equipment are still not being produced in our country; individual machines rather than complexes of equipment provided with transport and loading-unloading systems and means of automation are being supplied. As a result, the quantitative growth of machines used in production is disconnected, although they are high-production machines and equipment; it does not as yet create conditions for integrated mechanization and automation of production processes in machine building and therefore is not distinguished by high economic effectiveness.

The qualitative change of production fixed capital in machine building depends first of all on the state and growth of such sectors as machine-tool and electrical equipment industry, instrument making, materials handling, machine building, and in part metallurgical machine building, repair of machines and equipment and bearing industry. During 1966-1975, the production capital of these sectors increased roughly threefold (for instrument making--3.6-fold). But the share of their fixed capital in machine building is small. Thus for the

electrical equipment industry in 1975 it amounted to 6.3 percent and for machine tool and instrument making-- 4.9 percent. But in the total amount of production fixed capital of industry, the share of each of these leading sectors does not exceed 2 percent.

The dynamics of the technological structure of the fixed production capital of machine building and metalworking is characterized by an increase of the relative share of machines and equipment. During 1966-1980, their share increased from 35.3 to 46.3 percent. The biggest increase of the relative share of active capital was observed in the electrical equipment industry (from 42.5 to 49.0 percent), in the chemical and petrochemical machine building (from 38.0 to 43.1 percent) and instrument making (from 42.0 to 49.9 percent) and in road construction machine building (from 25.0 to 42.3 percent). In other sectors of machine building, the share of active capital dropped somewhat.

The growth of technical equipment of production in machine building and metalworking is shown by the dynamics of the capital-labor ratio. During 1965-1980, overall capital-labor ratio in the sector increased 2.7-fold, including the capital-labor ratio of active capital (machine equipment)--2.8-fold.

Machine equipment compared to other sectors of industry shows a more favorable dynamics for yield on capital: output capital here does not display a tendency for reduction; it grows. Thus during 1961-1975, it increased almost 30 percent. Advancing growth of machine equipment (over general capital-labor ratio) was responsible to a certain extent for the superiority (of 30 points) of the growth rate of labor productivity compared to its capital-labor ratio.

What has been said shows that domestic machine building possesses a tremendous production-technical potential. But the special role of the machine-building industry demands further improvement of its technical base.

Reequipment of the sector. As we know the basis of the production apparatus of machine building is metalworking equipment whose park is relatively young in our country. But the share of metal-cutting machine tools and forging and pressing machine that have been in service less than 10 years is being steadily being reduced. The fact is that the overwhelming part of annual receipts of metalworking equipment goes to increase its park, while the annual volume of written-off equipment remains at the level of the midfifties.

The coefficient of intensive renewal, reflecting the internal relations of accumulation and renewal of the means of labor, is lower in domestic machine building than for industry as a whole and shows a tendency for reduction. In 1975 it was 0.20 versus 0.25 in 1966 (this coefficient on the average for industry in 1975 equaled 0.29). The share of annually replaced equipment in the total park of the machine-building and metalworking industry during 1966-1975 did not exceed 3.0 percent (aside from 1972, when the norm for replacement of equipment in the sector equaled 3.23) which under conditions of intensification of production is manifestly inadequate). In the opinion of specialists of the Experimental Scientific-Research Institute of Metal-Cutting Machine Tools, the size of annual replacement of metalworking equipment should not be less than 6-8 percent.

It is true that for some sectors of machine building, the norm of equipment replacement is significant higher than the mean indicator for industry. Thus for instrument making in 1975, it was 5.1 percent, machine building for light and food industry--5.15 percent, for road construction machine building--5.96 percent and for the machine-tool industry 7.52 percent.

But inasmuch as replacement of equipment at enterprises is not integrated and individual machine tools or equipment rather than entire production lines are replaced, it does not produce the necessary effect. Moreover, for some sectors of machine building, particularly heavy machine building--metallurgical and materials-handling--less than 1 percent of the old equipment is removed.

For this reason, in addition to modern units, representing the latest achievements of science and technology, obsolete machines and equipment are operated. They, on the one hand, divert a significant part of worker cadres, which leads to deterioration in the use of new equipment and, as a consequence, to significant losses in the productivity of its park, reduction of labor productivity, growth of metal intensiveness and deterioration of production quality. On the other hand, they result in overexpenditure of funds for capital repairs.

Consequently, with slower growth of output of machines and equipment and a high rate of growth of its available park, the possibilities of replacement of equipment are steadily reduced, while length of its service grows. Right now the possibilities of machine building to provide rapid replacement are most limited. It should be remembered that the need for replacement grows 3.5-fold faster than resources. Thus, with a lower rate of output of metal-cutting machine tools,<sup>6</sup> the need for replacement of the machine-tool park even if the entire receipt of machine tools is used for replacement of obsolete ones would be satisfied only 50-60 percent.<sup>7</sup> At the present time, about 30 percent of receipts of machine tools, that is, 15-20 percent of yearly requirements, is actually allotted for these purposes. At the same time, metalworking equipment comprises the basic portion of the machine park, and its timely renewal determines the efficiency of public production. According to calculations of specialists, this equipment should be produced at the present time 2.0-2.5-fold more.

Structure of the park of metalworking equipment and level of its utilization. Lack of correspondence between the possibilities of the technical base of machine building and metalworking and modern requirements of production is also manifested in the unfavorable structure of the park of metalworking equipment and the level of its use.

The share of forging and pressing machines in the total park of metalworking equipment is only about 16 percent. At the same time, according to the experience of industrially developed countries, an efficient ratio of forging and pressing equipment and metal-cutting equipment is 1:3. But the existing structure of production of metalworking equipment is poorly oriented toward improvement of proportions in the operative park of equipment. The relative share of progressive forging and pressing machines being produced, while it is gradually increasing, still does not exceed 21-22 percent. The shortage of modern forging and pressing machines and the predominance in the park of

of machine-building plants of equipment for free forging, is responsible for massive metal expenditures, which reach 27 percent of the metal used (more than 15 million tons).

Machine-building enterprises are inadequately supplied with progressive types of production equipment: 38 percent of metal-cutting machine tools are designated for ferrous processing of parts<sup>8</sup> and only 11.3 percent for high-precision machine tools; the share of precision, automatic equipment, particularly equipment with numerical program operation. In addition, the production structure of metal-cutting machine tools so far has been unable to significantly contribute to the improvement of the existing park of equipment in domestic machine building. The share of progressive groups of machine tools (specialized, special, grinding, stripping-polishing, equipment for electrophysical and electrochemical technologies) providing a high level of labor productivity, although it possesses a tendency for rising, it still remains low. As a result, only 25 percent of assembly operations have been mechanized and about 5 percent automated in machine building.

#### Ways of Intensification and Raising of Efficiency of Machine Building

The solution of the social-economic tasks set by the 26th party congress requires that the production of tools of labor surpass the output of means of production for the reequipment of machine-building and metalworking sectors. There is consequently the problem of eliminating disproportions in the development of machine building and related sectors without which it would be impossible to provide a high rate of expanded reproduction, rapid growth of labor productivity, integrated mechanization and automation of production processes in the national economy.

In view of the limited nature of capital resources, it would seem sensible to change sectorial distribution of capital investment in favor of such, for example, directions.

(1) Improvement of the structure of metal products, improvement of their quality, development of production of special economical shapes of rolled metal for the needs of machine building. Modernization of existing production and organization of production of new high-efficiency metallurgical equipment, accelerated development of the fourth redivision of the metallurgical industry.

(2) Speeding up of scientific-technical progress in machine building itself for the improvement of its technical base, including:

- development and improvement of the technical base of the machine-tool industry;
- creation and development of a specialized and concentrated procurement base and production of products of general machine-building application;
- development of centralized production of materials-handling machines and mechanisms;

- maintenance of high rates of development for instrument making and automation equipment;
- specialization and concentration of repair production operations and output of spare parts.

The predominant direction of capital investment in machine building should be modernization, expansion and reequipping of existing production. Large-scale new construction is apparently warranted only for the realization of essentially new technical solutions and organizational forms of production exceeding the parameters of possibilities of reequipping of existing production apparatus and shifting of new varieties of production of new regions, particularly eastern regions.

For the improvement of the technical base of the national economy and more intensive renewal of the production apparatus, there should first of all be ensured the leading development of machine building itself, improvement of its sectorial structure, improvement of quality, reliability and service life of manufactured machine and equipment. In order to increase the role of machine building and metalworking in industry, significant progressive changes would have to be attained in intersectorial and intrasectorial proportions.

First, progressive proportions should be achieved between the growth rate of machine-building production, on the one hand, and the tempi of all industry and construction, on the other. Acceleration of renewal of the production apparatus connected with rapid obsolescence of equipment and technology, mechanization of sectors of material production and their automation over the long term will significantly expand demand for high-production machines and equipment. According to calculations, for the reequipping of the national economy and satisfaction of the needs of the sphere of nonmaterial production, the rate of growth of production of equipment by 1990 will have to exceed the rate of growth of industry roughly 1.5-1.6-fold. In the opposite case, with retention of existing proportions and tempi of production of equipment, products of industry and of construction-installation work, it not only will not be possible to speed up renewal of the park of equipment but it also will be necessary to be reconciled to its slowing down.

Second, it will be necessary to achieve rational proportions between the development of machine building and the sectors that provide it with basic types of labor and services. Intensification of machine building requires the development of sectors providing it with resources: capital construction; improvement of quality and assortment of structural materials; reequipping and development of the technical base of scientific-research organizations and experimental production facilities for expansion of the front of pilot work and reduction of time periods of development and introduction into production of new examples of machines and equipment.

It is necessary subsequently to achieve effective proportions in the development of individual sectors of machine building and metalworking, that provide means and objects of labor, on the one hand, for the machine-building complex, and, on the other, for nonmachine-building sectors of the national economy. It

is now time for radical changes in the structure of machine-building production, involving first of all a sharp rise in the relative share of production of metallurgical machine building and sectors of general machine building (machine-tool, electrical equipment, bearing industry, instrument making, intersectorial production operations, materials-handling machine building). The share of these sectors determining the technical base of machine-building production seemingly should rise to a level of 28-30 percent.

It is possible to achieve serious changes only by increasing the mobility of machine building, which is necessary in the development of new types of equipment and new machine models. For this reason there should be provided reserve production capacities which would make it possible for sectors of machine building to effectively reorganize work.

It is urgently necessary to improve proportions between expansion and renewal of fixed capital in accordance with developmental plans of public production for long-term interests of its maneuverability and normal activity. The chief method of renewal of active capital of machine building in the next 15-20 years will have to be that of accelerated replacement of obsolete equipment accompanied by a reduction in the growth rate of the park. According to calculations of scientific-research organizations, over the long term 35-40 percent of the production of equipment should be used for the replacement of written-off equipment (instead of approximately 20 percent at the present time).

For acceleration of scientific-technical progress in machine building itself and the increased effectiveness of its production, the character of allocation of equipment should apparently be change: to significantly increase deliveries of new metalworking equipment to machine-building ministries. Equipment formerly in use at machine-building enterprises should be turned over after its capital repair to nonmachine-building production facilities.

The maintenance of a unified policy and coordination of technical development of the machine-building industry and the entire complex of material producing sectors, especially ferrous metallurgy deserves, special attention. It is a question of raising the general level of metallurgy, expanding the assortment of metal products, improving its quality and developing the production of special economical forms of rolled metal. In addition, it will be necessary to be concerned with the creation and increased output of modern high-efficiency machines and automated reliable complexes of metallurgical equipment.

Progress in metal production should be closely connected to the needs of metalworking. The country needs such metal products as are designated for working with maximal approximation of the form and dimensions of the finished part with a minimal number of operations. Together with modification of traditional methods (precision casting, cold and semihot forging, cold and hot extrusion and others), the efforts of technologists are directed at the creation and experimental finished development of essentially new technologies: electrotechnical and electroerosion, electron-beam (including laser), high-energy stamping, working with ultrasound, operations in a vacuum, new forms of welding, soldering and gluing.

Dissemination of new methods of working and accelerated renewal of the technical base of machine building presuppose an increase in the deliveries of progressive equipment and tools. Quantitative, qualitative and structural changes require expansion of production capacities, first a primary development of the machine-tool industry. For expanded reproduction of active production fixed capital and for its replenishment, the share of the machine-tool industry in machine building itself (without intersectorial production operations), will have to be increased according to preliminary estimates no less than 2.7-3.0 percent in the gross production of machine building.

Deepening of part and technological specialization in machine building presupposes a radical reorganization of the complex of intersectorial and auxiliary production operations through change of the organizational structure of machine-building plants--earmarking of production, servicing and auxiliary shops for independent production units and bringing up the scale of production to optimal. It seemingly would make sense to single out a specialized sector, uniting enterprises of one type within the framework of a department authorized to develop and carry out a unified production policy and to centralize capital investment into the manufacture of products of general machine-building use. According to preliminary calculations, even partial part specialization will provide the possibility of doubling in a short time the production of many kinds of products and to release up to 40 percent of the auxiliary workers.

But the creation and development of a reliable procurement and intersectorial base is a complex affair and requires time. Therefore, at the first stage, as proposed by specialist machine-tool makers,<sup>9</sup> a kind of inventory should be taken of already completed projects as well as of existing and under-construction shops and plants of this type. It would be possible to select from among them those whose construction or modernization is approaching completion and then concentrate funds, materials and equipment on them for their quickest possible startup. Furthermore, doing this would make sense even at the cost of investment in other sectors of machine building, especially of mechanized assembly production installations, which are not loaded to full capacity (because of the absence of the required quantity of billets).

A major reserve of growth of efficiency of public production in the long term could be found in increasing the role of foreign economic ties. First, for example, it would make sense to include among imports the relative share of products of machine-tool building for the expanded reproduction of production equipment at domestic enterprises. It would seem practicable to expand purchases of component items for machine-tool making (electro-hydro-pneumo-apparatus, bearings, systems of programmed control and so on) and other assemblies. This would make it possible to gain time and to economize on labor and material resources required for the organization and development of their own production.

At the same time, it would also makes sense to reduce in the next 10 years the share of exports of metalworking, metallurgical and materials-handling equipment. They would be allotted for the renewal and expansion of the equipment park in the country's national economy.

The survey of the problems facing domestic machine building shows that their successful solution can be ensured only with methods of comprehensive planning and integration of development of material production, scientific-technical and planning solutions, an experimental-design and semiindustrial base and cadre training and retraining. Over the long term, it will be necessary to work up a list of central problems and an optimal strategy for their solution.

Machine building and more precise study and solution of outstanding problems will have to be approached as a complex multisectorial aggregate with an internal relatively independent logic of development. A hypothetical structure of the machine-building complex in our view suggests that it be broken down into three parts with different functional loads:

1--the nucleus of the machine-building complex: production of tools of labor, determining technical progress in machine building (instrument making, automation equipment, machine-tool industry);

2--production of objects of labor and means of production of general purpose for machine building (electrical equipment industry, materials-handling machine building, intersectorial production operations, bearing production and so forth);

3--final stages of machine-building production: manufacture of specialized tools of labor for other sectors of the national economy.

Each preceding of the three levels of the machine-building complex receives advanced development and serves for subsequent ones as a material condition of their development and functioning. Such a conception of the machine-building complex can serve as a basis of forecast and calculations of proposed tempi and proportions of development of the USSR machine-building and metalworking industry.

#### FOOTNOTES

1. According to data of the statistical yearbook of CEMA member-countries (Moscow, "Statistika", 1976), the share of this part of capital in 1975 amounted to 50.5 percent in the GDR and 40.6 percent in the CSSR.
2. Statistical yearbook "Narodnoye khozyaystvo v 1979 g." [USSR National Economy in 1979]. Moscow, "Statistika", 1980, p 114.
3. Fal'tsman, V.K., "Potrebnost' v sredstvakh proizvodstva" [Requirement for Means of Production]. Moscow, "Mysl'", 1975.
4. Palterovich, D.M., "On Service Life and Renewal of Industrial Equipment." --VOPROSY EKONOMIKI, No 2, 1970, pp 67-68.
5. VOPROSY EKONOMIKI, No 1, 1978, p 33.
6. The average annual growth rate of production of metal-cutting machine tools was: 1966-1970--8.9 percent; 1971-1975--8.8 percent; 1976-1979--6.3 percent.

7. Ivanov, Yu.M., "Proportions of Expanded Reproduction Under Conditions of Intensification." "Problemy narodnokhozyaystvennogo optimuma" [Problems of a National-Economic Optimum]. Novosibirsk, "Nauka", 1980, p 234.
8. Such a structure of the park of metal-cutting machine tools is conditioned by the structure and quality of structural materials (high tolerances) as well as by a weak development of specialized intersectorial production operations.
9. PRAVDA, 16 Jun 1976.

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## INDUSTRY PLANNING AND ECONOMICS

### PROBLEMS WITH REPAIR SYSTEM SPUR NEED FOR CENTRALIZED MACHINE TOOL REPAIR CENTERS

Minsk SOVETSKAYA BELORUSSIYA in Russian 15 Sep 82 p 2

[Article by R. Ivut', candidate of economic sciences: "Who is Centralizing Repair Work?"]

[Text] An analysis shows that labor expenses associated with the repair of modern machines and equipment are steadily rising. The fact of the matter is that more than 40 percent of the total number of the most qualified workers are employed in this sphere of production. And this figure is gradually increasing. The further intensification of production is inconceivable without the application of advanced systems for organizing repair work and modernizing technology.

The collective of the repair and mechanization shop in the Minsk Tractor Plant has accumulated no small amount of experience in this area. They have centralized capital repair work for multiple spindled semiautomatic lathe machines, semiautomatic hydraulic duplication machines, gear milling machines, presses and foundry machines. Specialized crews of metal workers are restoring equipment. Each crew member is engaged in repairing individual assemblies. At the same time the possibility has arisen of manufacturing the most complicated assemblies according to a planned system.

Internal plant centralization, as is known, is only the first link in the transition to industrial rails. The next step is the union of several small capacity shops into one, the formation of a network of specialized intersector enterprises that would be engaged in the output of spare parts and assemblies along with repair work.

There is no such plant in our republic. Calculations convince us that all interested ministries, departments and enterprises in the republic could participate in its construction irrespective of their sector affiliation. First of all, it is necessary to centralize capital repair work for the widely used models of lathe machine tools and the manufacture of spare parts for them. This promises huge benefits. First, it will not be necessary to transport equipment to repair enterprises in the Ukraine and RSFSR. It has been calculated that transportation expenses often exceed the cost of the repair work itself. In addition, interplant centralization and specialization make it possible to organize serial and mass production, to completely mechanize and automate restoration work, to sharply increase labor productivity and to free highly qualified workers for other sections.

The traditional planned preventive system of maintenance (PPR) for equipment has become a serious hindrance in improving production efficiency. For example, the standards recommended by the PPR system are not being applied at a single one of the 50 machine building plants that were examined by us. Maybe enterprises are operating according to their own system which is better? It turns out that the answer is no. At the majority of them there is generally no kind of method of preventive inspection and restoration of machine tools. In a number of instances inspection, lubrication, and minor and medium-sized maintenance work is not planned. And if it is planned there are not sufficient hands to go around as a rule since repairmen are constantly engaged in fixing accidental breakdowns.

As bad as the existing PPR is why are they abandoning it? The explanation is simple: its basic standards were reviewed and approved more than 15 years ago. Certainly it is lagging behind the continuously growing demands of basic production.

Recently the collective of the Belorussian Polytechnical Institute worked out a new system--regulated technical service for equipment (RTO). Minsk motor vehicle plants are adopting it and, judging by the first results, it is quite effective. The essence of it consists of the fact that instead of a nine-period, three-type structure for the maintenance cycle a two-type, five-period structure is used.

The traditional conditions for paying bonuses to lathe operators and electricians have also been changed. Three statutes concerning bonuses for workers who are engaged in regulated technical service have been approved at the motor vehicle plant. The first specifies supplemental pay for a crew completing the standard tasks. The second--a bonus for repairmen for each percentage point that the idle time of equipment due to non-planned repair work is reduced. The third statute recommends that supplemental pay be given to workers who have attained a professional skill level or who have learned related professions.

Such a bonus system promotes the efficient use of work time, improves responsibility for the quality of work and fosters collectivism and a feeling of mutual assistance.

Obviously its adoption requires a certain amount of reorganization. In particular it is necessary to form complete crews, to remove repairmen from under the jurisdiction of basic shop administrators, and to concentrate them in a single center--a main mechanics and power service.

Under modern production conditions only a system of active service and maintenance is capable of improving the technical state of equipment. Technical diagnostics plays an important role here. It is known that when the complexity of machines increases the time needed to fix breakdowns also grows. Sometimes more time is needed to determine the reasons for the breakdown than to fix it. The main thing, however, is not only to determine the location and reason for the fault. It is more important to prevent it. Technical diagnostics is called upon to serve just this purpose. One must only regret that they are still adopting it in a timid manner at the enterprises in the republic. Due to this the vast potential capable of reducing expenditures for repair work is not functioning.

And there is one more thing. The effectiveness of maintenance work on machines and equipment depends in many ways on production management. It seems that the time has come to extensively apply the "ASU-maintenance" automated system, which looks like a special block in the complete automated system of managing production. Practice shows that at many enterprises they approach this in a formal manner and solve only an extremely narrow range of problems by EVM [computer]. The expertise of the leading enterprises in the country testify to the fact that completely concentrating repair subdivisions under the aegis of a main mechanics service is a necessary condition for adopting the "ASU-maintenance" subsystem. In a word, centralization is required. This trend may be considered generally acceptable for all enterprises today irrespective of the type of production and sector affiliation. Certainly its fate depends to a significant degree on the initiative and enterprise of administrators and on their capability of creatively applying accumulated expertise. Without this, it seems, it is impossible to ensure the steady fruitful work of enterprises.

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## AUTOMATED LINES AND AGGREGATED MACHINING SYSTEMS

### FLEXIBLE MACHINING SYSTEMS DISCUSSED

Leningrad LENINGRADSKAYA PRAVDA in Russian 8 Jul 82 p 2

[Article by M. Ignat'ev, professor and department chief in the Leningrad Aviation Instrument Building Institute: "Shops of the Future: How to Accelerate the Transition to the Formation of Flexible Automated Production on a Mass Scale"]

[Text] According to statistical data at the present day there are several dozen completely automated shops and sections at enterprises in the country. If one even relates them to the model subdivisions for the special kinds of propaganda and prototype production of yesterday there are still not very many of them. Yet according to calculations by the State Committee for Science and Technology the national economy requires 10,000 such complexes. Thus, the most important stage in intensifying production was determined to be the transition to the formation of automated shops, sections and whole plants in the resolutions of the 26th CPSU Congress.

The economic and technical preconditions for meeting such a goal do exist in the country. Our industry developed the output of computer programmed machine tools, robot manipulators are being created and methods for planning and managing under automated production conditions have been worked out. Naturally the question arises of how to use these fruits of scientific and technical progress as effectively as possible. One of the most effective ways is to have automated production become not only total but also flexible.

The point being made concerns, in essence, the new stage of using computer technology, robots and programmed systems for production. It was no coincidence that the very term "flexible automation" appeared. A modern economic structure is characterized by a large stream of changes: planned goals, the number and quality of blanks and machines engaged in the technological process, the composition of the people, and so forth, change. Naturally, additional demands on production flexibility arise under such conditions. How can this be achieved? Rigidly organized automated lines are not suitable here. The way out, as research and the first experiments have shown, is in the formation of flexible complexes. Their fundamental differences are the fact that first, the transporter conveyor safely connects all of the working places with the warehouse and when the products list changes it is possible to change a tool and obtain the required blank more quickly. Secondly, all changes in the labor process, including a worker's tasks, are determined with the aid of information and computer technology, and this means quickly. And, finally, the functions of all participants in the production process are precisely defined.

And just what else happens from time to time? Let's say the products list changed and precious work days are lost in searching for and substituting the rigging and fittings for the machine tools. In addition, the previous tools and blanks that are no longer needed are exchanged. And such situations that are associated with reorganizing on the run arise quite regularly for in machine building, for example, a large portion of the products are manufactured in small series and, at times, for individual orders. The capability of quickly rearranging technology in many ways solves this painful problem for enterprises.

When changing the products list for ChPU [computer programmed] machine tools one need only change the program rather than the tool and the section can again turn out the needed product.

The experience gained in operating the automated shop at the Dnepropetrovsk electric locomotive plant has clearly demonstrated these advantages. The new mechanical processing shop, which manufactures 370 types of parts, was formed by specialists from several collectives including Leningrad specialists--the All-Union Structural Design Institute for the Technology of Electrotechnical Production and the Leningrad Aviation Instrument Building Institute. I would particularly like to emphasize that reconstruction was done under conditions of operating production. The introduction of complete automation made it possible for the collective to increase the annual output of parts by 20 percent along with a substantial reduction in production area. Labor productivity increased by more than a factor of 3 and 83 people were freed for other sections of the plant.

The social effect derived from the reorganization is also important. It fundamentally changed the nature of almost all operations. You will not see people cleaning up shavings here or hauling materials from the warehouse as at related enterprises in the sector. All the heavy physical labor has been laid on the shoulders of automated machinery. ChPU equipment made it possible to transfer to a multi-machine tool service and, as a result, the main figure in the new shop became the operator who has control over the implementation of the program that has been placed in the machine. Production sophistication has increased, working conditions have improved and therefore personnel turnover has practically been eliminated.

I would like to pause more in detail at one of the points. There is a fundamental difference between the use of individual ChPU machine tools or robots and their total utilization. Perhaps this is more distinctly apparent in a comparison of coefficients for use of equipment. On the average, single machine tools have less of a workload than in complexes by a factor of 2.5. It seems as if the advantage is apparent. Yet nonetheless it is as if automated shops are still little islands in the ocean.

One of the reasons for such a situation is the fact that in many enterprises the process of adopting the newest equipment appears to be too simple at times--supply us with robots and ChPU machine tools and then we will work according to the new system. Yet in practice something else occurs. The lack of a precise long-range program for adopting automated machines and in particular the variations of combining them in complexes leads to the fact that the most perfect and expensive technology sometimes only "plugs" the tight spots in the technological process and therefore is only used to a quarter of its capabilities.

From this point of view an approach to the problem of a number of Leningrad collectives, among whom are such large ones as the "Kirovskiy Plant," the Leningrad Electromechanical Plant and LOMO Associations, deserves the most intent attention. The main work here to form automated shops is distinguished not only by the vast scale but by the close coordination of the complexes that are being worked out with the long-range plans for the economic and social growth of enterprises. The majority of them have already conducted a predesign survey of the shops where new technology will be adopted. The importance of this, which at first glance appears to be a purely organizational stage, cannot be overemphasized. At some enterprises it turned out that if just the equipment that is in operation is combined with robots and ChPU machine tools in complexes it can already provide a substantial effect. It goes without saying that it will be easier and more profitable to form flexible automated production on this basis--less new expensive technology will be required and its coefficient of use will increase.

However, there are obviously few existing automated complexes for such a large economic region as Leningrad and the oblast where 5,000 ChPU machine tools and more than a thousand robots are already in operation--there are only about 10 in all. In order to accelerate their formation much remains to be done not only by the enterprises but by the sector technological institutes. It is possible to name no less than 15 Leningrad structural design organizations that are doing work in this direction. Yet just the same the return from it is obviously insufficient. First of all this is due to the time frame for design work. At present it lasts for three to four years which hardly suits production workers. Can this time frame be reduced? I think that it is completely realistic to reduce it by one to one and a half years. But for this it is necessary to summarize the existing expertise if only in the confines of Leningrad, to prepare recommendations for forming automated shops and to work out their typical designs.

Incidentally something has already been done. The method of predesign investigation has successfully withstood the test. Work is purposefully being done to evaluate advanced expertise and to create more economical designs on this basis for automated shops in VPTIElektro and VPTIEnergomash. Thus this problem is being solved considerably faster in these sectors than in others.

In a word such an important national economic problem, on the solution to which an increase in the intensification of production directly depends, must already become one of the important trends today in the activities of structural design organizations and the enterprises that will receive new technology. This is even more important if one considers that flexible automated complexes must appear at enterprises in nine sectors of industry in Leningrad during the 11th Five-Year Plan.

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