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D04542

United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.113/39
15 December 1972

ORIGINAL: ENGLISH

Regional Seminar on Machine Tools for
Countries in Latin America

Buenos Aires, Argentina
16-25 October 1972

São Paulo, Brazil
26-27 October 1972

SOME ASPECTS OF MACHINE TOOL INDUSTRY IN DEVELOPING COUNTRIES AND QUALITY OF ITS PRODUCTS[1/]

by

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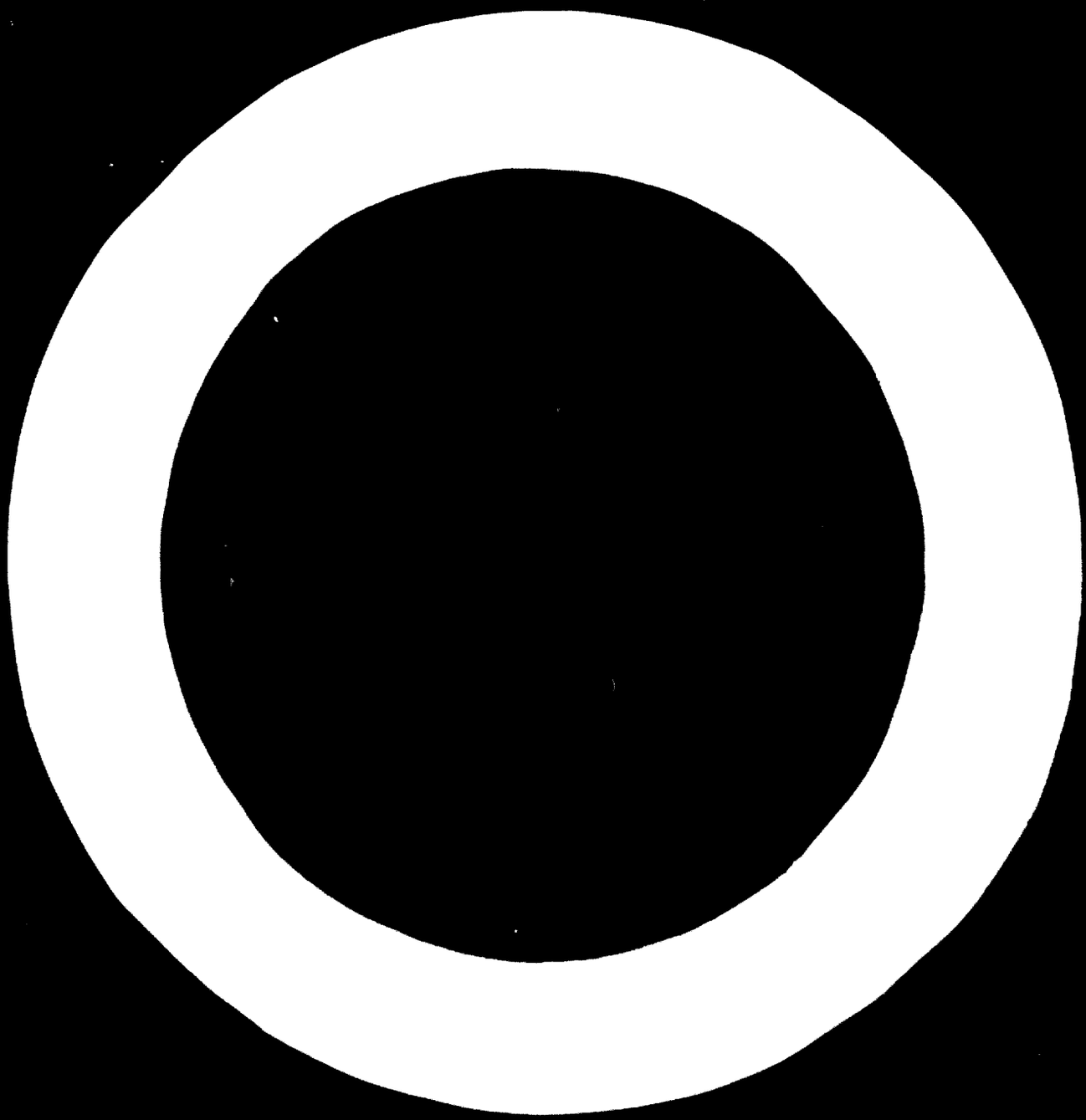


This meeting deals with problems, concerning machine-tool industry in developing countries. The term "developing" itself already means that these countries are moving in a progressive direction to a certain aim. Naturally, economical and political conditions existing in the countries, which are called "developing" are not the same in all of them and accordingly, the speed of development and today's main problems are different as well. Even whithin one region, in Latin America, it would not be easy to find two countries, having just the same situation. As the general economical and social conditions are different, do not coincide the problems concerning particular branches of country's economy, and this applies also to machine-tool industry. In this aspect, the developing countries of Latin America can be classified into three main groups:

a. Countries with well developed metal-working industries and machine-tool industry, already established as a separate branch. They are Brazil, Argentina and Mexico.

b. Countries with developed metal-working industries, but having no machine-tool industry as a separate branch, and now considering setting-up machine-tool industry, such as Chile and Colombia.

c. Countries with limited metal-working industries and no machine-tool industry at all in most of them. Their require

nents for machine tools are met by imports. Among such countries are Ecuador, Paraguay, Peru, Uruguay and Venezuela.

As to the development of machine-tool industry it is quite natural that countries, belonging to the different groups mentioned above, face different problems: some countries have practically to start from the very beginning, while the others should reform and improve the existing system of enterprises. There are, however, many problems in common, because even in the most industrially developed countries belonging to these groups, such as Brazil and Argentina, the development of machine-tool industry has not yet reached the level, achieved by advanced industrial countries, which are main machine tool producers in the present world, such as the German Federal Republic (which takes the first place), the Soviet Union (the second place), the United States of America (the third place) and Japan (the fourth place).

While discussing the problems, concerning the development of machine-tool industry it is necessary to take into account the specific role of this branch in the economy of any country.

Machine-tool industry is the production of machines designed for building other machines and, therefore, it takes key and decisive positions in industry as a whole. A well developed machine-tool industry which can meet the demands of other branches of economy is a necessary and important condition for creating an independent economy, capable of free development. This thesis is evident not only from the theoretical point of view, but also from the practical one and is proved by history, the most striking demonstration of it being the development of machine-tool

industry in the Soviet Union, which for a short period of time has traversed a long path from an agrarian and industrially backward country to the advanced industrial state, manufacturing in particular, over 15 per cent of the total number of metal-working machine tools produced in the whole world.

At the moment when the Great October Revolution had occured machine-tool industry in Russia was approximately at the same level as it is now in Latin American countries, belonging to group "b" according to the classification mentioned above. It was not an independent branch of industry, machine tools were produced at general-purpose machine-building factories, and according to their technical level these machine tools could not be considered modern designs of that time. There were only 40 enterprises in Russia which somehow were connected with the production of machine tools, not a single enterprise having machine tools as the main product. Typical in that respect is the structure of the output of one of the main "machine tool-building" factories in the pre-revolutionary Russia, namely, Moscow enterprise - "Br. Bromley's Joint-Stock Company". In 1913 the factory produced:

Name of product	Per cent of gross output
Motors	31
Machine tools	27
Steam-operated machines	8,5
boilers	3,9
Tubes and other articles	23,0
Parts for water conduits	12,0

The production of machine tools at other enterprises makes a similar or even smaller share of the total output. Home-made machine tools could not meet all the demands of the country. In 1914 - 1917 the share of home-made machine tools was only 19.6% of the total number of machine tools in the country.

Such was the level from which the Soviet State had to begin the creation of home machine-tool industry, taking a course since 1925 for transforming the country from an agrarian to an industrial one, capable of producing necessary equipment by its own efforts. A planned character of the Soviet economy, centralized management by industry, lack of competition between enterprises, labour enthusiasm of the people - all that made it possible for the shortest historical period to solve in complex the problem concerning the creation of Soviet machine-tool industry, to build large specialized machine tool plants, to develop a powerful designing, technological and scientific research base, to organize a branch which can meet all the needs of economy at an up-to-date technical level. The production of machine tools in the USSR was rapidly growing, especially during the secon and th third five-year plans, as it can be seen from the following table (in per cent as compared to 1933):

Second 5-year plan				Third 5-year plan			
1933	1934	1935	1936	1937	1938	1939	1940
100,0	105,1	129,0	169,5	201.4	253.3	320.0	353.0

While the total output of machine tools increased 3.5 times since 1933 till 1940, the production of certain types of machine tools grew 3-8 times.

The number of automatics and semiautomatics, gear-cutting, drawing, grinding and special-purpose machines increased tenfold. Since 1937-1938 was started the production of heavy-duty vertical turning lathes, planers, boring machines and others.

The Second World War has caused enormous damage to the economy of the Soviet Union. Machine-tool industry has suffered as well. After the restoration of the economy machine-tool industry advanced very rapidly. Now the USSR machine-tools industry has successfully completed the eighth five-year plan and is fulfilling the ninth one. During the eighth five-year plan (1965-1970) the volume of the machine-tool and metal-working production has increased 74 per cent. Now the Soviet Union's industry numbers over 3.3 million metal-cutting machine tools, 730 thousand forging equipment, tens of thousands of various casting machines. This range of equipment is constantly widened and renewed.

Soviet machine tool plants produce over 45 thousand various forging equipment (more than 1000 models) a year. Some models are equipped with NC systems. The largest in the world hydraulic press of 75,000 tons capacity is built in the Soviet Union. By 1975 it is planned to bring the output of forging equipment up to 60-65 thousand pieces a year. The production of casting machines is rapidly developed, alongside an intensive scientific research, experimental and designing work is carried out on creating automatic complexes, which enable to free a man from hard labour in the foundry. Now the volume of the production of

metal-cutting machine tools in the Soviet Union exceeds 200 thousand pieces a year. Over 1,500 types of machine tools are put into serial production. Among them over 60 types are numerically controlled and tens of types are equipped with a plug-in system.

By 1975 the output of machine tools will increase up to 230-250 thousand pieces a year. Besides machine tools specialized plants produce all the necessary assortment of cutting and measuring tools including diamond and carbide tools as well as tools made of "Elbor" material created by Soviet scientists, which successfully competes with diamond in many manufacturing processes.

Characterizing the Soviet machine-tool industry it should be noted in conclusion that its geography covers all the republics making up the Soviet Union. Before the revolution none of these republics had no machine-building at all. Today, Soviet Georgia, Armenia, Uzbekistan, Kirghisia and other republics are industrial states with well developed machine-building and large machine tool plants. It is especially pleasant to underline this today, when in December 1972 our country will celebrate the 50-th anniversary of the foundation of the USSR.

The Soviet Union is not only one of the main producers of metal-cutting machine tools in the world, but also a large exporter of metal-working equipment. The number of Soviet machine tools exported to foreign countries is increasing from year to year.

Various metal-cutting equipment is supplied to the countries of East Europe, Africa and Asia as well as to England, France, Austria, Italy and West Germany. At present, trade in machine

tools is establishing with the USA. The Soviet Union exports a wide range of machine tools, beginning from universal lathes, milling and drilling machines up to precision jig-boring and grinding machines as well as heavy-duty unique machines, such as a vertical turning machine with a faceplate diameter of 20 m, recently sold to Japan and used for machining part of large generators.

It should be noted that due to a large scale of production (some types of machine tools, in particular lathes, are progressively assembled) and a distinct specialization of plants, Soviet machine tools successfully compete in cost with machine tools of other countries. In addition, universal types of machine tools produced in the Soviet Union are notable for high rigidity and accordingly, a long life.

Telling about the experience of the Soviet Union, made an unprecedented in history leap from backwardness to the front line of the development of economy we are, naturally, far from the thought of recommending for developing countries to immitate blindly this experience. However, taking into account a certain similarity of initial conditions we are sure that our experience is worthy of the most careful consideration which can render a great assistance in searching optimal ways of development.

We would like to underline, in particular, three moments which, in our opinion, are essential in solving the problems of creating and improving machine-tool industry in developing countries.

1. The necessity of a planned approach in solving the problems concerning the creation of modernization and expansion of existing machine tool plants. In planning it is necessary

to take into account all the factors which have an influence on the effectiveness of production, including the demands of home market, possibilities of export, specialization and cooperation. Such an approach implies the availability of a state planning body which would work in close cooperation with the industry of a country, its scientific research organizations and international organizations, in particular, with UNIDO.

2. The necessity of a special scientific research center dealing with the study of conditions and prospects for the development of machine-tool industry in a country, stock and state of machine tools, questions on a rational use of machine tools as well as scientific research and designing work in a volume defined by the requirements of machine-tool industry in the given country. Such a center in developing countries cannot be organized by individual machine tool enterprises, therefore, this task should be solved by the state itself. Some developing countries, including Latin American ones, have already a favourable experience in this respect. In our opinion, the organization of such centers, planning of their work, interrelations of centers and industry as well as other problems of their activity could be a subject of special discussion at one of seminars of UNIDO in the nearest future.
3. The quality control system and engineering service, including consultations and technical assistance as well as regulation of quality according to adopted national standards. National metrological organizations, which function is to

keep the unity of measures and weights in a country, are called upon to play an important role in solving the problems of machine tool quality. The last problem, i.e. production quality, includes in itself many various aspects which can be roughly divided into two main groups: technical aspects of providing high quality of machine tools produced and practical measures which assist in keeping to national and international standards both within separate enterprises and on the scale of machine-tool industry as a whole. We would like to dwell upon the first group of questions, i.e. technical aspects of providing high quality of the production of a machine tool factory.

There are two main preconditions necessary for manufacturing high-quality machine tools at a particular factory:

a. The complete set of equipment (machine tools, cutting and measuring tools etc.) which is always maintained up to a good technical standard;

b. Labour force qualified for the job - machine tool operators assembly men, inspectors.

Proper choice of machine tools and their maintenance up to a certain standard are the problems of vital importance in developing countries. As a rule, machine tools are produced here on a limited scale, and every factory has a minimum necessary number of machines, there are no spare machine tools available. It means that any break-down or poor condition of a single machine can create major difficulties in production. Hence, the importance of putting all the machine tools and equipment under permanent technical supervision, including preventive inspection and repair. To do this the factory needs a special department,

the size of it being determined according to the number of machine tools under supervision. The department has to have a time-table and do servicing of every machine strictly in time. Then for every machine tool there must a special maintenance book or list to write down the results of periodic inspections: when a machine was checked, a kind of trouble found and replacement or repair done. Having this information one can replace faulty or worn-out parts, units and machines in time, thus, avoiding breakdowns in production and using machine tools available most effectively.

It should be kept in mind that there are direct connections between quality of machine tools used for manufacturing parts and amount of labour spent on assembly operations. So it is often more economic to replace a losing accuracy machine tool, than to keep it in operation, because of increasing time, required at the assembly area where better qualified and better payed people are usually employed.

The professional skill of workers is another precondition for high quality of products. At the same time it helps to keep the factory's equipment in a good condition, thus, cutting down maintenance and repair costs, often caused by wrong handling of machines. It is desirable to have at the factory some kinds of training facilities for improving professional skill of workers. Good results can also be obtained by organising such campaigns as, for instance, "Zero defect campaign".

Apart from main preconditions considered above a major part in solving quality problems plays inspection at every stage of manufacturing. The first stage is the so-called "input inspectio

of parts and subassemblies bought from outside the factory. The way this inspection is performed and the number of parts undergoing inspection depends on the company's experience and on supplier's reputation. The usual procedure in industrial countries is to organize a selective inspection (spot check), comprising 10-15 per cent of goods coming into the factory. But some parts, such as ball bearings for spindle units undergo a 100% inspection. The accuracy of outer and inner diameters is checked as well as roundness and straightness of working surfaces, radial and axial run-out. At the factories manufacturing precision machine tools, while checking the bearings , an inspector measures the exact size of outer and inner diameters. Every bearing gets a certificate where its dimensions are written down. At the assembly shop the size of a hole in the housing of a headstock is also measured, then the diameter of a spindle shaft and then an assembly man takes the bearing which provides the fit required.

The second stage of inspection is checking parts during a manufacturing process. There are two possible systems of inspection at this stage. The first one is that an inspector checks up every part after every operation. So the part goes from the machine tool operator to the inspection area, gets checked up and then proceeds to the next operation. As the manufacturing is completed the final inspection takes place and the finished part goes to the assembly. The system described provides the possibility to discover any fault immediately it occurs and, thus, to avoid unnecessary expenditure on machining the part which has to be rejected already. But at the same time this system requires comparatively large inspection staff, as one inspector can control only the limited number of machine tool operators. It is advi-

able to employ the inspection system like this if the professional skill of machine tool operator is not reliable and essential losses may occur on mechanical operations.

The second possible inspection system does not include a special check-up after every operation. This kind of inspection is done by the machine tool operator himself. The inspector checks up only finally machined parts to let them go to the assembly area. From time to time he also makes spot checks after some most difficult operations. This system, of course, requires high skilled and reliable operators of machine tools. It is widely used, for instance, at machine tool-building factories in the USA. To make one's choice of a proper system to introduce, one needs to take into account the local experience and to study carefully the situation at the factory in question. The final assembly of machine tool is usually performed by making subassemblies - headstocks, gear boxes and so on. If this is the case, then the inspection of subassemblies is required. For this inspection manufacturers of precision machine tools often use some special rigs designed to check a particular unit. As the production of high precision machine tools is not typical of developing countries we shall not discuss this point any further.

Now comes the main stage of quality inspection at the machine tool building factory - the inspection of finally assembled and adjusted machine tool. It may be divided into the following steps:

a. Inspection of general appearance and workmanship, technical specification's check;
b. alignment test (idle)
c. running test (idle)
d. machining a test piece or a test batch.

While the final inspection takes place, a special attention should be paid to the environment. There must not be any disturbance from outside the machine, influencing the results of tests. First of all, we mean vibrations caused by other machine tools around the one under test and also by transport, cranes etc. Testing of some precision machine tools, such as jig-borers, requires temperature controlled rooms. Cleanliness is of great importance in testing machines, performing finishing operations (grinding machines, honing machines), because dust and particles can easily spoil the surface finish of a test part.

Inspection of general appearance has for its object to reveal faults in painting, obvious mistakes in assembling (it is) to check all controls functioning, availability of necessary accessories and tools.

Alignment tests are performed according to the test chart which is prepared for each particular model. The chart comprises all the necessary instructions for an inspector: the parameter to test, how to measure it, measuring instruments to be used and the permissible error or tolerance. The inspector then writes down in a special column of this chart the results obtained. The main problems associated with alignmeht tests are discussed in UN paper "

published in New York, 1972, so there is no need to repeat this information here. The only point we would like to stress is that while preparing the test chart for a machine tool it must be always remembered, that all the tests are in a way connected with each other and constitute the single whole system. This system should be as simple as possible and at the same time cover all the important parameters of a machine tool. There are some gene-

ral principles to follow:

1. The number and kind of tests required are determined by the specification of machine tool accuracy. Tests must cover all the parameters which influence directly the accuracy of a part produced on the machine.

2. Alignment tests are performed on a finally assembled machine tool. Any dismantling of the machine or separate units is prohibited.

3. Relative positions and movements of units during tests must reproduce those taking place while machining. As a rule, a dial indicator (or any other type of a pick-up) should be placed there, where the cutting tool is placed placed while machining. Measuring instruments representing reference surfaces, lines etc. (straight edges, bars, reference fine scales and so on) must be based and clamped the part to machine.

4. The system of tests should be built up in such a way, that they do not repeat each other directly or indirectly.

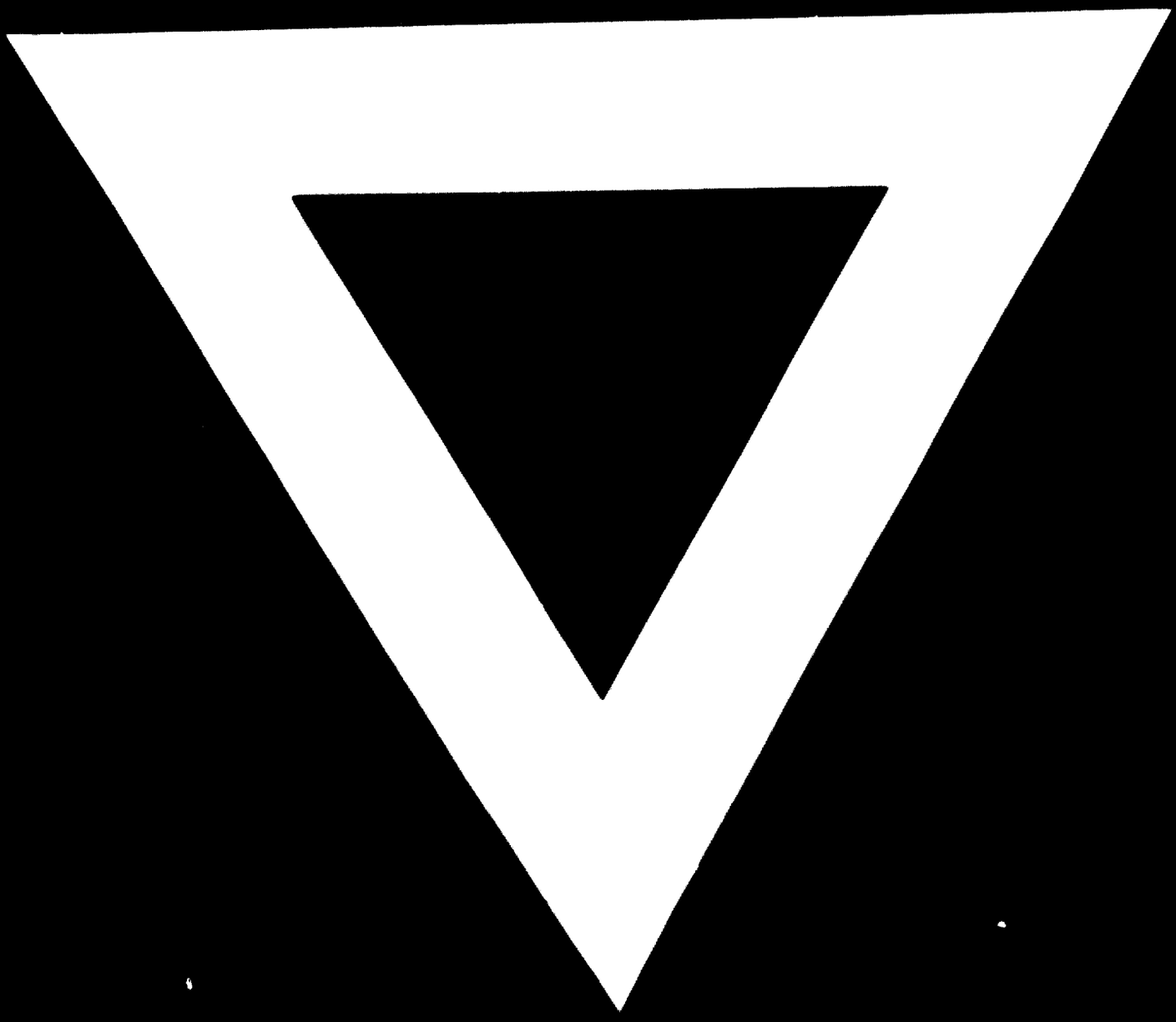
5. Preference must be given to the tests showing the parameter of interest directly without any calculations or graphical manipulations.

6. Preference must be given to measuring instruments graduated in the same units, as the tolerance is expressed.

7. The sequence of tests should be carefully chosen to minimize displacements and replacements of measuring instruments.

The running tests and the machining of a test part are fully described in the U.N. publication mentioned above. More details can be recommended only for a particular model of a machine tool in question and such information may be easily obtained through UNIDO.

We would like to mention only one more point, the small one and easy to forget at the factory. That is the necessity to keep all the documents concerning quality tests of machine tools produced. These records accumulated through years of manufacturing represent a very valuable source of information for research and development people to improve the design of a machine and the manufacturing process.



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