OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

mk

05720

Distr.
LIMITED

ID/WG.187/11
9 September 1974

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

Meeting of Experts/Decision Makers for Promotion and Development of Machine Tool Industries in Developing Countries of Asia and the Far East

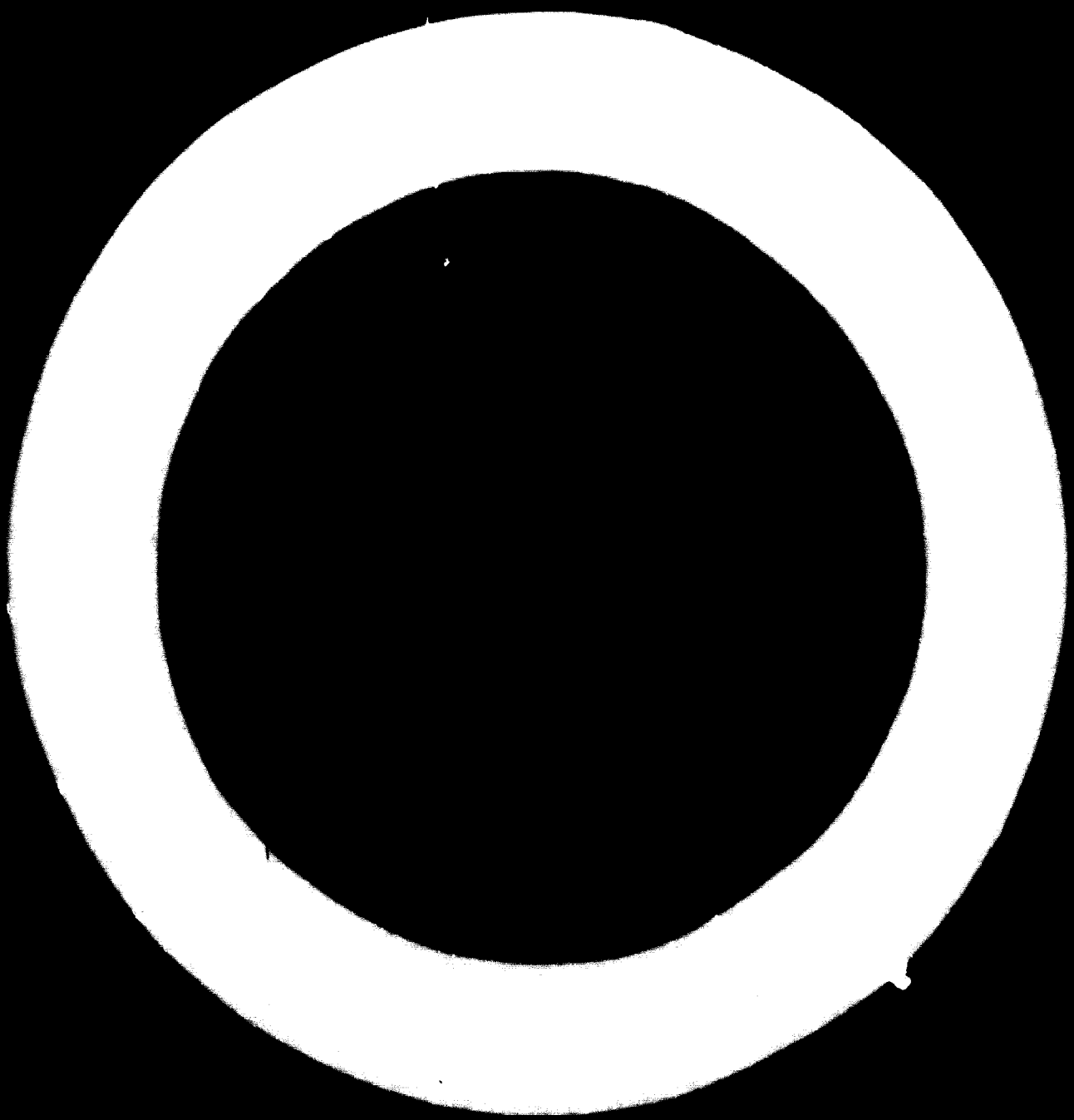
Tbilisi, Georgia, USSR
5 - 15 October 1974

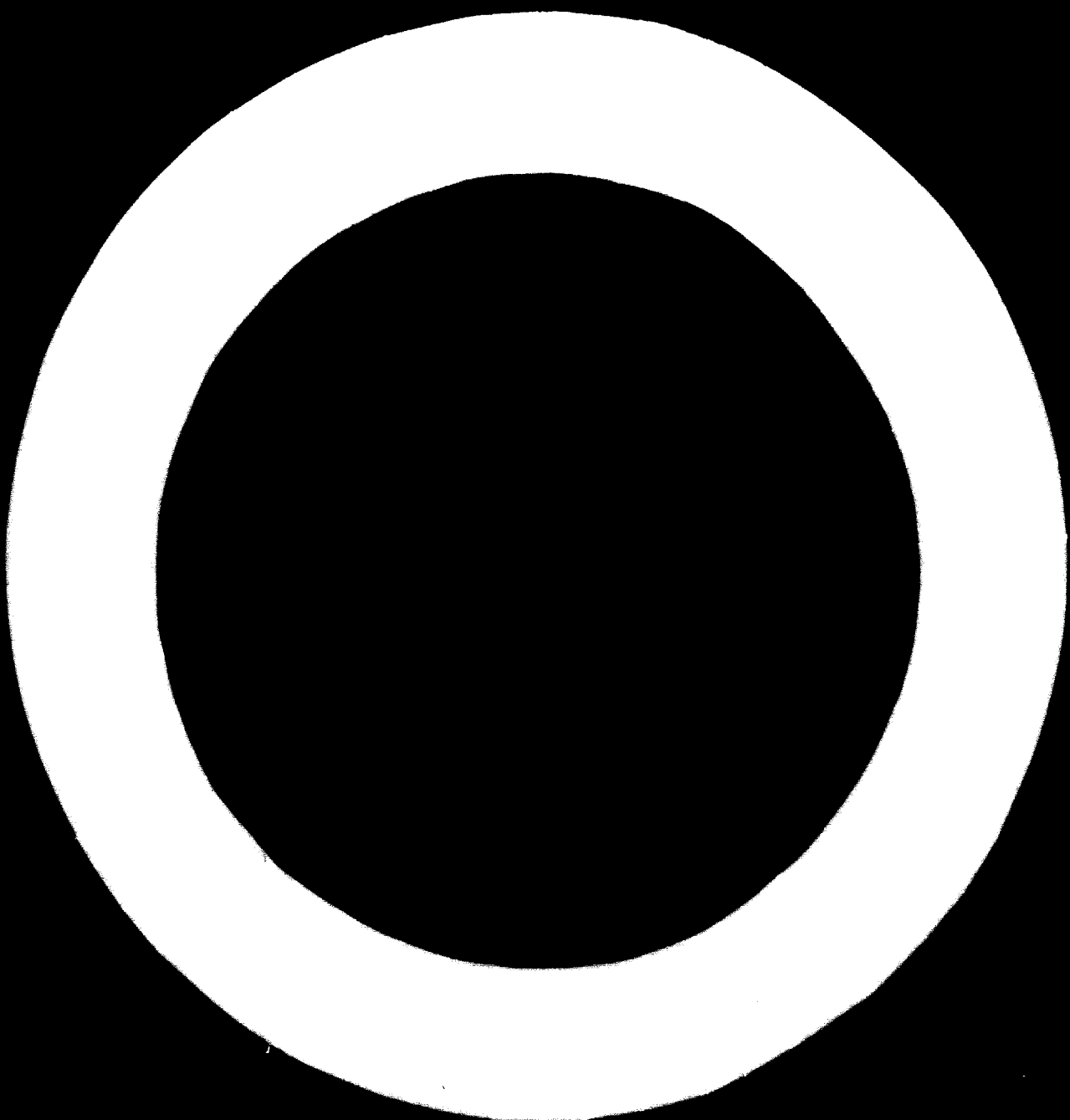
PREREQUISITES FOR MACHINE-TOOL PRODUCTION IN A DEVELOPING COUNTRY 1/

P. Stöckmann */

*/ Member of the Board of Directors, Pittler Maschinenfabrik AG, Langen, Frankfurt/Main.

1/ The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO.





The importance of machine tools and the machine-tool industry for any economic system is known from previous literature. The knowledge and experience gained by the industrialized countries would be beneficial when establishing machine-tool production in developing countries, leading to faster and more economic realization of targets.

The following report is based on experience in the Federal Republic of Germany, the country with the largest machine-tool exports in the world. Figure 1 shows the distribution of machine-tool exports in 1973. Due to large exports to nearly all the countries in the world, some knowledge about the use of machine tools in developing countries was also gained. Additional experience concerning the problems of industrialisation in foreign countries was obtained when establishing our own manufacturing plants there, and also through co-operation on large industrial projects in developing countries.

Before starting any manufacture, the following six main points must be very carefully considered:

1. What should be produced? This refers to problems of product planning.
2. How should the product be manufactured? This concerns technological questions of manufacture.
3. Where should production take place? This is the question of optimal location.
4. Who should produce? This is the very important question of personnel planning.
5. How is the manufactured product sold? This is the question of optimal sales organisation.

And the last but very important question concerns the financing. Where is the money coming from?

One of the most important points is the product planning, which is the most difficult, as much data from a developing country itself, from its environment, from its political and economic intentions, and the possibility of the realisation of such intentions, have to be considered. Advisers from other countries can only offer recommendations. The data must be acquired, assessed and judged relevant to each country. Consultant firms in industrialised countries will readily offer help in the collection of such information.

Figure 2 shows important points of product planning, which are identical with the aims of marketing research. The first question relates to the product, that is, what machine tool is required? The second, what quantities are required? Third, for what price can such machine tools be sold? And fourth, when and how long will the demand last?

The various aspects of carrying out marketing research are shown in figure 3. In general marketing research, one has to determine the economic and industrial development in the developing country itself and that in the surrounding countries, as shown in the figure and marked x, y, z. Apart from general economic and industrial development, technological development is of great importance. The following points are also important:

(a) The development of progress in the large countries of the world;

(b) The development in countries surrounding the developing country, here called regional, should be observed, particularly national development in technology is of the utmost importance.

Regarding the period during which various aspects have to be checked, the present is not the only consideration; of great importance is development in approximately 5 years' time, as introduction of the new product should take place then. After approximately 10 years, the new product would reach maximum production and, especially in view of its export to neighbouring countries, it would increase in importance. Considering that a machine tool must be marketable for approximately 10 years, it must be suitable for export for 15 years.

Besides the aspects of economic and general industrial development, shown on the left side of the figure, technological development is important when planning the manufacture of machine tools and the product planning connected with it.

There should be clarification of the machining operations that are to be performed with the machine tool to be manufactured, whether it would be forming, for which forging presses or similar machines are used, or a metal-cutting machine tool, that is, for boring, milling; turning or grinding; alternatively, is there a real demand for electrochemical machining processes, a method that has recently become more significant in industrialized countries.

Only after deciding this basic question, can details of the required machine tool be determined. A turning machine, for example, shows that the decision on the tooling system has a great influence on the basic conception of the machine. Figure 4 shows a summary of various possibilities of arranging tools on automatic turning machines.

Apart from the basic decision on the tooling systems, it is important to determine the required size and capacity of the machine tool in question. Size concerns mainly the turning diameter and turning length, whereas capacity concerns the main drive, the required spindle speeds and, possibly, feed rates. The answer to these questions can be found through critical analysis of the parts to be machined; further information may be gained which could affect the design of the machine to be built.

We differentiate between single-part production, small-series production, up to lot sizes of approximately 20 to 30 pieces, medium-series production, with lot sizes between 100 and 2,000 pieces, and large-series production, right up to mass production.

The decision on lot sizes will very quickly lead to the question as to the extent to which the machine tool should be automated. From our experience in the developing countries, determination of the correct extent of automation is often especially difficult. It is understandable that each manufacturer of machine tools aims at international standards, that is, to produce as highly automated machine tools as possible. However, it is frequently overlooked that, for the economic use of highly automated machine tools, very high demands are made on the environment of the machine tool during operation. These conditions are important when using highly automated machine tools, and in developing countries they often do not exist, or are just beginning.

Regarding problems of product planning, the industrialized countries can be of great help and can give valuable advice.

In close connexion with the degree of automation is the question of processing information within the machine, that is, the type of control. Should preference be given to a well proved, reliable and robust cam control, programme control, or numerical control? Is preference to be given to reliable and robust electrical equipment, such as high-voltage relays (110 or 220 V)? Is the use of low-voltage relays, as used in telephone equipment, advantageous, or are there technical reasons demanding modern electronic equipment of integrated circuitry. Apart from NC machine tools, there are various possible alternatives, which should be determined according to manufacturing facilities and future service requirements. Figure 5 shows the principle of control on a multi-spindle automatic, where the control cams are very reliable and are the most economic storage of information. As shown in figure 6, the high-voltage controls are used for the electric control of the separate functions.

On single-spindle automatics suitable for the manufacture of parts in series, a quick change of programming is desirable. The selection of programmes is carried out with programme plugs, as shown in figure 7. For the control of the machine, either plug-in relays, figure 8, or low-voltage relays, as used in telephone equipment, are suitable (figure 9). The right selection depends on the manufacturing capacity and the standard of the service personnel of the machine-tool users.

Printed circuits with Reed relays have proved to be very reliable on our single-spindle turning automatics with programme control. Figure 10 shows such a printed circuit; the Reed relays are clearly seen.

Figure 11 shows an electronic programme storage with integrated circuits for the quick transferrence of impulses. The fast registration of commands on NC machines definitely requires the use of electronic elements. Today, the controls of these machines are very highly developed; they also incorporate printed circuits (figure 12). Figure 13 shows a continuous path control on a turning machine, equipped with several tooling systems to cope with all manufacturing problems.

The product planning discussed so far gives information about the type of machine tool to be produced. Because of world-wide competition the price of the product that can be obtained at home and abroad is also of great importance. The price of a machine tool influences, to a great extent, the economic production with the machine, namely, the price of the products manufactured with it.

Very closely tied in with the price of the machine is the salable number of machines. This results from the requirement of the economic situation, but does not mean that this requirement can be met only with the product planned, because in a free economy there is always the possibility of a cheaper competitive product to be introduced into the market. The protection of national machine-tool manufacturers by means of high import duty for foreign machine tools for a period of time is not helpful to the national machine-tool industry itself, nor to the over-all economy of the country.

At the beginning of a machine-tool industry in a developing country, tariff protection may be advantageous, but over a period of time this prevents comparison between the home product and international products. Furthermore, high tariff protection prevents the purchase of available foreign machines for certain manufacturing tasks, which leads to uneconomic production, so that the home product is not competitive on the world market.

Besides assigning an appropriate price for the new product, the right time to introduce the machine to the market is important and can only be solved in connexion with the over-all economic planning of the country.

After finalizing the basic product planning work, the second step is to decide how to plan the technological manufacture of the machine itself. Much information and data are required for this.

Tool drawings of the planned machine are essential. These should be available in a language understandable in the developing country; they can be produced in drawing offices, be bought on a licence basis, or be acquired by co-operation agreements. In any case, they must be revised in the developing country in order to adapt them to regional requirements, for example, the language, or the measuring system being used; consideration must be given to the standard parts and accessories available in the developing country.

Apart from the drawings, manufacturing data are required to enable parts to be manufactured and the machine to be assembled.

A decision must be made as to the extent to which the machine is to be produced in the planned factory. This is the depth of production to be aimed at. The machine tool could be assembled from single parts produced in other factories, or even imported, or the machine tool could be manufactured in the home factory. The latter is rare, because parts for the electric control are bought from outside, as are the castings, semi-finished products and the mass-produced accessories, that is, ball-bearings, screws, electric parts and others.

In practice, it will always be a compromise between 100 per cent home production and assembly only. In the early stages, assembly would very likely be carried out using assemblies and individual components supplied from outside. This would give the factory time to establish its own manufacturing facilities. Later on, the optimum degree of manufacture would be found.

Manufacturing data could be obtained in the same way. They could be provided by the factory's own personnel, or be acquired in conjunction with a licence or a co-operation agreement. In any case, these manufacturing documents must correspond to the actual situation existing at the factory. According to this data, the manufacturing process of each part is determined, first in principle and then in detail. The documentation for the machining of parts on various machine tools must then be completed.

Following this, the flow of production and production equipment must be ascertain This not only concerns machine tools, but also auxiliary equipment for the production, such as tools, grinding facilities for tools, the establishment of a jig-and-tool shop where jigs are manufactured and repaired, measuring and testing equipment for quality control, facilities for chemical treatment - chromium-plating, cadmium-plating, hardening - and facilities for priming and painting the machine. Furthermore, the following facilities must be considered: transport equipment for internal use, such as the crane, the fork lift truck and trolls; storage capacity for raw material and auxiliary material, such as steel and casting stores, semi-finished products, parts, lubricants, and completed machines, until delivery to the customers.

Subsequent to planning the production equipment, the optimum flow of production must be arranged, which requires a smooth flow of material through the various departments. According to the planning of the flow of material, the location of the machines and auxiliary equipment has to be decided. Figure 14 shows the flow of material at one plant.

After providing the drawings and manufacturing data, planning must be done. This includes the location of the factory; when choosing the location, policy and economic aspects must be considered. Policy aspects are important in developing countries, for example, concentrating industry in districts having no agricultural background, and with a surplus of non-skilled labour would mean an increase in employment; other industries could be supplemented, for example, processing raw material, or particular kinds of machine-tool manufacture could be installed. These policy aspects already include certain economic considerations, for instance, the location of the plant and the distance to subcontractors, foundries, forging shops, and the supplier of electrical equipment.

Depending on the kind of machine tool to be manufactured, the value of the material is approximately 35 to 50 per cent of the sales price. The distance to energy sources is of minor importance, because today energy can be transported very economically over long distances; it is only necessary to have a supply of energy. Machine tools require a fairly stable current supply, provided by means of a factory's own energy plant, which is seldom, or by connexion to a high-voltage grid. In one plant 7,000,000 kWh per annum are used, with a maximum requirement of 2,300 kVA.

Depending on the kind of production, additional energy may be required, for example in the hardening shop, and (depending on the climate) for heating or cooling the premises. In one factory approximately 1.7 million Mcal of natural gas and 2,500 cubic metres of fuel oil are used per annum. Approximately 1,000 high-quality turning automatics are being produced in the factory annually.

If the factory is not located near an industrial area, transportation by road and rail must be secured at an early stage. If, for instance, heavy machine tools are produced, a railway connexion is necessary for transportation of the finished product. For factories using a high percentage of raw material a rail connexion is useful for the supply. If good road connexions exist, the rail connexion is less important.

When choosing the location an additional aspect to be considered is the climate. High humidity is detrimental to machine tools in large unprotected areas. We all know about the problem of corrosion, especially on newly machined areas. Electric and hydraulic controls without additional equipment will operate normally only at temperatures of between 35 to 40°C in the factory. If temperature and humidity are excessively high, air-conditioning of the factory must be considered, which means additional costs. The machine tool could be protected against the influence of a high ambient temperature by means of additional cooling systems.

Figure 15 shows a twin-spindle front turning automatic, prepared for use in tropical countries. The extremely large cross-section of the air intake for the electric cabinet containing 160 relays is clearly shown.

The large amount of parts which are not manufactured in the machine-tool factory, such as ball bearings, electric motors, other electric equipment, and hydraulics, which must be obtained from outside, need early ordering to secure the necessary supplies.

The deciding factors are: What is required in quality and quantity, where will it be manufactured, and how can it be obtained? A very thorough planning guarantees fast and smooth progress in building the factory and starting production.

Planning the buildings of the machine-tool factory and the equipment is similar to that of other machine factories, and for this reason is not dealt with in detail in this paper.

The question of suitable personnel for the machine-tool factory is closely connected to the location. Besides material and energy, personnel costs are extremely high in the machine-tool industry. Depending on the kind of machine tool, personnel costs are approximately 40 to 50 per cent of those of the machine. To operate a machine-tool factory a sufficient number of qualified personnel must be planned. It will be a question of policy whether the location of the factory is near highly populated areas or if the personnel required are housed near the factory. Many

governments in developing countries promote the building-up of industries away from existing industrial areas to solve infrastructural problems. The demands of the qualified personnel on their environment also have to be taken into consideration. Such personnel expect cultural facilities for their families and good schools, or even universities, for their children, near the job.

The mixture of personnel in a machine-tool factory depends to a great extent on the product itself, on the type of manufacture, that is, whether manufacture is for large-scale production or limited quantities, and also on the depth of manufacture visualized. In the mass production of the more simple machine tools the depth of manufacture is very low and the number of technically qualified personnel is limited. When special purpose machine tools are required in very limited quantities, then obviously a much higher number of technically qualified personnel is required.

The machine-tool industry requires proportionally fewer highly scientifically educated doctor engineers, that is, diploma engineers, than graduated engineers with a solid technical background. Men of this calibre are rarely available in the developing countries desiring to establish a machine-tool industry. Personnel with somewhat lower technical capabilities than qualified engineers are also required; they should have served an apprenticeship, such as draughtsman, fitter, or electrician, and preferably have attended evening school or special training courses. In any case, fitters and electricians are required for the assembly and quality control. They should be reliable specialists, capable of working with a minimum of supervision. Machine operators must be capable of understanding technical drawings and instructions and be familiar with the standard measuring equipment used in the factory. For the more common machines, that is, the turning, milling and grinding machines, operators can usually be trained within a period of 3 to 12 months. The time depends on the education and capabilities of the persons concerned - for instance, a horizontal-boring-machine operator will take much longer to train than a milling- or drilling-machine operator.

Theoretically, it is possible for a country that has adequate financial backing to purchase all its requirements from outside sources, but it is absolutely essential to begin a training programme immediately, in standard and technical schools, apprentice schools, engineering colleges and/or universities. Additional training can be given abroad in the industrialized countries, if required.

It must be realized and emphasized that, in spite of all modern technical perfection and the automation of production, man is the most valuable asset, and his education is the beginning of any industrialization.

The early planning of a sales organization is another important factor to be taken into consideration when building up a machine-tool factory in a developing country. Sophisticated machine tools are sold in a similar manner to a finished house, that is, as a complete unit, rather than as a collection of bricks, doors, windows and so on. For this reason, the preparation of quotations must be undertaken by sales engineers with a good knowledge of the machine tool and its production capabilities. A good sales organization with expert outside personnel is essential in order to forge the link between the supplier and the user. This link ensures that the machine-tool user can readily obtain expert advice from the manufacturer, which helps him solve any production problems with the machine.

All the activities mentioned, from beginning product planning to building and equipping the works and starting production, requires adequate capital. This must be available at the appropriate time if schedules are to be maintained. Obviously, this is applicable to any similar industry. Because of the demand for quality and the high amount of capital involved when building up a machine-tool factory, careful consideration must be given to this point.

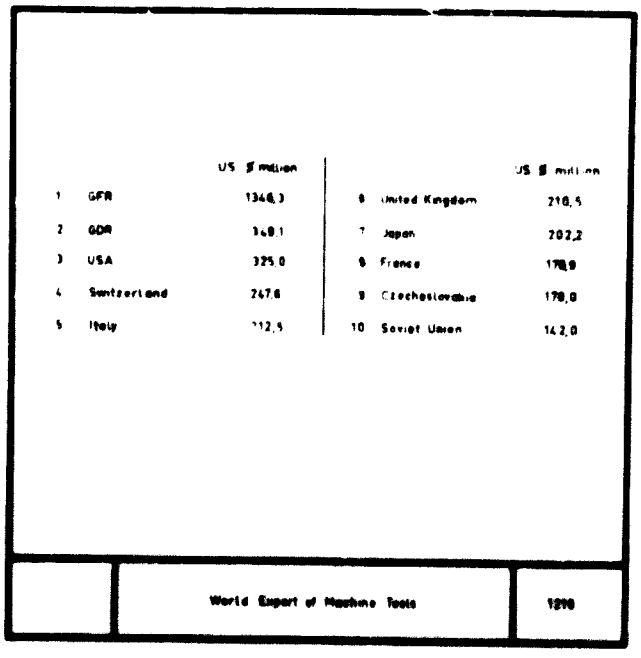
SUMMARY

For economic production in all industries, production facilities must meet the requirements of manufacture, and machine tool is one of the most important elements.

A national machine-tool industry should cater for the needs of the metalworking industry. To bring uneconomic development to an acceptable level, co-operation with other countries should be envisaged, and a certain degree of competition should be encouraged.

Determination of products to be manufactured to be decided by market requirements rather than prestige

Depending on marketing research, the product must be planned, developed and manufactured. Good planning of technique, sale and finance is of vital importance. Realistic completion dates for the various functions ensure an economic start in production. Many starting problems can be avoided by purchasing drawings, technical data, know-how, whole factory layouts and equipment. The industrialized countries can supply a large amount of expertise and assistance, but naturally, because of the high costs involved, this assistance cannot be supplied free of all charge. The pre-planning and availability of qualified personnel suitable for the higher requirements of the machine-tool industry is, and will always be, the responsibility of each individual country.

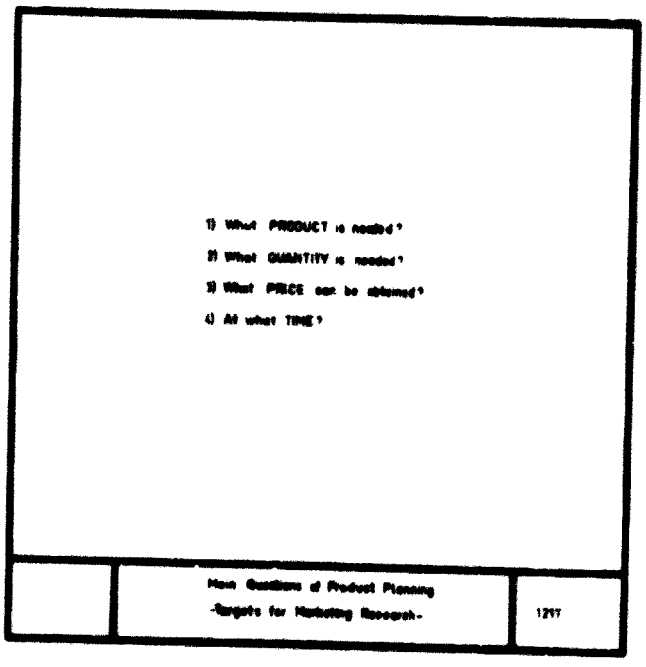


		US $ million			US $ million
1	GFR	1348,3	6	United Kingdom	218,5
2	GDR	348,1	7	Japan	202,2
3	USA	325,0	8	France	178,9
4	Switzerland	267,6	9	Czechoslovakia	178,8
5	Italy	212,5	10	Soviet Union	142,0

World Export of Machine Tools

1210

Figure No.1

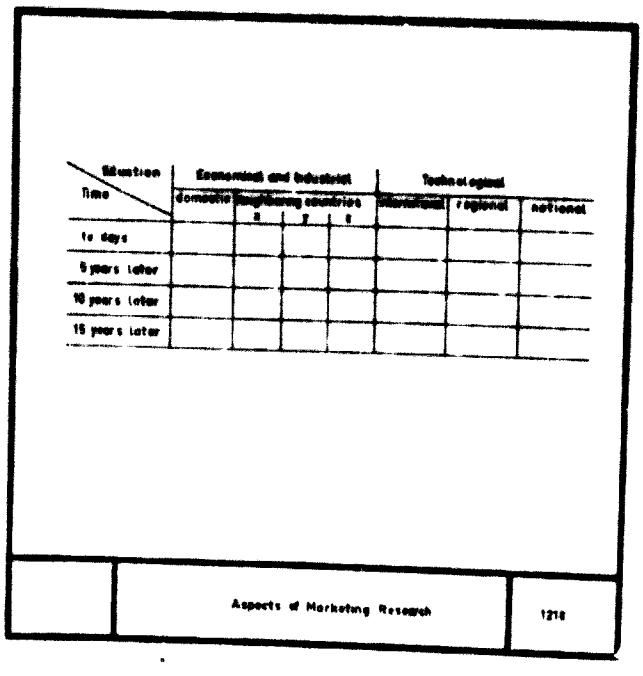


1) What PRODUCT is needed?
2) What QUANTITY is needed?
3) What PRICE can be obtained?
4) At what TIME?

New Questions of Product Planning
-Targets for Marketing Research-

1217

Figure No.2

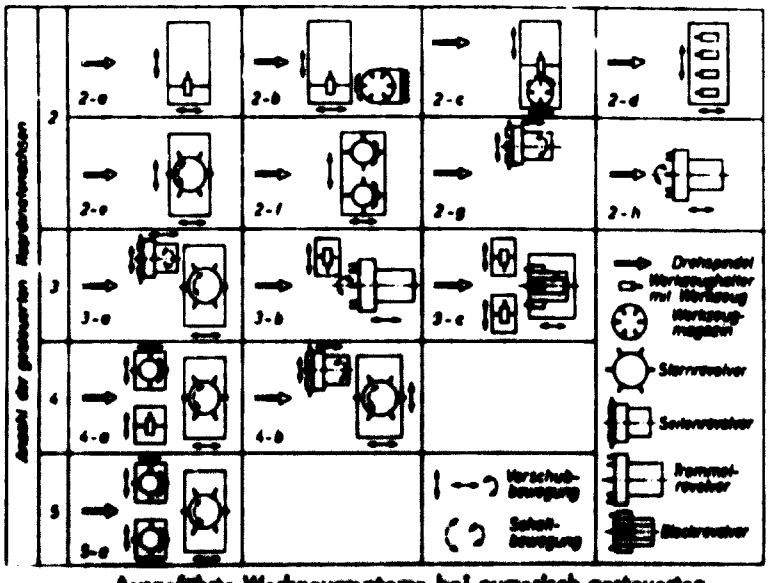


Situation / Time	Economical and industrial				Technical aspect		
	domestic	neighbouring countries			international	regional	national
		1	2	3			
to days							
5 years later							
10 years later							
15 years later							

Aspects of Marketing Research

1218

Figure No.3



Ausgeführte Werkzeugsysteme bei numerisch gesteuerten Waagerecht-Drehmaschinen

Figure No.4

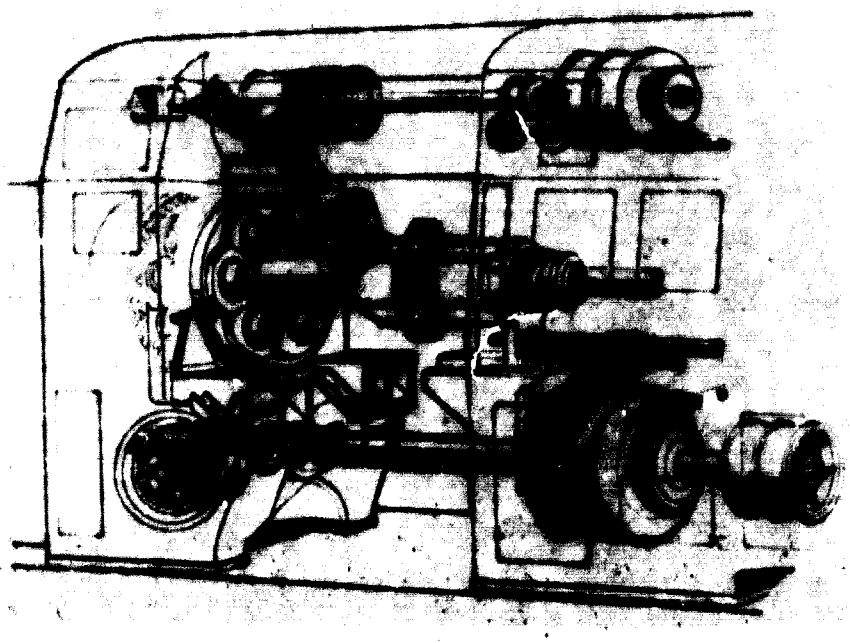


Figure No.5

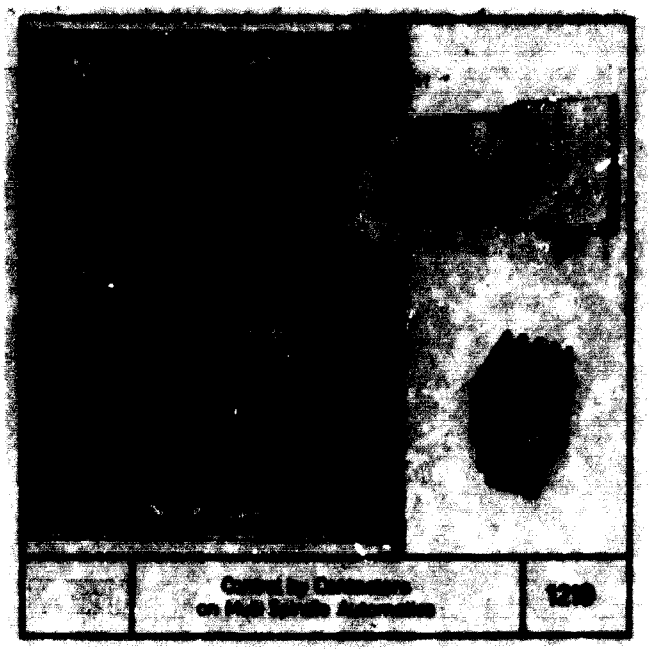
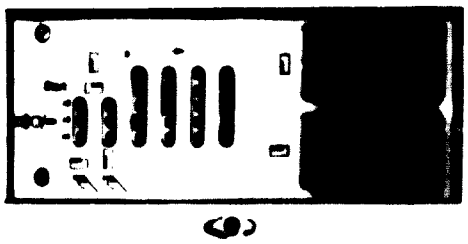


Figure No.6



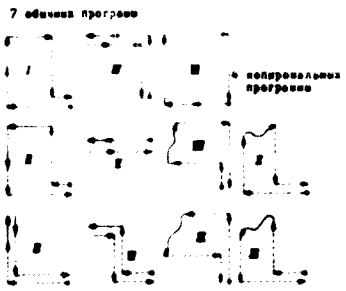


Figure No.7

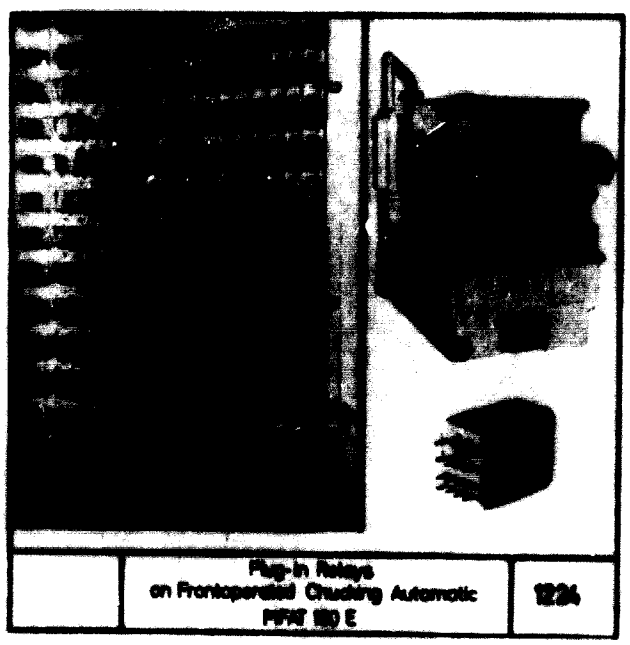


Figure No.8

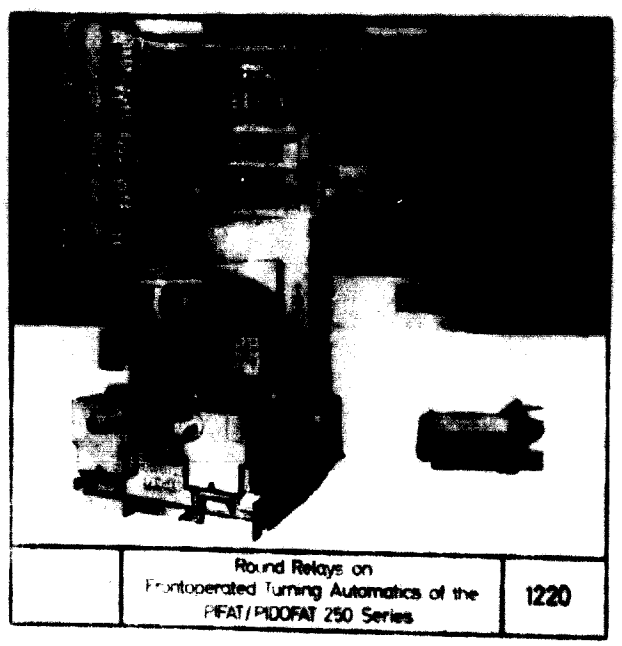


Figure No.9

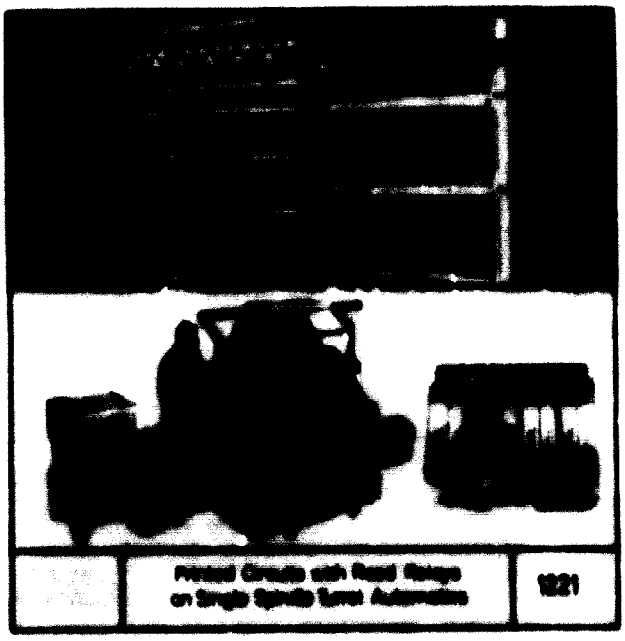


Figure
No.10

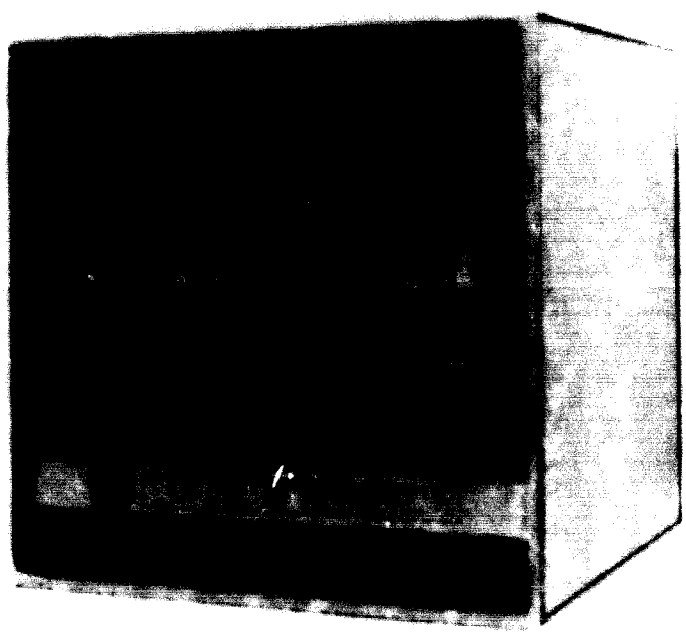


Figure
No.11

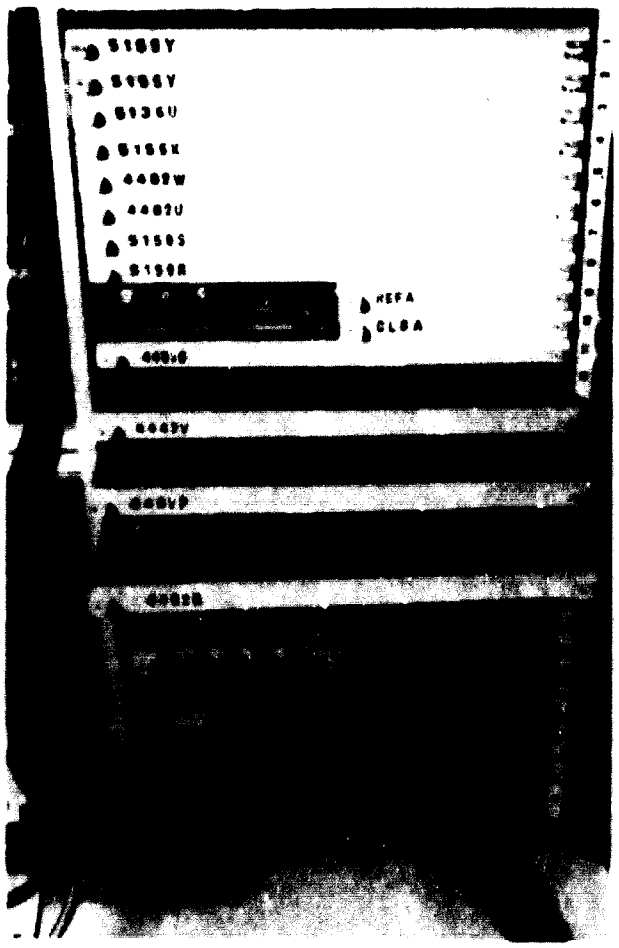


Figure No.12

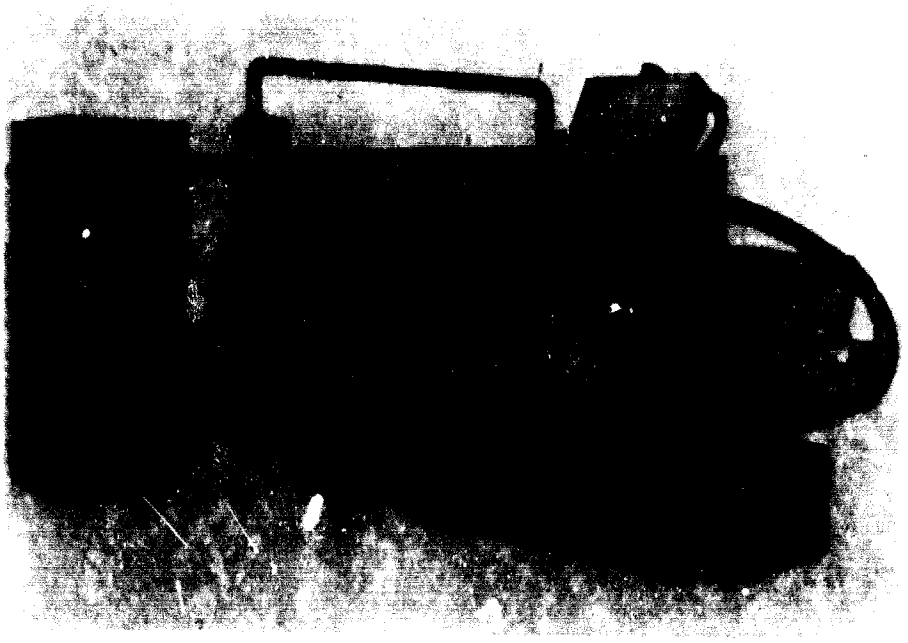


Figure No.13

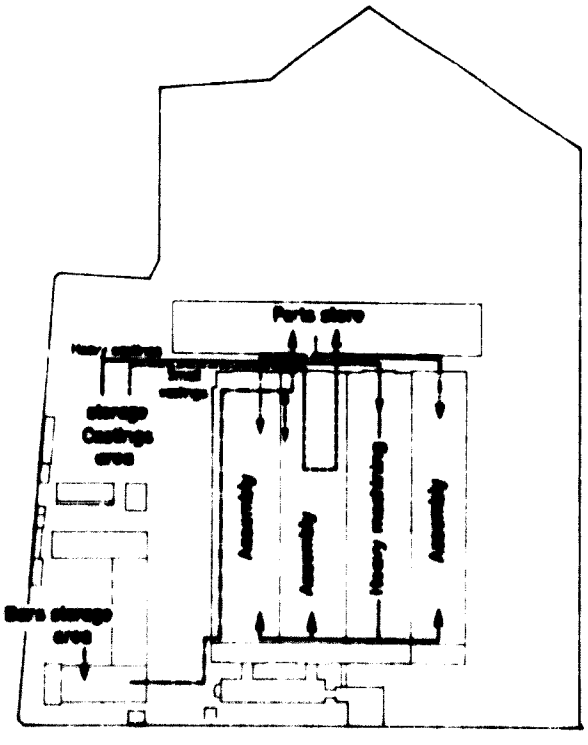


Figure No.14

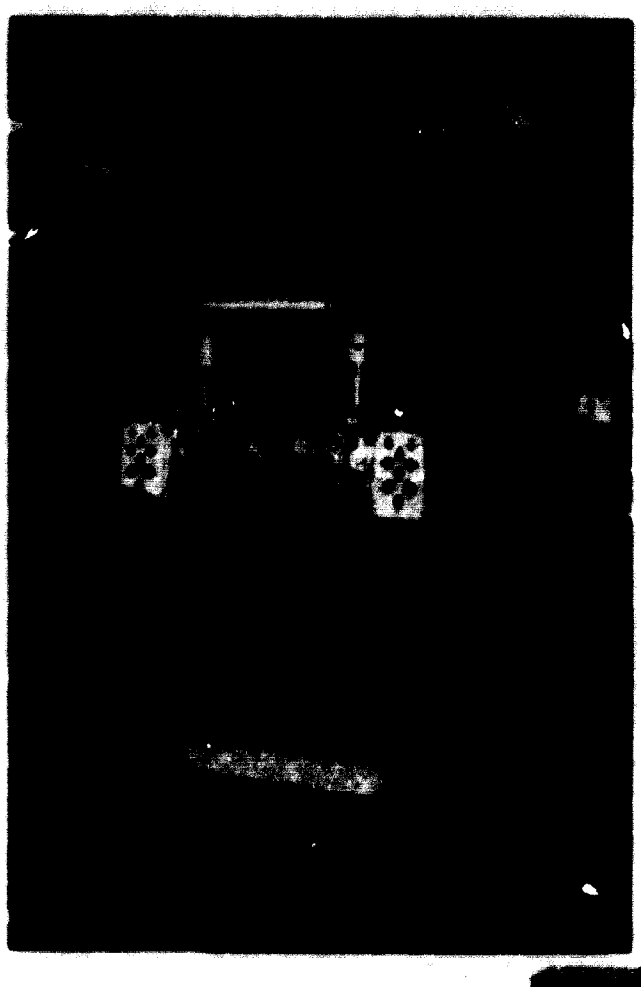
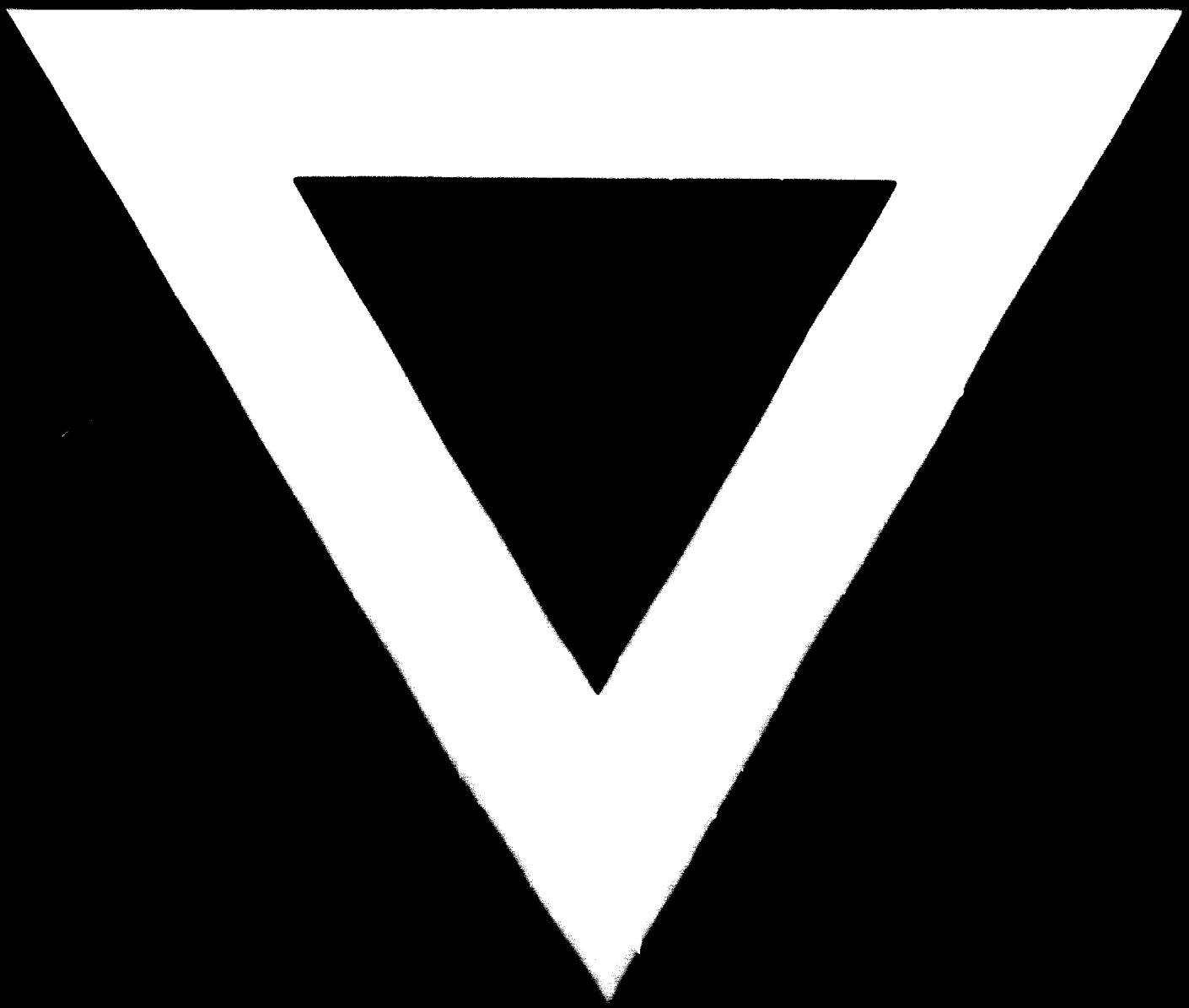


Figure No.15



74.11.27