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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

D03769

Distr.
LIMITED

ID/WG.113/21
31 August 1972

ENGLISH
ORIGINAL: SPANISH

United Nations Industrial Development Organization

Regional Seminar on Machine Tools
for Countries in Latin America

Buenos Aires, Argentina
16 - 25 October 1972

Sao Paulo, Brazil
26 - 27 October 1972

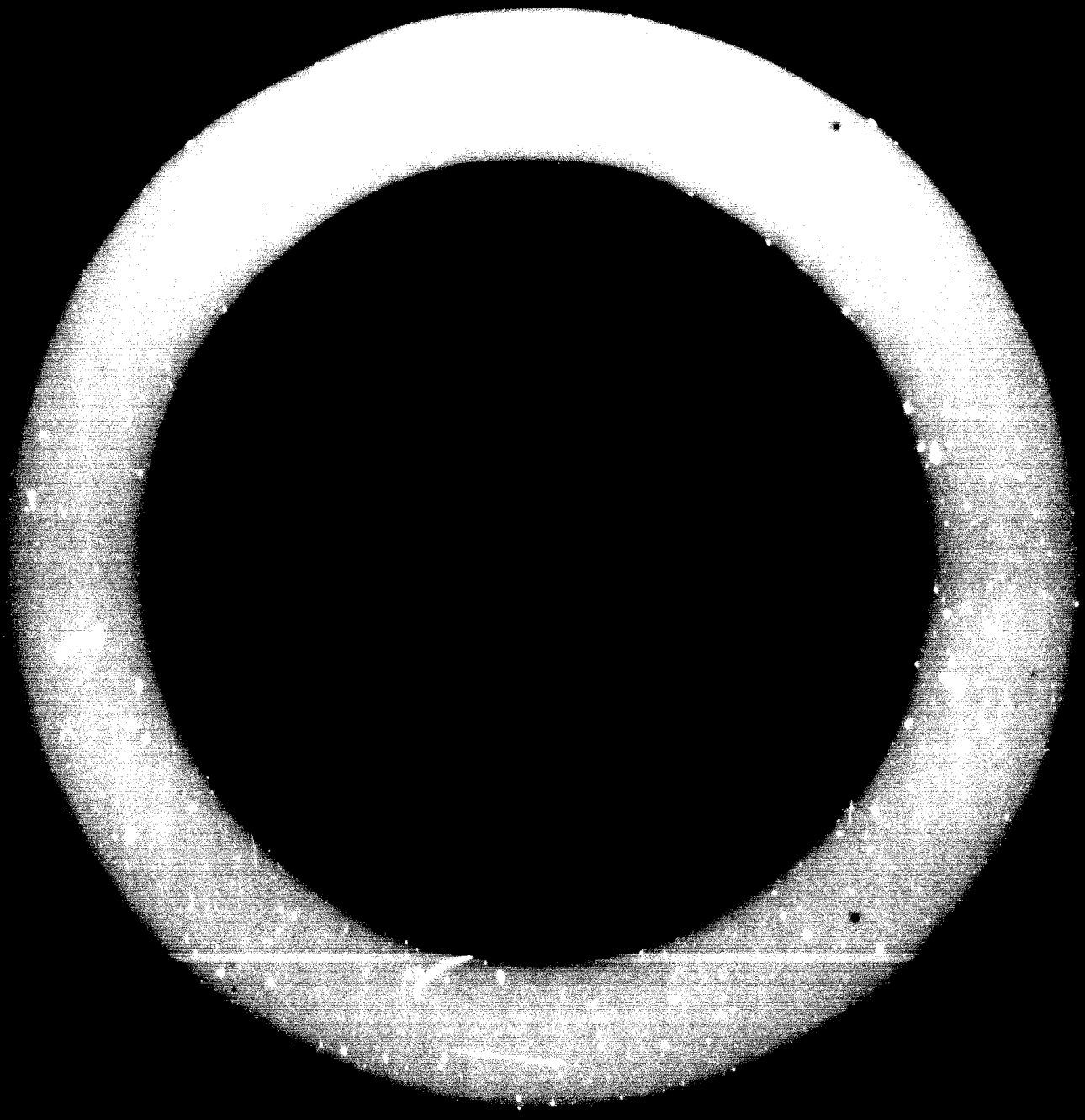
REPORT ON THE MACHINE TOOL INDUSTRY IN CHILE 1/

by

E.M. Miralles
Deputy Manager

Machine Tool Project CORFO
Santiago, Chile

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. This document has been translated from an unofficially edited text.



I. POLICY AND GENERAL ASPECTS

Background

Everyone knows the importance for a country's industrial, technological and social development of the manufacture of capital goods and specifically of machine tools. Indeed, the machine tool sector, which we are concerned with here, is one of the indicators used to measure the level of development in any type of economy.

There can be no doubt that this sector provides training opportunities both at professional levels and for skilled workers. Furthermore, it necessitates the development of an entire manufacturing infrastructure - casting, forging, electrical equipment and parts, etc. - besides permitting the development of sub-contracting arrangements with minor industries, including some in sectors that are scarcely more than artisanal.

Broadly speaking, it can be said all countries, especially the developing ones, seek to develop their machine tool sector in one way or another.

1. Policy and general background

1.1. Situation of the machine tool sector in Chile

An analysis of the situation with regard to the machine tool sector in Chile reveals a somewhat bleak picture, which has been brought about by the absence of any clearly defined development policy for the manufacture of capital goods.

This is probably due to the fact that Chile, as a country with an economy still in the early stages of expansion, has looked, both for its social and its technological development, almost exclusively to its basic resources - copper, iron, saltpetre, etc. These are sectors whose various stages, from extraction to refining, require large investments, and whose development entailed a high degree of economic and technological dependence.

A large part of Chile's internal resources had to be expended on such basic infrastructural works as roads, electrification, irrigation dams, harbour works etc. - all of which, in a country with a geographical conformation as irregular as Chile's, entailed major investments and meant that the development of products involving medium-level and advanced technology had to take second place in the order of national priorities.

The whole approach to development was essentially [illegible] external credits, with the well-known selection of importing plants on a "turnkey" basis - i.e., for financial reasons, installations were imported which included not only the basic items of engineering but also a considerable quantity of components for the manufacture of which could easily have provided more work for local industries, thus enabling them to develop their technology, equip themselves and indeed evolve an equipment policy relying on basic machine tools, which would have allowed the manufacture of capital goods to be gradually improved.

It is hardly necessary to say that this situation is far from satisfactory from the point of view of the machine tool sector which, because of its highly technical character, needs a very clear development policy if it is to be able to make the necessary investments in terms both of material resources and of manpower training.

It could be said that the machine tool sector in Chile has only begun to take shape in the last eight years, i.e. with the appearance with the automotive industry, which brought with it a demand for such basic concepts of every phase of industrialization as the training of qualified manpower, quality control, sub-contracting etc. We must, however, recognize that in order to develop the machine tool sector it is essential to have a whole industrial infrastructure ranging from an adequate foundation to a market eager for machine tools.

1.2. Existing stock and planning to meet the demands of the metallurgical and other industries

For the reasons already indicated, Chile's stock of machine tools is extremely varied as regards both age and character. For this reason it is by no means easy to justify the figures reflected in the attached annex.

1.3. Demand, production, import and export

It is unlikely that the demand reflected in the attached annex can be covered by national production, which will have to be essentially oriented to the manufacture of basic products such as drills, shapers, lathes and certain metal-shaping machine tools, since these are what might be termed the basic items of equipment that will pave the way to eventual mastery of the various technological disciplines involved in other machine tools, such as millers, grinders, etc.

For the same reason, it is logical to suppose that, [illegible] Chile pursues a coherent policy for the development of machine tools during the period 1970/1980 which will go a long way towards replacing imports, it will still undoubtedly be necessary to continue importing large quantities of more sophisticated machine tools from more highly developed countries. It therefore seems illusory to persist in regarding machine tools as constituting a Chilean export item. Nevertheless, it may well be that, to some extent and for reasons connected with production scales, Chile may have a certain surplus for export around 1980 of simple machine tools such as drills, lathes and eccentric presses.

1.4. Selection by type based on the evolution of lines of production

In a country such as Chile, with an economy relying mainly - as we have said - on its basic products, i.e. the mining sector, it is reasonable to suppose that the domestic machine tool industry should be oriented towards the manufacture of basic machines (drills, lathes, millers, planes) for small and medium-sized works principally engaged in providing services, i.e. making and repairing parts, components and spares, for the mining sector.

Logically, to fit in with the policy of developing the manufacture of capital goods in Chile, imports of machine tools will be designed to cover the demand for sophisticated equipment needed in the more mass-production-oriented industries such as the automotive sector. Equally, for the manufacture of capital goods in which production scales are lower but the components to be manufactured are of a certain size and complexity, the basic production equipment will have to be imported.

1.5. Machine tools that should be produced and machine tools that should be imported

In accordance with what has been said above, it would seem reasonable to lay down criteria for determining what machine tools which should be produced in Chile in the period 1970/1980. A preliminary list might read roughly as follows:

(a) Drills. As this is a type of machine tool that does not require a very high degree of technological sophistication, Chile should produce table- or bench-mounted drills with a boring capacity of up to 20 mm in steel; it is probable that the various industries now developing in Chile will oblige manufacturers of this type of machine to produce drills with automatic and semi-automatic threading devices and drills in batteries.

Chile is already producing radial drills with [illegible] of [illegible] mm in steel; here, too, there are grounds for thinking that it will be possible for this type of manufacture to be extended to machines of larger capacity.

As regards radial drills, it would seem appropriate to begin developing their manufacture after 1975.

(b) Lathes. Chile currently produces lathes of normal quality and specifications, which are mainly used in industrial schools and in the small-industry and artisanal sectors. The capacity of these machines as regards swing over the bed does not exceed 280 mm, with a maximum distance between points of 1,500 mm and an estimated weight of 1,000 kgs.

As the lathe is one of the basic machine tools, Chile will start to manufacture medium-duty lathes with swings over the bed of 500 and 700 mm, length between centres from 1 to 3 metres, weight in basic machine (500 x 1,000) of the order of 2,400 kgs and capacities of 7.5 to 15 HP.

(c) Milling machines. Up to now, the manufacture of milling machines in Chile has been extremely sporadic and mainly intended for teaching purposes. Development of this type of machine is programmed for 1975.

(d) Other machine tools. Chile is already producing other types of machine tools, in which we may include woodworking and other machines which, although to some extent still at the level of small and medium-scale industry - as in the case of eccentric presses, folding machines and guillotine cutters - constitute a sector which should continue to be encouraged so as to ensure a gradual growth sufficient to meet the needs of small and medium-scale industry.

From what has been said above it will be clear what machine tools will have to continue to be imported.

1.6. Ancillary industries

As already indicated, the situation with regard to ancillary industries is far from satisfactory. As an example, we could take the case of castings, a sector in which owing to the lack of a clearly-defined policy which we have already mentioned, we currently find a large number of foundries that are ill-equipped both materially and from the point of view of manpower. There can be no doubt that the only way to

reform this sector - which is of basic importance for the manufacture of capital goods in general - is to think in terms of its complete restructuring in order that basic problems such as those of the fundamental inputs - especially rock, pig and scrap iron - may be studied and solved, and of the merging of certain companies so as to ensure better utilization of their production installations and improved quality control, and enable them to operate at a level, in terms of tonnage, that will permit them to continue to develop under rational conditions. The same phenomenon exists - perhaps in a more acute form - in Chile's forges, which are at present basically geared to the railway and to some extent the automotive sector. As regards bearings, electrical components and tools, there is the same regrettable lack of a basic infrastructure; it is reasonable to suppose that the development in Chile of the automotive, machine tool and other capital goods industries will permit rapid and rational growth in the ancillary industries. Furthermore, the full potential significance of the development of machine tools in Chile is not to be measured solely in terms of classical economic patterns, but by the collateral effects which it produces, especially in relation to the ancillary industries or in other words to the basic infrastructure which is being created as a consequence of the technological requirements of the machine tool.

1.7. State policy with regard to machine tools

There is no doubt that Chile is approaching a period in which it will be necessary for it to step up its manufacture of capital goods considerably, and it is therefore reasonable to suppose that the machine tool industry should be one of the sectors to benefit.

For the reasons we have given, and because this is a sector that requires very large investments both in equipment and in manpower training - a type of expenditure that shows little immediate return - the necessary initiative in this field is being taken in Chile by Corfo (Corporación de Fomento de la Producción).

On the one hand, Corfo has been providing the private sector with equipment incentives and has established lines of credit for the marketing of machine tools produced in Chile. Furthermore, in close co-operation with the Central Bank, it has established a coherent policy for the protection of domestic manufacturers. Drawback-type incentives have been established to encourage exports, although here results have been disappointing, partly because of the quality of the articles produced but mainly because of the complicated problems of exchange mechanisms in the developing countries.

To sum up, it [illegible] machine tool sector in general, [illegible] National Machine Tool Factory, including the establishment of priorities, protection and reserve, the waiving of duty on equipment imported [illegible] manufacture of national interest, lines of credit for the marketing of products, assistance in exhibiting Chilean products at international fairs, technical assistance to small and medium-scale industries providing components for larger industries, etc.

2. External technical assistance for the development of the Chilean machine tool industry

Clearly a sector such as the machine tool industry, which involves practically the whole range of technological disciplines, cannot do without adequate external assistance, whether in the form of licensing and/or consultancy agreements or in that of association with foreign enterprises possessing greater experience in the sector.

Here as elsewhere, it is clearly desirable to strike a sensible balance, avoiding on the one hand a misguided nationalism that would allow such an important sector to stagnate, and on the other hand an excessive dependence on external help that could prove equally harmful.

That is why it is felt in the case of Chile that, while licensing and consultancy agreements and the establishment of mixed enterprises are all instruments that must be used, fairness to both sides requires reciprocity between what is sought and what is offered. Now, by looking around among its neighbours, any Latin American country can broaden its ideas on the basis of bilateral and multilateral assistance, both through individual contacts and exchanges of experience, through licensing and consultancy agreements, both technical and commercial, and also through the exchange either of finished articles or simply of components and parts.

There is no doubt that all this, besides encouraging human contacts, will tend to promote better utilization of installed capacity, inasmuch as the scale of production will no longer be governed solely by the size of the domestic market.

3. Co-operation and technical assistance required

3.1. Co-operation with foreign enterprises in the machine tool industry

In this respect, Chile has tended to adopt a fairly positive approach to the idea of collaboration with foreign enterprises. Moreover, studies are currently being made of the possibilities of licensing or the establishment of mixed enterprises on the basis of proposals submitted by foreign enterprises, or alternatively of licensing agreements with other countries.

These negotiations have encountered some delays [illegible], [illegible] was said [illegible], a bargain is to be fair to both sides, both sides must have a [illegible] knowledge of the subject of discussion. That is why, in the case of Chile, Corfo is studying the offers submitted while pressing on with the manufacture of machine tools and with the development and training of manpower that it entails.

Whatever result emerges from the study of these offers, there can be no doubt of Chile's abiding interest in arriving at some type of agreement that would enable its machine tool industry to incorporate technologically more sophisticated machine tools at an early date.

3.2. Details of technical assistance required from UNIDO

It would seem that the most useful contributions that UNIDO could make would be the promotion of contacts and exchanges of experience through specialists in the machine tool sector, the organization of machine-tool seminars at various levels and the collection and dissemination at the Latin American level of information on the development and needs of the machine tool sector. In other words, UNIDO has an important contribution to make through its ability to serve as a first-class medium of communication.

II. TECHNICAL ASPECTS

1. Problems related to the development and use of machine tools

1.1. Design and adaptation

While the urgent need to develop the machine tool industry is universally admitted, criteria have yet to be established in connexion with the actual use of machine tools, the type of design that would enable the existing infrastructure to be utilized and improved, and the adaptation of machine tools, both imported and home-produced, to the requirements of the various enterprises using this type of equipment.

The design of a lathe, for example, must be such that, while it can be used for conventional purposes, it can also be fitted with various accessories, e.g. copying devices, screw-cutting devices, etc., to enable it to be used for mass production purposes. All this constitutes a philosophy of design not all that dissimilar from the "modular" approach.

1.2. [illegible]

One [illegible] thing [illegible] production of prototypes, and this is [illegible] one of the most important [illegible] in any production process, since it makes it possible [illegible] capacity of the production facilities available, [illegible] possibilities [illegible] of the country and of the enterprise itself to train the necessary manpower, and the possibility of formulating a coherent policy for the [illegible] of the machine tool sector, either with conventional machines and the corresponding manufacturing tools, or, alternatively, with programmed machine tools.

It must, of course, be clearly realized that to serve its purpose a prototype must be precisely what its name implies -- in other words, it is not a marketable product that can help to offset part of the heavy investment made in it, but an amalgam of all the various elements (mechanical, technological, etc.) that the product must embody if it is to survive the criticisms, objections and comments that are to be expected when it is to be tested in an internal market. It is only if this is borne in mind that a prototype can be expected to shed genuine light on the problems of a new product.

1.3. Organization of production

Clearly the organization of production in an industry or enterprise devoted to the manufacture of machine tools requires special attention, since what is needed is not only an efficient organizational structure in which all the functions and basic principles to be found in any reasonably well-organized enterprise are provided for, but also adequate communication between the various sectors or groups of functions making up the production process; thus, for example, a machine tool manufacturing enterprise must, from the strictly technical point of view, have departments covering such basic functions as methods, design, operation, and production programming, all working in harmony with one another, without overlooking other functions that are important in any organization such as sales, technical [illegible], personnel, industrial relations, etc.

This seems perfectly [illegible] at the level of the individual enterprise, but it [illegible] projected [illegible] the proper co-ordination of enterprises engaged in [illegible] (In this [illegible] manufacture of machi

tools) and of their [illegible] [illegible], a coherent policy at national level regarding the [illegible] for the various industries in the sector, which [illegible] in the policies governing the import and export of capital [illegible].

1.4. Quality control and testing

This is one of the most important aspects, since it is not sufficient for machine tool manufacturers to claim, or aim, to apply certain norms - such as, for example, Schlesinger, Salmo or Din. Awareness of the importance of quality control must begin with the basic inputs, which must be completely standardized, and extend to subcontracts with ancillary industries.

This means, first, that the terminal industries - in this case machine-tool producing enterprises - must have adequate means of inspection, and, secondly, that those means must also be available to the ancillary industries that provide components and parts.

In this respect, it can be said that Chile has taken a considerable step forward with the establishment of various quality control laboratories, such as those of the Centro de Estudios Metalúrgicos (Cesmec), Servicio de Cooperación Técnica (SCT), Instituto de Investigaciones y Ensayos de Materiales (Idiem), Universidad Católica (UC), Universidad Técnica del Estado (UTE), etc. A valuable contribution is also made by Inditecnor with respect to standardization, and for that matter by the automotive sector which for the past seven or eight years has been extremely exacting in this respect.

There can, however, be no question of our being satisfied with things as they are, since the machine tool sector, not only through its own development but because of all the collateral effects which that development produces, obliges us to be more exacting and critical in this field.

1.5. Subcontracting and its fundamental causes

The lack of development in certain sectors that are traditionally exacting in their subcontracting requirements, such as the automotive and machine tool sectors, combined with a somewhat vague policy with regard to import substitution, led to attempts at re-equipment through import substitution [illegible] Chile [illegible]

thoroughly unsatisfactory. This, in conjunction with the existing cumulative sales tax policy, has resulted in the prevailing tendency towards vertical development that is to be found in almost all industries, and in a tendency for new projects to be conceived in terms of 100 per cent self-sufficiency from the outset. This naturally produces a deplorable situation as regards the utilization of both human and material resources.

1.6. Steps taken to secure effective utilization

There can be no doubt that the most effective method is the development of basic sectors, such as the machine tool and automotive sectors, which tend through their respective end industries to develop solely in terms of basic processes, leaving the manufacture of a large number of components to ancillary industries.

Another good way of encouraging the effective utilization of national production capacity is the creation of engineering enterprises, since the engineering industry will tend, here as everywhere, to satisfy the country's entire demand for capital goods through the use of existing installed capacity - workshops, foundries, electrical industry etc. This naturally presupposes the existence at State level of a clear policy with respect to imports and exports and to the development of the various sectors producing capital goods.

Clearly all these tasks will be made easier if adequate means are available for ensuring quality control and carrying out all the necessary research.

1.7. Rebuilding, maintenance and repairs

There has unfortunately been far too little development of machine tool rebuilding facilities in Chile, basically because there are no enterprises rationally geared to the manufacture of machine tools, and also because of the shortage at every level of personnel equipped to carry out more complex operations.

With regard to the maintenance and repair of machine tools the situation is just as bad if not worse, since the lack of any clear development policy in this sector and in the capital goods sector has prevented industry from becoming machine-tool mind

To see the truth of this we have only to look at the experience of more developed countries, in which properly trained machine tool specialists exist at every level - indeed one could almost say that the machine tool has become a cult.

1.6. Training of technical personnel

Although Chile has made considerable progress in this field through the work of the Instituto Nacional de Capacitación Profesional (INACAP), which has training centres throughout the country, and in that of the various industrial and technical schools, there can be no doubt that the development of the machine tool sector will make even more exacting demands and that it will be necessary to introduce courses specifically designed to train qualified personnel for this sector. The success of these efforts will obviously depend on the extent to which the training centres receive the support and co-operation of the machine tool manufacturing enterprises.

2. Factors to be taken into account in connexion with the introduction of numerically controlled machine tools to Chile.

2.1. Cost and economic viability of machine tools

One of the most critical aspects of any new designs today is undeniably the investment it requires in manufacturing tools, since, however well-designed these tools may be, they tend to inhibit any subsequent change of design, especially in countries with only small or medium-sized production series.

For this reason numerically controlled machine tools are becoming more necessary every day, even when they involve a completely new approach to the manufacturing process. While it is true that a numerically controlled machine tool cannot shift metals more rapidly than a conventional machine, it nevertheless reduces the positioning time required by each component, enables the expensive tools used in conventional machines to be dispensed with, practically eliminates the time lost between operations and leaves the manufacturer with far more freedom to introduce any changes of design that he may consider desirable.

To sum up, it could be said that while numerically controlled machine tools are substantially more expensive than conventional machine tools, the final results, even in the comparatively short term, are highly satisfactory for the reasons indicated.

2.2. Technical skills required for their operation

As already stated, the introduction of numerically controlled machine tools involves a completely new approach to manufacturing and must therefore be proceeded with cautiously. It would seem appropriate to begin with two-co-ordinate drilling machines, subsequently introducing boring machines incorporating, besides the co-ordinates of longitudinal and transversal tool displacement, tool rotation and bore and spindle positioning movements.

A [illegible]
digit[illegible]l control [illegible]
control.

In any case, the introduction [illegible] will [illegible] numerical [illegible]
accompanied by the [illegible] training [illegible],
operators, electronics [illegible] for [illegible] maintenance and repair of
controls, mechanics for the installation and maintenance of the machine itself -
in short, the training of [illegible] with [illegible] numerical
control.

SITUATION WITH REGARD TO MACHINE TOOLS

Machine tools*

Years	Number of machine tools produced	Number of machine tools imported	Number of machine tools exported	Stock of machine tools	Demand
1950	2,379	11,264	-	22,421	13,643
1970	2,520	23,436	-	48,477	25,956
1980	14,600	34,942	-	98,017	49,542
A. Milling machines					
1960	33	755	-	1,381	788
1970	40	1,652	-	2,573	1,692
1980	600	2,593	-	5,766	3,193
B. Drilling machines					
1960	520	2,339	-	4,989	2,859
1970	940	4,771	-	10,700	5,711
1980	1,800	8,311	-	20,811	10,111
C. Lathes					
1960	990	1,829	-	4,445	2,779
1970	900	2,850	-	7,795	3,350
1980	5,000	905	-	13,700	5,905
D. Grinding machines					
1960	-	1,001	-	1,615	1,001
1970	-	1,994	-	3,609	1,994
1980	90	3,462	-	7,121	3,512
E. Presses					
1960	430	3,254	-	5,439	3,684
1970	790	5,543	-	12,872	7,433
1980	3,150	10,154	-	25,176	13,304
F. Miscellaneous					
1960	446	2,086	-	4,552	2,532
1970	850	5,526	-	10,928	6,376
1980	4,000	9,517	-	24,445	13,517

* The term 'machine tools' comprises metal cutters and shapers, machines for electrical or chemical processes, machines for welding and other related machines.

12.7.74